ISEA2020

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WHY SENTIENCE?

26th International Symposium on Electronic Art

ISEA2020

PROCEEDINGS

OCTOBER 13–18, 2020
ONLINE FROM MONTREAL, CANADA

AN EVENT BY PRINTEMPS NUMÉRIQUE

26th International Symposium on Electronic Art
ISEA2020

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On behalf of Printemps numérique (Montreal Digital Spring), our partner institutions, and the organizing committee, we are proud to present the ISEA2020 Online: Why Sentience? proceedings. The 26th International Symposium on Electronic Art is the first ISEA edition to be held entirely online and will take place in tandem with the second edition of MTL connect: Digital Week (Printemps numérique's own online symposium), and will act as the latter's creativity pavilion.

We are living in unprecedented times—the global COVID-19 pandemic, with its ensuing social distancing measures, economic shutdowns, sanitary rules and travel restrictions—and as a result the planning for the symposium was swiftly reconfigured to produce what we consider to be its most innovative iteration. The International Symposium on Electronic Art belongs in the digital space, where it can be accessible to all regardless of zone or continent; it is not only suitable but inevitable that the event should move to an online platform, where participants and presenters will reconsider in a myriad of imaginative and surprising ways the conduits of creative information dissemination and exchange.

The online event will consist of four full days of 12 hours of presentations on three different live streams: 108 full papers, 96 short papers, 24 panels and 18 posters, selected from nearly 1000 submissions from 58 countries. Our rich and interdisciplinary programme continues on the weekend with instructive workshops. In addition to this, ISEA will be hosting an entirely virtual series of exhibitions, based on the following themes and their correlation with the symposium's throughline, Why Sentience? : Animality, The Ecosophic World, Politics of Sentience, Matter's Mattering, The Planetary, Machinic Sense & Sensibility, and Sentient Difference. Happening in tandem with the online offerings, ISEA will be physically present in its host city, Montreal, with in-situ exhibitions and performances at Les maisons de la culture Claude-Léveillée, Janine-Sutto, and Côte-des-Neiges. This hybrid programming represents an exact reflection of our current societal modus operandi : full online connection, limited physical presence, for the optimal reach and impact in our local communities and those at large.

An extraordinary effort and help is required in organizing an International Symposium such as ISEA, especially during a global pandemic. Printemps numérique would like to thank Erandy Vergara, for her extraordinary ability and leadership to guide the team and work together with the Academic and Artistic Chairs and Committees, specially her behind-the scenes work managing the content and form of ISEA2020 Online. We also would like to thank the academic chairs Christine Ros and Chris Salter, whose insight and vision regarding the 26th edition's theme, Why Sentience, were both essential and without comparison, as well as Manuelle Freire, who all together curated the impressive academic programme and talks. Thank you the artistic co-chairs Erandy Vergara, Alice Jim and Caroline Andrieux for their rigorous yet open spirit in making the final selection of ISEA2020's Juried Selection. A deeply appreciative thank you to the ISEA2020 International Program Committee (IPC) and Artistic Jury. Thank you to the ISEA team for their invaluable work, patience, and endless hours devoted to finding solutions for unprecedented challenges, and for their

on-the-spot creativity and flexibility when it was crucial to getting the job done: Pauline Barthe, Maximilien Briat Martin, Sylvaine Chassay, Stephanie Creaghan, Margaux Davoine, Pascal Dufaux, Iriana Rakotobe, Marine Villedieu.

We would also like to thank the supporting institutions and various partners, without whom the symposium would not be possible: the Gouvernement du Québec (Ministère de la Culture et des communications and the Fonds d'initiative et de rayonnement de la métropole), the Conseil des arts et des lettres du Québec, Ville de Montréal, Tourisme Montréal, le Conseil des arts du Canada, le Conseil des arts de Montréal, Patrimoine Canadien, NAD (École des arts numériques, de l'animation et du design), Concordia University, Synthèse, Destination centre-ville, Reflector, ISEA International, the University of Brighton, Maison de la culture Claude-Léveillée, Maison de la culture Janine Sutto, Maison de la culture de Côte-des-Neiges, Maison du développement durable, Sensorium: Centre for Digital Art and Technology (York University) le Consulat de France, OFQJ France (Office franco-québécois pour la jeunesse), Goethe-Institut Montreal, Sporobole, New Media Gallery, Manifestations Festival, Scopitone Festival, Composite, Milieux Institute, ELEKTRA, Centre PHI, Espace art actuel, Ciel variable and Esse.

Lastly, ISEA2020 would like to thank all our participants, artists and scholars who applied to the symposium back in December of 2019 for your willingness to continue to work with us and evolve with us as we transitioned to the new online format. Your understanding and capacity to adapt are what made the symposium the success that it is. Your generous and insightful reflections on sentience proved more relevant than ever in the face of the pandemic, and we are eternally grateful for your contribution, participation, and adaptability.

Mehdi Benboubakeur

EXECUTIVE DIRECTOR, PRINTEMPS NUMÉRIQUE
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In late August 2019, when the ISEA 2020 academic committee began discussing the theme of "Why Sentience"? little did we know how prescient the topic would become. With the initial themes tossed around – "animality," "the politics of sentience," "sentient difference" and "matter's mattering" - we were trying to capture the significance of a broader symbiotic turn taking place in the technoscientific arts, humanities and social sciences – the term that the late biologist Lynn Margulis used to describe "the living together in physical contact of organisms of different species." [1] Living together, however, involves sensing together – where the etymology of the Latin word sentientem signifies being "capable of feeling," not only for ourselves but also for others. But we weren't wholly satisfied with the theme of "sentience" alone – we sought to turn it into a question to demonstrate that living together as different species is not easy, especially among entities and things we wouldn't necessarily consider "like us": nonhuman animals, plants, bacteria but also machines and the Earth itself. By making sentience into the question of "why sentience," we thus hoped to provoke a debate around two core issues: (1) why is sentience something that presently occupies many artists, scholars and scientists and, (2) what degree and nuance of difference would a deeper exploration of sentience imply?

This was in August 2019. One year later, we are living through a triple catastrophe: the novel coronavirus, the resulting economic collapse and the worldwide unrest brought upon by the exposure and explosion of systematic racism, as well as gender-based violence. These crises have resulted in a major transformation of human and nonhuman life, bringing the theme of ISEA 2020 into a new perspective. It is not that the virus - an invisible entity that some 25% of US citizens (as well as others) think has been invented and planned by a worldwide conspiracy but that has visibly wreaked havoc across the world - is unprecedented. From the Black Death that eliminated at least 60% of Europe's population between 1346-1353 and the 40-100 million lost during the Spanish Flu, to 2003's SARS epidemic, we as humans have long had to live with the otherness of the bacterial and the viral. As historian Mike Davis wrote with uncanny foresight in 2005 in The Monster at our Door , "Human-induced environmental shocks—overseas tourism, wetland destruction, a corporate 'Livestock Revolution', and Third World urbanization with the attendant growth of megaslums—are responsible for turning influenza's extraordinary Darwinian mutability into one of the most dangerous biological forces on our besieged planet." [2] What, however, is unprecedented is the planetary scale and speed of this entanglement of contemporary conditions in which socio-technical-political-economic systems are so deeply and fundamentally intertwined with and influencing each other.

But what does this global crisis we are all living through have to do with the theme of Why Sentience? First, the "pandemic condition" has demonstrated that viral, machinic and terrestrial forces are indeed symbiotic. For example, a May 2020 Science article reported on a global "quieting" taking place as the amount of "anthropogenic" (human made) vibrations fell by almost 50% due to the effective shutdowns of the world economy. Utilizing a network of 268 seismographic sensors in 117 countries, geophysicists at Imperial College London could observe a literal "wave of silence" sweeping across the globe from China to Europe to Australia to North and South America as transport networks, football games, air traffic and effectively stopped. This near planetary reduction in noise catalyzed by the global shutdown and picked up by machine-automated sensors thus shows the close coupling of technical, natural and human worlds. Meanwhile, the media has also been filled with stories of renewal – the return of the natural world in the canals of Venice, the purifying of air in

normally pollution-choked global cities or the increase in birdsong, usually masked out by the sound of transport infrastructure.

At the same time, if sentience signifies "the ability to feel," the crisis has also revealed the inability to feel – to sense the plight of others. As Davis argues, "The essence of the avian flu threat … is that a mutant influenza of nightmarish virulence—evolved and now entrenched in ecological niches recently created by global agro-capitalism—is searching for the new gene or two that will enable it to travel at pandemic velocity through a densely urbanized and mostly poor humanity." [3] The ingrained injustices of the colonial past and the repeated and acute amplification of these through our pandemic present thus compel us to address the hard questions asked by the Cameroonian philosopher Achille Mbembe concerning what he calls "the ordeal of the world" – "Can the Other, in light of all that is happening, still be regarded as my fellow creature? When the extremes are broached, as is the case for us here and now, precisely what does my and the other's humanity consist in? The Other's burden having become too overwhelming, would it not be better for my life to stop being linked to its presence, as much as its to mine? Why must I, despite all opposition, nonetheless look after the other, stand as close as possible to his life if, in return, his only aim is my ruin?" [4]

These questions are not the usual bill of fare for ISEA, which has long been focused on the relationship between technology and the arts. Indeed, in these proceedings you will find this focus again – along with perhaps something new: critical positions in race and anti-racism studies, queer studies and disability studies, Indigenous knowledge, eco-criticism, reflections and interrogations of the histories and geographies, places and non-places, temporalities, processes, and residual colonialisms of sentience through an international cross section of current explorations in the media arts and technological aesthetics. As philosopher Bernard Stiegler (1952-2020), the great pharmacologist of technology who recently left us, argued: now is perhaps the time to think as a form of healing.

Like most cultural events in 2020, ISEA 2020 is thus both a response to crisis and an experience with a not yet realized imaginary. Experience here is used in the French sense of the word: as both an experiment, an attempt and an experience . Through these contributions from scholars and creators from across the world, it is our hope that the question of why sentience – of not only sensing the world but also acting with it – can be a response to our more than uncertain future.

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NOTES

[1] Margulis, Lynn. The Symbiotic Planet: A New Look at Evolution. New York: Basic Books, 1988, 3.

[2] Mike Davis, The Monster at our Door: The Global Threat of Avian Flu. New York/London: New Books, 2005, 25.

[3] Davis, 26.

[4] Achille Mbembe, Necropolitics. Durham: Duke University Press, 2019, 2-3.

Animality

Animality treats of the non-human and beyond human senses, of expanded notions of aliveness, panpsychism and hylozoism in species other than the humans of ISEA2020. A few non-humans are accepted at ISEA2020, just not as presenters.

The Ecosophic World

The theme Ecosophic World proposes explorations of sentience understood within the entanglem ents of scientific, environmental, and multispecies ecologies, and their current crises. Case-studies of symbiotic and expanded ecosystems, both natural and human-made will be explored in 10 different sessions at ISEA2020.

Machinic Sense and Sensibility

Machinic Sense and Sensibility saw a great deal of proposals about the autonomy and agency, and even intentionality of robotic and digital creations. Presentations in this theme take on both the sentience of machines and sentience through machines.

Sentient Difference

Sentient Difference shines a light on ways of navigating the social, natural and materials worlds that go beyond or against normativity in regards to race, gender, queer and trans, and (dis)ability.

Matter's Mattering

Matter's Mattering brings forward the tangible, materials things of sentience: the bodies, circuits, infrastructures, matter, how they come to be and the place they take in modalities of engagement and sentience.

The Politics of Sentience

The Politics of Sentience was tackled by some of the most critical scholars who will present their takes on the post-truth, post-sense, sensorization, surveillance, racism, weaponization, control, inequality, re-bordering, capitalism, neo-liberalism, other isms and the institutions of knowledge creation and management of today.

The Planetary

The Planetary: few but worthwhile proposals rethink the global to reaffirm, through creation, the aesthetics of sharing in the global currents and streams of the natural elements, shared resources, beneath and above this planet's surface.

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FULL PAPERS

Sentience as The Antidote to Our Frenzied Mediated Selves

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Abstract

How did we become a species willing to poison the environment that sustains us? Perhaps, the answer lays in a long history of anthropocentric cultural narratives, that gradually drove many westerners towards sensory and somatic illiteracy, and deeply disrupted our relationship to sentience.

Sentience is a form of sensory awareness that is deeply embedded within our bodies. It simultaneously facilitates internal, social and spatial non-verbal communication; allowing awareness of one's self, others, and of natural sentient eco-systems. Born a sentient being that thinks, feels and senses through the body, westerners are acculturated to become rational beings that ignore their sentience.

This article explores some of the ecosophic dimensions of sentience. It retraces how anthropocentric culture, which developed at the intersection of multiple histories and forms of cultural colonization, has progressively remapped sensory perception with mediated simulations, and profoundly altered our perception of reality. In this process, we grew increasingly blind to the complex needs of our natural sentient environments.

As simulation and data supersede sentient reality, we are becoming disembodied frenzied selves, unaware of the toxicity we bring to our environment. Sentience seems to be the antidote to the internalized western techno-anthropocentric norms fabricated over millennia of sensory oppression.

Keywords

Sentience; Sensorium; Colonization of the senses; Sensory literacy; Anthropocentric culture; Indigenous self; Spatial communication; Rewilding; Universal Recycling.

Introduction

Sentience is a form of sensory awareness deeply embedded within our bodies. It is demarcated by our relationship to space, which plays a much more fundamental role in identity formation, and consciousness, than we tend to realize.

Psychologists consider human behaviors to be derived from coexisting patterns of interactions, between the individual and the environment. They make up a "dynamic field", in which the state of any part of the field depends on every other part. [1] Hence, our consciousness is formulated by interrelations, which are taking place within the body and within the spaces we inhabit. [2]

Sentience is the communication tool of these interconnections. It simultaneously facilitates internal, social and spatial non-verbal communication; allowing awareness of one's self, others, and our natural sentient eco-systems. It is the way to become aware of the environment that sustains us, and to gage our own influence on other sentient lifeforms.

Like breathing, sensing is an unconscious process. When we become aware of its power, we can use it to read the subtle "flow" of space, its invisible order. [3] The earth is a perfect example of this flow. It is always in flux: the wind, rain, and other elements continuously affecting it. The flow of space seems chaotic, as the order it contains can only be experienced and sensed. [4] This flow is called smooth space. It is the medium of "difference", a real system of differential relations that create actual spaces, times, and sensations. [5] Difference is the language of sensory experiences. It is tactile, haptic and sonorous.

As the pre-language experience of sensations, sentience can access "poetic space", the metaphysical quality of the world. [6] It is a deep form of embodied hearing that reaches beyond words, a type of "exposed hearing". [7] Western science is beginning to demonstrate something fundamental to indigenous sciences: we share this primordial form of hearing with all lifeforms and the cosmos. [8],[9]

Even though rarely rendered explicit, we communicate and learn considerably through our bodies. Non-verbal communication is predominant in human interactions. [10] A phenomenon that is not limited to humans. [11]

Consequently, it does not seem far fetch to consider sensory experience as the vocabulary of a universal sentient grammar. Not a grammar existing within the cognitive structures of thoughts. [12] Instead, an embodied pre-language mechanism necessary to feel and sense the world.

This sensing, the "bodily ways of gathering information", is profoundly involved with a society's epistemology, the development of its cultural identity, and its forms of being-in-the-world. [13] The way a culture defines sensorium is one of the most basic elements of making ourselves human. [14] Since understanding of this sensory apparatus is culturally constructed, societal biases can recalibrate our understanding of sentience in unique ways.

Regrettably, a long history of anthropocentric narratives has deeply disrupted western awareness of sentience. As anthropocentrism developed, westerners became increasingly somatic and sensory illiterate. Most urban humans no longer use their senses to be aware of smooth space. Instead, they use various technologies to read the terrain of data embedded in augmented spaces. As the natural world is increasingly understood through the lens of mediation and data, it has become incomprehensible to many.

Countless individuals, localities, cultures and countries do not abide by these ideals. Numerous cultures never stopped being cognisant of the importance of the senses. [15] Perhaps, by looking at sentience in older cultures, we can regain some insights on the importance of understanding ourselves and the environment in a non-anthropocentric way.

Sentience as Embodied Consciousness

First humans developed nomadic cultures rooted in their relationship to the natural world. Their survival in the wild depended on being in sync with the rhythms and cycles of nature's eco-systems. Their heightened senses allowed to read subtle changes in the air that could announce forthcoming weather, food or danger. Human consciousness emerged from both sentience, psychological processes and reason. [16]

In many parts of the world, humans are still deeply connected to this primordial mode of perception, a sensory way of being embedded within the land. [17] Hinduism is an example of such a culture. As one of the most ancient belief systems in the world, it echoes what first humans recognized: that we are part of a natural sentient ecosystem, and of a cosmic unity built on interrelations. [18] In Hinduism, the five elements - space, air, fire, water and earth - create a web of life that is shown forth in the structure and interconnectedness of both the cosmos and the human body.

Hinduism celebrates diversity and plurality. As a result, there are many different Hindu traditions, rituals, cultures, and practices. Nonetheless, they share a common notion of Brahman, the true reality of things. It is a sort of cosmic unity that is shapeless, genderless, and bodiless. Sentience is the only way to perceive Brahman, it cannot be described, only experienced. All of nature is part of Brahman, as such humans must be at peace and in balance with nature.

Many indigenous cultures still consider spirit to be embedded in the land. Deeply listening with the body is essential since: "*it is not people who are the best storytellers: the birds, the animals, the trees, the rocks, and the land, our mother, have the most important stories to tell us. These stories exist in place*". [19]

Today, Eco-centrism is a philosophy reviving sentience in western culture. Founded on the ancient idea of unity in diversity, it places intrinsic value on all living organisms and their natural environment, regardless of their perceived usefulness or importance to human beings. It celebrates and respects pluralism, diversity and differences between people and nature's eco-systems. Eco-centrism is emerging as a potential alternative to the Anthropocene culture that is driving us towards our own extinction.

Anthropocentric Colonialist Mono Culture

Anthropocentrism is recognized as the "dominant view" in the history of Western culture. [20] It has facilitated the progressive degradation of humans' relationship to the web of life. In its place, it introduced human social hierarchies and systems of control. Anthropocentrism is constructed on a pyramid of needs, with man at the top, superior to women, themselves superior to animals, and plants. In this hierarchy, self-interest is at the foundation of morality. [21] Thus, personal needs give the right to control or take advantage of those lower on the pyramid.

Anthropocentrism had a profound influence on our understanding of sentience. Born a sentient being that thinks, feels and senses through the body, we are acculturated to become a rational being that ignores his/her sentience.

There is much debate as to when Anthropocentrism started. Very likely, it initiated at different times, and in different places. Some consider the mid 20th century as its starting point, while others date it to the beginning of farming. [22] Others recognize anthropocentrism as profoundly grounded in western theology, often seen as the source of modern environmental problems. [23] Undeniably, in Europe, the catholic church perfected and imposed anthropocentrism through religious narratives interwoven in western visual culture, science and medicine. Nevertheless, anthropocentrism did not start with Christianity, it is the result of multiple histories and eras of colonization.

A Very Brief History of Oppression

Western history is littered with tales of conflicts between empires over territories. Nevertheless, when nature is considered sentient, it becomes evident that it was the first to be colonized through the gradual control of its space.

As humans moved into cities, they stopped sharing space with nature, instead, they began to control it. Over time, as social hierarchies emerged, space became a conduit for meta-narratives and part of power relationships. It became a system of discipline. [24]

In addition to farming, with these social hierarchies, the Anthropocene was beginning to take shape. The transition from foraging to states and empires precipitated new social and political environments. The states born out of the Neolithic revolution, such as those of Ancient Egypt and Mesopotamia, were theocracies, with heads of state playing dual roles of political and spiritual leaders. [25] Giving leaders the status of a god insured the stability of their social system. It also justified the control they exercised over the population.

The first recorded law system, the Babylonian Code of Hammurabi, reinforced these hierarchical power relationships. Embedded in law, was a culture of control and violence against slaves and women. [26] As Leanne Simpson explains regarding North American indigenous women who are working to preserve their culture: *"The violence against women and the violence occurring against Mother Earth are also directly connected. Haudenosaunee planting ceremonies acknowledge that the women are the seed –*

the connection between the Creator and Mother Earth." [27]

There is a strategic reason for this unending tradition of violence. Demonizing and oppressing women was an important step in stopping the transmission of local culture to the next generations. For colonial social hierarchies to take hold, local cultural norms, knowledge and traditions had to be invalidated, if not eliminated. These were usually transmitted by women, who did so by learning from each other, and passing on knowledge through experiences, from neighbor to neighbor, and mother to daughter. Ancient European healers and holder of the local culture were called "wise women" by the people, witches or charlatans by the authorities. [28] .

The middle ages' European inquisition served to execute wise women. Witch-hunts were forms of genocide designed to silence European indigenous knowledge. The church enslaved people by taking away their ability to live autonomous lives. Without access to local indigenous knowledge, people were obliged to increasingly depend on the church. Women were replaced with church trained doctors, promoters of anthropocentrism. [29] These doctors promoted an oppressive mono-culture of indifference. They did so by transmitting anthropocentric myths through their medical practices.

Myths as Apparatus of Control

Since the beginning of humanity, myths have had for mandate to help us reflect on and understand the present through the wisdom of our ancestors. Myths and spirituality are both important cultural narratives that provide answers to the meaning of existence.

The first humans most likely had individual spiritual experiences through time in nature. Their spiritual narratives probably reflected their connection to the environment and transmitted the importance of the body and space as tools of perception.

Human spirituality transformed into religion as humans adapted to new urban situations. Like spirituality, religion developed as a mean to lessen the fear of dying and understand the meaning of life, but it included new mandates related to social order and urban life.

The organized religion, that emerged 11000 years ago, brought new cultural narratives that stabilized new social orders. [30] Worldwide, religion became an apparatus of control, as virtually all ancient state societies and chiefdoms co-opted collective religious belief to bolster themselves. [31]

Political objectives began to reshape myths. The ancient Egyptians, the Greeks and later the Christians transformed myths, from ethical messages regarding fluid human existence into messages of territorialisation of time, space and behaviors. Over time, people began to forge their lives on the values of these mythical systems.

The infiltration of platonic control in western myths meant that stories began to teach us to mistrust our senses. Plato's Allegory of the Cave suggests that both the senses and visual representations create worlds of illusions. [32] Neither could show reality, no longer a reference to the natural world, but as another realm of "pure beauty and form" inaccessible to humans. Consequently, our embodied sentience lost its spiritual purpose and the rational for anesthetizing our senses was born.

Christianity pushed this sensory negation further by valuing reason and ostracizing women's carnal knowledge. [33] The story of Adam and Eve tells us that listening to women has dangerous consequences. It also asks us to feel ashamed for existing within the flesh and within nature, and to repudiate sensorial knowledge equated with savagery.

The negative connotations of the snake presented in the myth is a refutation of the cyclical nature of life. Commonly, in many non-western traditions, the serpent often represents immortal energy and consciousness engaged in the field of time, constantly throwing off death and being born again. [34] This immortality was also part of early European indigenous spirituality. The idea of universal recycling integrated death and eternity in the web of life and its cycles. Nothing ever died as it fuelled the birth of something else, everything was eternally part of the land. [35]

These universal recycling ideals were a blatant contradiction to church teachings. They left little room for fearing death, a necessity to make people abide by the rules of the dualistic moral code: the "colonialist good" versus the "evil other", as a determinant for living in an eternal paradise or hell.

Religious myths asked us to stop living in the moment, and to stop sensing the infinity of our localities. Instead, it requested us to freeze our "self" in sanitized, disembodied, delocalized and dualistic versions of ourselves. By accepting these myths, western culture embarked on a quiet journey of sensorial genocide. Our reason became a dominant voice of internalized fear, criticism, denial, and oppression of our sentient being.

As a person failed to meet the church's standards, shame and guilt grew, and the fear of being stigmatized created the need to hide elements of the self that are "faulty" or could be judged negatively. [36] Anthropocentrism shares with the church this approach: it oppresses people by making them feel shame and guilt.

Eventually, western church science and medicine coexisted with religion as some of the dominant transmitter of anthropocentric narratives. [37] Progressively encoded in all societal systems, anthropocentric coercion became increasingly internalized.

Sentience as Madness

Difference became considered a pathology. "Difference", both as Deleuze's flow of space and in its broader senses of all ideas, cultures and forms of beings, was abolished from social life. Difference was relegated to stereotypes of illness, madness and/or stigmatized as abnormalities to be feared and eliminated. Hence, embodied awareness became considered a form of madness. [38]

In its pursuit for control, it is the foundational knowledge of sentient life itself that European anthropo-

centric narratives almost destroyed. Sentience became associated with disease. The way water became despised typifies these destructive tendencies. According to Aboriginal women, water is not only essential to life, health and healing, it is life itself. Water is sentient and forms relationships, it can heal and is essential to both physical and spiritual life. [39] During the 15th century, European urbanization disregarded the importance of clean water. Water became so polluted that it brought illness to many cities. Europeans blamed water, instead of their own actions. Water then became feared and seen as an enemy, to be avoided at all cost. [40]

Western Science as Gatekeeper of Culture

By the seventeen century, somatic illiteracy became common to modern Western society, the contribution that the body makes to everyday experience going largely unacknowledged. When philosopher Margaret Cavendish articulated that, just like the mind, the eye, ear, nose, tongue and all the body had knowledge, main stream philosophers of the time ignored and dismissed her as mad. [41]

This was reinforced by Descartes' famous sentence: "I think therefore I am". Additionally, Descartes' scientific method provided European culture with a process by which to control the flow of knowledge. This made it possible to formally validate, or reject, certain forms of narratives.

The age of enlightenment dimmed sentience. Ever since Descartes, western society has been plunged in a "Cartesian anxiety". [42] An examination of the world as separate from ourselves. This fear has contributed to our becoming disciplined version of ourselves, learning to self-censor our senses and to fear difference which could bring about loss of control.

We became increasingly dissociated from our body. Western science passed off this pathological dissociation as completely normal and unavoidable. [43] Nevertheless, dissociation from our embodied sentience is a form of deep trauma.

Our traumatized western "self" went in a state of freeze response. As we lost the capacity to read body language, to sense and to feel empathy, we became unable to recognize, or react, to the signs of our own embodied oppression.

With modernity, social planners, politicians, and leaders of various industries came to believe that they could remodel and subsequently remake society according to scientific and rational principles. The uniqueness of the individual was negated in favor of statistical averages, humans became seen as abstractions, homogenous social units to be managed and manipulated. [44] This, and the emergence of mass media, set the stage for the existential and environmental crises we are now facing.

Mediated Sensory Anesthetic

Media played an important role in the colonization of our sentience. A process that began when the first humans began to mediate cultural transmission. Human-made symbolic representations of social rituals, that are ordered and disciplined, gradually replaced the experiences of an unpredictable, dynamic, natural and poetic space. [45]

This process began with some of the oldest recorded narratives, cave paintings. The flickering lights of fire would have animated the depiction on the walls. As memories of a previous time or a depiction of the dreamland, these narratives simulated another time and space. Through these experiences, first humans mentally travelled to virtual spaces. This simulation of reality began a process of remapping sentient earth into a terrain of delocalized symbols, which will eventually lead to the simplification of our relationship to the environment.

With urbanization and the loss of embodied personal relationships to the land, sensory information became increasingly described in a medium, instead of experienced. Visual and written culture became a dominant form of storytelling, increasingly carrying static representations of cultural and social meaning. [46]

Without orality, cultural myths stopped to evolve or adapt to their contexts. The environment began to be understood as timeless frozen images and virtual mental constructs. The spirit of the land was lost, religious things (such as a bible or a temple) became sacred instead. [47] Those who could control the recording of their stories, gained a place in history and began to reshape humans' understanding of reality.

The human worship of images of gods embedded in giant monuments, signaled this significant shift. Spirituality and meaning were no longer tied to embodied experiences of the land, they had become related to the worship of representations.

However, for Plato, images were misrepresentations of reality that needed to be controlled in order not to misguide the population. [48] The political manipulation of mediated message for social order became explicit.

As we know today, we learn about social systems through patterns of interpersonal nonverbal communication. [49] By increasingly focusing the mind on mediated narratives, we lost the capacity to consciously read the world through our sentience, and we became unaware of the oppression and social control embedded in non verbal forms of communication. As Desmond Tutu once said: "*When the missionaries came to Africa, they had the Bible and we had the land. They said, 'Let us pray.' We closed our eyes. When we opened them, we had the Bible and they had the land*". Colonialist strategies perfected the aesthetics of non verbal oppression, which became embedded in the body, affecting spatial, social and interpersonal relationships in intricate, yet, invisible ways.

By the 19th and 20th century, mass media had become another important apparatus of social control. As Western cities became societies of consumption and spectacles, media increasingly promoted "being" as "having" and eventually "appearing". [50] Individuals were progressively reduced to the role of performers. [51]

Space's social dimensions were compartmentalized. Public space became seen as a stage, individuals simulta-

neously being actors and audience. Only within private space, or one could argue only within the privacy of the mind, could individuals be themselves and get rid of their societal role. [52]

Mass media such as radio, and later television, became windows into other spaces. Through them, we created conceptual frame structures to understand society. [53] These structures function like mental pictures of what should be a "perfect" life.

The environment itself became a conceptual frame with no depth nor sentience. The environment was reduced to a thing for humans to re-shape, without any insights into the consequences these actions would have on its invisible eco-systems.

But smooth space isn't just a system of communication, it carries life itself. As anthropocentric approaches denaturalized life and nature, gradually mechanized and controlled them, westerners created increasingly toxic environments. [54] As demonstrated by 20th century buildings that made people sick, we forgot that humans are vulnerable to the invisible qualities of the space they inhabit.

Frenzied Mediated Selves

Contemporary western tools of perception have adapted to a human consciousness that exists in hybrid techno-natural spaces. We increasingly make sense of the world through mental processes that dance in these mediated spaces. We exist in a frenzy of online social performances and simulated realities, constantly moving from one network node to another. As our mobile devices reconfigure our modalities of perception, mediated narratives are increasingly mistaken for reality.

This flood of disembodied connections affects the development of the self in many ways. Our identity now includes mediated networked selves. [55] We accept that we share technological eco-systems with simulations and machines.

We have reached a time when the body is often seen as a mere container for information and code, which are more important than the material. [56] Mobile sensors, data sets and algorithms are essential to read the invisible data embedded in the technological eco-systems we now inhabit. Nonetheless, they reinforce our sensory anesthesia and cut off access to the embodied intelligence of our sentience.

This disembodied and delocalized life is useful to advance anthropocentric colonization to its next frontier: interstellar space. From a perspective where the body is only a vessel, a technology that can be replaced by another, a consciousness can travel to places like Mars, and colonize the universe by filling it with disembodied human consciousness. [57]

Nevertheless, while we can pretend to live in our minds, our mental health is intricately embedded in the vibrancy of our bodies and our environments. Moreover, individuals without sentience can become toxic, as their sensory anesthetic prevents them from appreciating the destructive impact of their way of life on others.

The extensive time spent in online spaces, has opened the door to dangerous toxic consequences. We are losing the ability to be mentally alone and present within our bodies. [58] As a result, alone time often translates into vicious cycles of hyper-focused thinking, which turn our minds into echo chambers, where ideas feedback upon themselves. The toxicity inherent to media frenzies can become our mental reality. When our anxieties and other negative thoughts and behaviors are blown out of proportion, we turn into frenzied selves. We fear embodied solitude, yet, it is the pathway to energize and restore our health, and to rediscover sentience.

Conclusion

We easily forget that if anthropocentric messages dominate our media landscapes, they are not reality, but ideological tools designed to keep us overwhelmed.

We can choose to believe the reductive anthropocentric narratives, which suggest humans must intervene, and take control of people and nature, reshaping it even further. We can continue to consume media that distribute gloom and doom stories and reinforce the shame and guilt complex inherent to Anthropocene oppression.

Or we can choose to participate in a new eco-centric narrative, which focuses on the power of the individual and nature to heal themselves. The "Recoverable Earth" narrative is a story of socio-ecological recovery and wellness, that promotes cultures of self-discovery, environmental recovery and restoration. [59]

Our challenge is not so much to seek ever more sophisticated technological solutions to existential and environmental problems, as it is to re-establish a moral, emotional, and perhaps spiritual, relationship with the biosphere: living with empathy and consciousness, with respect for the land, the plants, the animals, and people. [60]

Sentience seems to be the antidote to the internalized western anthropocentric norms fabricated over millennia of colonialist oppression. It accesses what some call our indigenous self. [61] This part of ourselves lives deep within our body, appearing when we enter natural spaces and leave behind urban spatial conventions. It is the part we need to rewild ourselves and nature.

Rewilding ourselves, by rediscovering our indigenous self, is not an act of cultural appropriation, but a deep personal journey into our own body and, when possible, ancestral knowledge, to revive the language and culture of sentience. This to recalibrate our urban frenzied mediated selves towards a more balanced and healthy techno-sentient understanding of ourselves, that has regained the empathy and emotions we need for a healthier and balanced coexistence with sentient earth.

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After The *Tunnel*: on shifting ontology and ethology of the emerging art-subject

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Abstract

During ISEA1995, the *Tunnel Under the Atlantic* presented an artwork that Maurice Benayoun conceived at the time as a manifesto supporting virtuality as a medium. 25 years later, we propose a new understanding of the work and its emergence along with a reconfiguration of the ontological status of contemporary media art. Rather than mere *object*, as defined by normalized code of representation, the artwork can now be characterized as a *subject* with operational sensitivities that allow complex reactive behaviors. Real-Time processing of information has played a major role in this mutation. Virtuality - understood as design of the potentialities of the work - sensors and other input devices keeping the work aware of the existence of its 'public' and environment seem to have converted the interactive artwork into a sentient entity, empowered with perceptive functionalities and new cognitive capacities: memory, artificial intelligence, and intentionality. This transductive process leading to the evolution of the original *art-object* into the *art-subject* announces an expansion of what is considered the artwork's milieu and potentiality. More recent works of Benayoun help us to envision the next steps in this evolution: opening the ontology of art further towards its subjective capacities and possible dynamic implications in society.

Keywords

Virtuality, Virtual Art, art-subject, Tunnel, EEG, transduction, individuation, blockchain

Introduction: The Tunnel

1995, ISEA Montreal. In the lobby of the Museum of Contemporary Art, visitors are digging. They are virtually digging the *Tunnel under the Atlantic*. [1] They are digging into culture, the past culture of France and Canada. 6000 km from Montreal, in the Pompidou Centre, Paris, another two meters in diameter-pipe is plugged in the ground, in the direction of Montreal. The visitors were digging in the opposite way. The Virtual Reality (VR) material to be dug was not the geological strata of the ground underneath the Atlantic Ocean. They were pictures, converted into blocks of virtual marble. When dug, they revealed veins that were actually fragments of the original image: paintings, maps, drawings, signs. If diggers could talk to each other from both sides of the Atlantic, they could see each other. It took five days before the first visual encounter. We could see the

Figure 1. *The Tunnel under the Atlantic*, M. Benayoun, sept 1995. Top: in the Contemporary Art Museum, Montreal, ISEA1995 Bottom: in the Pompidou Center, Paris (© Benayoun M.)

The first dialogue was not a message of the utmost importance transmitted from an emitter to a receiver. This was the time of the beginning of the "phatic era" [2], when the phatic dimension of communications was going to replace proper content. At the dawn of the Web, getting in touch, seeing each other, talking to each other was becoming the core of mediated communication. The history of social media will confirm later what the *Tunnel under the Atlantic* was offering: the experience of emotionally intense communication with no message other than its performativity. The work was drawing the public's attention to a significant social change derived from the specificity of the so-called communication highways (Figure 2). [3]

The *Tunnel* was a significant move in the field of VR applied to Art. Many witnesses identified a series of premières in the technological and aesthetic aspects of the project: the first intercontinental virtual environment, the first video in a shared VR, the first spatialized sound, generated music, real-time automatic mixing, virtual director producing a machinima, and first virtual librarian... Even though some of these claims can be debated, we may consider that something was pushed to its extreme boundaries.

All the work, in spite of its multiple layers, is a sentient entity. A new species that exists only in the realm of art. Most of the "organs" of the work responds to their ecosystem. Its relation to the public, the diggers, determines most of its behavior, as well as its appearance. Beyond only acknowledging the existence of the digger, the work interprets one's actions, one's interests, intentions, and motivation. Observing the digger's behavior, the *Tunnel* offers a responsive architecture with bespoke content. It builds another layer of meaning made possible by the "chance meeting" of an author's driven adaptive environment and its public: the visitor's experience triggers reactions from the artwork, and these reactions have been intentionally planned by the author. The work becomes the footprint of the visitor's experience). One can refer to this situation as a form of "dialogue" - not only the dialogue between two people, the artist and the spectator, but the equivalent of our relation to nature, our ecosystem. A complex evolving relation made of trial and errors, building a mutual understanding that allows the artist's intentions to become visible thanks to the visitor-behavioral questioning. Something with explicit intentions that feeds the audience sense-making.

At a time when VR was closer to simulation, the "visitor" of these worlds used to be like tourists discovering an uncharted territory with a specific culture. The *Tunnel* didn't want to offer a preconceived, prebuilt architecture. The architecture had to be the footprint of the "experience"; more specifically here the experience of meeting. Each segment of The *Tunnel* kept the shape resulting from the digging process, like the Jurassic mud preserving the trace of the late dinosaur. The path of the digger is converted into an architectural semantic space, at the same time construction and memory. Although the content waiting for revelation inside the marble-like blocks of images is structured around the digger's behavior.

The *Tunnel* integrates complex forms of agency based on user's behavior analysis and qualitative structured response. It uses an intrinsic and extrinsic knowledge to build a form of dialogue far from the usual pre-structured content offering. This is achieved through a piece of software created for the *Tunnel* called "le GADEVU," a cryptic reference to the Quebec expression: "C'est arrangé par le gars des vues" ("it has been arranged by the film maker in order to get a positive outcome") - the "guy" in charge of organizing the content in order to provide a more specific

Le Monde

VENDREDI 22 SEPTEMBRE 1995

Le creusement du tunnel sous l'Atlantique a commencé au Centre Pompidou

Maurice Benayoun propose une expérience exceptionnelle et ironique entre la France et le Canada

Une aventure unique attend les visiteurs du Centre Georges-Pompidou : participer au percement du tunnel sous... l'Atlantique. Virtuel bien sûr. Commande publique de la délégation des arts plastiques du ministère de la culture à l'artiste multimédia Maurice Benayoun, elle ouvre les portes d'une expérience extraordinaire à travers la matière, les sons et l'image, le tissu même des images.

LE TUNNEL SOUS L'ATLANTIQUE, événement de télévirtualité de Maurice Benayoun. Centre Georges-Pompidou, Grand Foyer. Tél. : 44-78-12-33. Jusqu'au 24 septembre.

Le premier coup de « pioche » a été donné mardi 19 septembre. A 18 heures à Paris, à midi à Montréal. Fin des travaux : cinq jours plus tard. Grâce au forage acharné de deux équipes, dont vous pouvez faire partie en vous rendant sur les lieux d'« embauche » (le Centre Pompidou à Paris, le Musée d'art contemporain à Montréal), l'Atlantique sera bientôt vaincu par un tunnel... virtuel.

Qu'est-ce qu'un tunnel ? C'est un trou. Une voie percée dans un obstacle sur un parcours. Et le tunnel sous l'Atlantique traverse vraiment une matière résistante qui s'interpose entre les deux bords de cet océan. Quelle est cette matière ? Il ne faut pas le révéler tout de suite, car là réside le coup de génie de Maurice Benayoun, le Lesseps de ce percement. Qu'appelle-t-on virtuel ? On appelle virtuel une réalité simulée par ordinateur qui garde certaines propriétés de la réalité. La possibilité, par exemple, d'évoluer différemment en fonction des actions diverses qui s'exercent sur elle, comme un être vivant réagit à son environnement. Qu'est-ce qu'un tunnel virtuel ? C'est un tunnel creusé par des ordinateurs dans un ordinateur.

Les promoteurs du tunnel sous la Manche ont dû simuler maintes fois son forage sur des petits écrans avant de lancer leurs béliers d'acier sous la terre. Le tunnel sous l'Atlantique, lui, est assez différent, puisqu'il n'a pas besoin, une fois simulé, d'être reproduit ailleurs. Une fois simulé, il existe. Pour creuser ce tunnel, Maurice Benayoun, artiste multimédia déjà remarqué pour ses installations « info-métaphysiques » (*Dieu est-il plat ?*; *Le Diable est-il courbe ?*), a bénéficié d'une commande publique de la délégation des arts plastiques du ministère de la culture. Il a créé un logiciel de forage capable de dévorer quelques kilomètres de « matière atlantique » par jour. Développé par les informaticiens David Nahon et Tristan Lorach, ce logiciel permet d'une part de creuser, d'autre part de coordonner la progression simultanée de deux actions dirigées l'une vers l'autre, enfin de visualiser ces progrès – rendus d'autant plus visibles que l'image du petit écran est projetée sur un grand écran.

Les volontaires qui attendent leur tour d'entrer dans le tunnel peuvent voir ainsi ce qui se passe dans les entrailles de l'Atlantide, quelle distance il reste encore de part et d'autre à dévorer. Deux personnes seulement à la fois, une en France, une au Canada, sont autorisées à prendre les commandes du percement. Le forceur s'installe devant une table sur laquelle se trouve un petit manche à balai qui lui permet de s'orienter. Devant lui, l'entrée du tunnel est matérialisée par le gigantesque orifice d'un boyau s'enfonçant dans le sol du musée. Tout ce qu'il entreprend à l'intérieur du tunnel, tout ce qu'il y découvre, s'affiche sur la peau de cet orifice. S'il veut aller très vite et tout droit, il ne voit pas grand-chose, ne trouve pas grand-chose à voir. S'il louvoie, le spectacle de la matière traversée peut devenir grandiose. Et tous ceux qui l'entourent en profitent comme lui.

UNE VRAIE CRÉATION

Parlons d'abord de ce qu'ils entendent. Le son joue en effet un rôle important dans cette aventure. Les deux forceurs, qui se voient par un système de téléconférence, peuvent s'interpeller, de part et d'autre de l'océan, du fond de leurs trous respectifs, et se poser des questions sur ce qu'ils aperçoivent.

Par ailleurs, une musique interactive, composée par l'Argentin Martin Matalon sur les ordinateurs de l'IRCAM, guide les progrès des forceurs l'un vers l'autre. « L'autre » est identifié par un thème distant (*Trompette Miles*), qui grandit au fur et à mesure de l'approche. Chaque coup de boutoir se traduit également par un son. Et toutes sortes de bruits musicalisés, spatialisés, manifestent la résistance de la matière pénétrée.

Si, comme acteur ou même comme spectateur, vous envisagez de participer au percement, ne lisez pas plus loin que la fin de ce paragraphe, et gardez-vous la surprise de découvrir vous-même cette matière. Interdisez à quiconque en revient de vous décrire ce qu'il a vu. Laissez-le seulement vous dire son impression d'avoir, pour une fois, participé à un événement virtuel d'une grande qualité, peut-être la première vraie création digne de ce nom en ce domaine, mettant en jeu participation du public et technologie sophistiquée au service d'une imagination renversante.

Il s'agit en effet d'entrer dans les images. Pas seulement dans ce qu'elles représentent, mais dans leur tissu même. S'y promener, y découvrir des canaux secrets, se lover dans leurs plis, se perdre dans leurs trames, les regarder palpiter de près, rebondir de l'une à l'autre comme sur une marelle courbe infinie. Cinq cents images appartenant au passé commun de la France et du Canada tissent une immense tapisserie de Bayeux numérique : des caravelles, des cariboux, des parchemins, des fortifications, Jacques Cartier, Champlain, des Indiens, des drapeaux, des batailles, des arbres, Trois-Rivières, etc. Cinq cents images tassées, emboîtées, épaisses, denses. Elles ne forment pas un couloir qu'il suffit de longer. Elles dorment, tels des minerais qu'il s'agit de dénicher – virtuellement – au fond d'un gisement.

C'est simple. Il fallait y penser ou plutôt cesser d'y penser et se mettre à le faire. *Benayoun tunnelum fecit.* Les autoroutes de la communication, cette métaphore inflationniste, passe-partout, sont enfin dotées d'un tunnel... ironique, et qui conduit quelque part.

Jean-Paul Fargier

Figure 2. Article in the French national newspaper: "The digging of Tunnel under the Atlantic just started in the Pompidou Center"

content to each *Tunnel*'s visitor. This neural-network approach would later evolve to become a more ambitious research project, the "eGonomy" maieutic engine: a technology to find the picture you look for without asking for it, and without even knowing that it exists. Maieutic here comes as a reference to Plato/Socrates' method that also refers to "Gnothi Seauton", "know thyself". [4]

The continuous transformation of the *Tunnel*, following the traces left by the previous diggers, reflects an ontogenetic process of the work whereby it comes into being. The art continuously evolves from the processual nature of its generative capacities. The generative capacities of the *Tunnel* derive from the sophistication of its real-time data processes and the intentional behaviors, by which it can be situated along a trajectory of processual paths in complex experiences in art and other symbolic fields - contingent with our technological evolution and advancing from real-time technologies. These contribute to some fundamental changes in the art, eventually leading to what we characterize as a significant art-ontological shift. What

evolves is not only the specific environment of the experience, shared between audience-participants in Montreal and Paris in 1995. The *Tunnel* also reveals an evolvement in art's ontological status in the world related to advancements in sensitivity.

With the *Tunnel* as an example, we wish to propose an ontological shift in art - one which we describe in a transductive perspective from the art-object to the art-subject. This shift, as we elaborate on its stages and implications for art in this paper, seems to be partially triggered by the introduction of sentience as the artwork feature. Today we may wonder, if the work starts feeling, it may start thinking. [5].

Considering the novelty and the apparent complexity of some key features of the *Tunnel*, we suggest the starting of a new taxonomy of media art practices. The real-time construction of the tunnel and the general virtualization of its continuous actualization lead us to reconceive the way we analyze and describe similar art endeavors. The transductive perspective, which we develop from the theory of Gilbert Simondon, spurs a way of thinking about technological art processually and contingently with its associated milieu, publics, and society. This approach rejects the art's imposing of form as well as its categorization by genre or technical specifications. It involves an alteration in how we think about art and how we understand its modes of existence and modes of implication in the world.

Real-Time, Virtuality, and the art-ontological shift

During the past decades, scholars have been trying to put words on the evolution that affected contemporary society in general and art practice in particular. The desire was to identify a linear process that would have funneled the apparently chaotic stream of art experiments and innovative artifacts in relation to media technologies. Historians have identified mutations going from figuration to abstraction, from static to dynamic, from reality to the virtual. Paul Milgram's linear model of the reality-virtual continuum [6], as well as others based on a continuity between the physical and the virtual, doesn't apply to the systemic mutations that involve a large range of parameters, even if some of them, like the digital, come at once with different masks.

This chapter tries to identify the major factors of the digital shift in art making. It may propose a new analytic understanding of contemporary art practices that goes beyond the specificity of related technologies.

Real-Time

We'll start with the notion of "real-time" and its avatars and the role real-time has played in the evolution of the arts from the 19th to the 21st Centuries, starting even before the actual use of the terms. Nobody used the expression "real-time" when performers in theaters and concert-rooms were producing a spectacle that the public could enjoy, immediately. In fact, the "live" performance is so close to the experience of real life that it doesn't challenge the question of Time. The observer just sees the similarity with real life. It is commonly admitted that the expression real-time (now often spelled "realtime") came from the computer simulation engineering field when the output is produced at the time the spectator can see it without noticeable delay.

Understanding the importance of live/real-time, the first question to wonder about could be: How the spectacle or the artwork is produced at the time it is experienced by the public? (Figure 3)

Process: If we list the processual paths that allow real-time experience, we can observe that the duality presentation/representation helps us to understand where the break in history happened. Live performance vs cinema. Physical presence of the actor vs recorded image.

Nature: we can categorize the transmission of visual information according to the different technologies employed: Natural (light waves through atmosphere), Optical (deviation of the light wave through reflective, diffractive or refractive device), Chemical (Cellulose acetate, silver salts), Electronic (analog electric signal), and Digital.

Signal: the signal is either continuous, sequential (cinema stills, 24/sec), linear (frame and fields of video signal), discrete (bits, digits, and pixels).

Recording: On the other hand, the mirror requires the physical presence while presenting an image. Cinema is recorded and is therefore not "real-time," but television was a real-time form of representation (in the 1930s) before being recorded at the end of the 1950s. Waiting for the electronic analog recording (Ampex), we used to shoot the TV screen or the video monitor with a film camera - usually 16mm.

This categorization reveals two facts: An attempt to find in the representation this very property of the physical world, which is its ability to be experienced through real-time perception of its phenomena. Representation (e.g. image, artificial sounds) converges with the presentation of the physical world in offering the visitor an immediate experience.

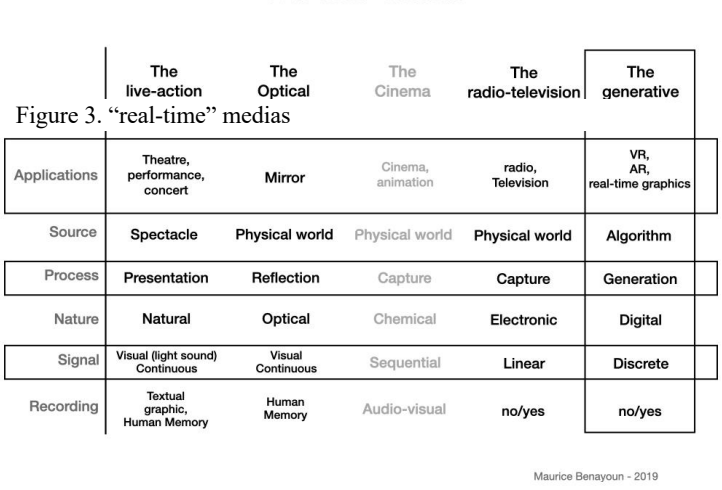


Figure 3. "real-time" medias

Real-time processing, which has become possible with digital production of the artwork, allows additional features like: generativity, interaction, virtuality, and immersion that were previously impossible in the realm of image production.

Virtuality

If the real-time treatment of signals had a strong impact on the evolution of information and communication, the one that could include all the others was to make possible the intrusion of *virtuality* in the realm of representation. With digital technology, along with how computers introduced new forms of interactivity in the realm of artmaking, virtuality became a component and sometimes medium of art.

Tunnel under the Atlantic is an artwork steeped in virtuality. Although it linked Paris and Montreal in a Virtual Reality experience, the *Tunnel* is however not an object of Virtual Art. It avoids any reductive categorization of 'Virtual Art' determined by categories or representations of technological instrumentalization. The artwork can rather be characterized by its generative and dialogical capacities that result from a collaboration between the intentionality of the artist and the intuitions and choices in the visitor's behavior. Rather than an image quality or space, the *Tunnel* explores virtuality as a process. Architecture, music, content, navigation, dialogue, database, narrative sequencing, were literally virtualized. They lost their status of pre-defined or predetermined components of the work to become an infinite combination of potentialities. Far from the concept of 'composition,' while, for example, observing a painting, the world resulting from the incidental design is thus the consequence of presence, action and reaction. The process takes over the result, providing unlimited variation on the author's intentions.

Far from trying to be "demonstrative", the *Tunnel* nevertheless demonstrates a processual notion of virtuality - not "virtuality" as abstract and external to the public experiencing it - but as consubstantial to the existence of the artwork. We can initially grasp this account of virtuality with reference to the French philosopher Henri Bergson (who is "re-actualized" in the work of Gilles Deleuze), writing in the late nineteenth and early twentieth centuries. For Bergson, the virtual realm is not an abstract, imaginary "third dimension." The virtual is a realm of reality that acts on the present and leads to actualization [7]. While the actual real relates to what has been historically actualized, what we know as the past, the virtual is made up of all those forces surrounding the present, which await actualization in the confluence of historical time. Like the endless possibilities of digging out the images converted into virtual blocks in the *Tunnel*, the virtual is something which *could* coalesce historically in the present moment in endless possible combinations, but which has not yet been actualized (or conceived as possible). Virtuality is a movement from which we emerge from our own duration, a term Bergson uses to describe a mode of being in the world in an active, processual manner. It is in the realm of the virtual that we invent what becomes actualized.

In the Bergsonian legacy, virtuality is a process, not a space. The understanding of virtuality in terms of a process, rather than a substance or representation surrounding you, can be elaborated further with Gilbert Simondon's conception of *transduction*. For Simondon, transduction concerns a rupture that reconfigures the structure of both the being and its milieu. [8] It is a process in which we evolve with potentialities of our environment, in which potentialities of our environment affect our state of becoming. It is about transformation rather than explanation, denoting both a structural change and an amplification process. It concerns a process, or an action, coming out of an energetic field related to communication and transmission. It announces an environment that is codependent with the individual - a heterogeneous composition in ongoing and highly complex processes of individuation with and within a milieu (and technological environment).

We see in the example of the *Tunnel* how individual perception participates in and constantly restructures the relation between the artwork and its milieu. The experience with the *Tunnel* is the outcome of a dialectical dialogue and negotiation between the audience's unpredictable subjectivity (i.e. "the diggers") - designed by nature and by culture, and the recently acquired perceptual sensitivities of the artwork - designed by the artist. The *Tunnel* therefore exists as an ontogenetic process whereby it comes into being with its environment and living beings within it. It behaves like a living artwork, facilitating multiple and ongoing processes of transformation within its own genesis and contingently with its associated milieu (society).

The sensory complex of the environment does not only contain elements of an external world but also elements of the artwork's public, which also feed into the process of individuation. The transductive process happens from individuations of human perceptual and affective components, psychic life, feelings, imagination, and memory, and human internal milieus such as perception, imagination, and memory. These perceptual capacities modulate relations between the perceivers (the art-"diggers") and their milieu, and between the artwork and the world. Processes of individuation of living things are sensorially and temporally variable. The domain of art structures itself through individuations, through the transductive transformation.

In the experience of the work of art, virtuality is not a category or a mode of representation but a behavioral dimension that triggers a capacity in the environment enacted in a collaboration between the artwork (the intention of the artist) and the artwork's public. In the experience of the *Tunnel*, as the artwork components are reduced at the level of infinite potentialities, the outcome becomes the footprint of the visitor's experience. Endowed with

awareness, the artwork acknowledges the presence and the singularity of its visitor. It responds to the behavioral perception of the public. It converts the situation into experience, and the work becomes responsive. Or, we could say that it perceives its public. As a transducer, it conveys expectations more than messages.

The Virtual Paradigm

If we follow and merge the literature on the subject, the impact of virtuality in art could be described as a set three different features: (Figure 4)

- *Potentiality* (not yet actualized),
- *Immateriality* (resulting of the digitization of the physical or from the modelisation of ideas),
- *interactivity* (real-time+virtuality make interaction with human and environment possible).

A fourth feature should be considered as an extension of the 19th century painted panorama, but affected by a significant move: the possibility to adapt the perspective in real-time according to the visitor displacements:

- *Immersion:* graded from exteriority of the public to full proprioceptive immersion, sensory-immersion.

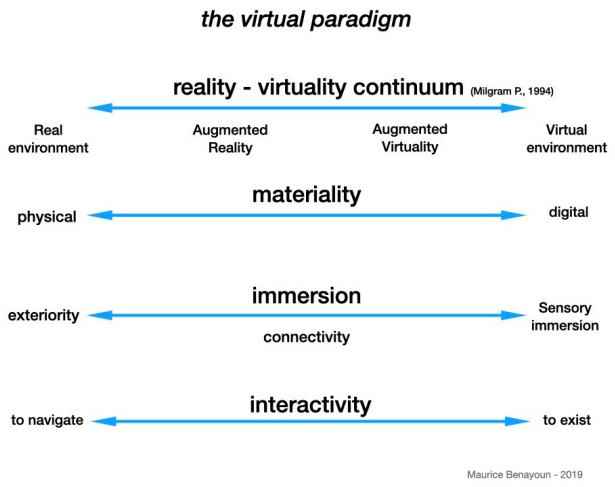


Figure 4. The virtual paradigm

Immersion. "To navigate in" or "to exist for"

With immersive forms of creation, the artwork develops primitive forms of perception of their public. The objective is to provide a visually/auditory responsive form of experience allowing immersion, being surrounded by the work, and being able to move in a predefined virtual environment. The interaction is limited to the tracking and observing of the visitor. This level of presence doesn't affect the representation, the virtual environment. The viewpoint and the perspective in VR are constantly and dynamically adjusted to the visitors' behaviors, but the architecture, colors, figurations and behaviors of living beings don't change. It can be a virtual ride, a virtual reality experience, a panoramic movie. As we'll see later, VR artworks like Jeffrey Shaw's *Legible City* in 1988 [9], or Char Davies' *Osmose* [10] in 1995, belong to this category.

Among early VR artworks are David Em's navigable virtual worlds in the 1970s, Jeffrey Shaw's *Legible City* [9] and *Virtual Museum* [11], and Char Davies' immersive and interactive VR environment installation *Osmose* (1995) realized as a space for exploring perceptual interplay between self and world, and navigated via one's breath and balance; and *Ephémère* following in 1998 [12]. Works like *Very Nervous System* by David Rokeby, in 1982-1991 [13], *Intersection* by Don Ritter in 1993 [14], *Interactive Plants Growing* and *e-Volve* by Laurent Mignonneau and Christa Sommerer [15], like the *Tunnel under the Atlantic* (1995) mentioned above, constitute but a few of the first attempts to capture inputs from the visitor in order to trigger a minimalistic or significant response from the work.

While *Osmose* was proposing a virtual visit of a pre-existing/pre-design environment, the physiological behavior of its visitors ("immersant" in Davies' terms) was taken into account not by having an impact on its environment but by moving the virtual camera according to the breathing, head rotation, and body tilting. The system was aware of the visitor's intentional navigation but the space to visit and its virtual life was not affected by the visitor's presence. This limited awareness of the system is extended during the last period of the experience, when the visitor navigates in the middle of the artwork code, executed according to the visitor's actions. At this stage, everything in the field of view is directly affected by the audience. [16]

Osmose makes an aesthetically stimulating and a quite literal example of a virtually immersive experience. At the same time, in the same venue, Montreal Museum of Contemporary Art, during ISEA1995, the *Tunnel under the Atlantic* proposed an environment aware of its public and directly affected by its presence and action. Architecture, sound, content, everything was the result of the digging and the meeting.

Even if the *Tunnel* was responsive and aware of its visitor, it was still a reactive piece of art limited to its exhibition space. The "digger" had to intentionally act inside the virtual substratum. The apparent complexity of the Tunnel's sensory-system would have led - if we compare to natural life - to a life-form similar to the one of the earthworm. Feeling its environment, avoiding the obstacle, absorbing food/information, repelling unused material that later becomes useful to other species. No apparent consciousness, no production of diversified content.

The Art Ontological Shift

How sentience brings life to the arts

The digital shift in 1995

The artwork sensory-motor system is no longer limited to capture the visitor position and action. Based on the property

of the living, the artwork can perceive and often combine multiple information of the audience and their environment. These data are analyzed, interpreted and used to determine the artwork behavior in response to the public intrusion. The behavior of the work becomes more complex but is still limited to their location and field of action. Artworks becoming sentient systems have been emerging at the time of information technologies. The *Cybernetic Tower* by Nicolas Schöffer [17], in the early 1960s, constitutes an excellent example of an artwork responding to Nature. Calder's Mobiles in the early 1930's could epitomize the unplugged version of the work. It is only later that the works started to react to people with the intention to institute a more complex cognitive relation.

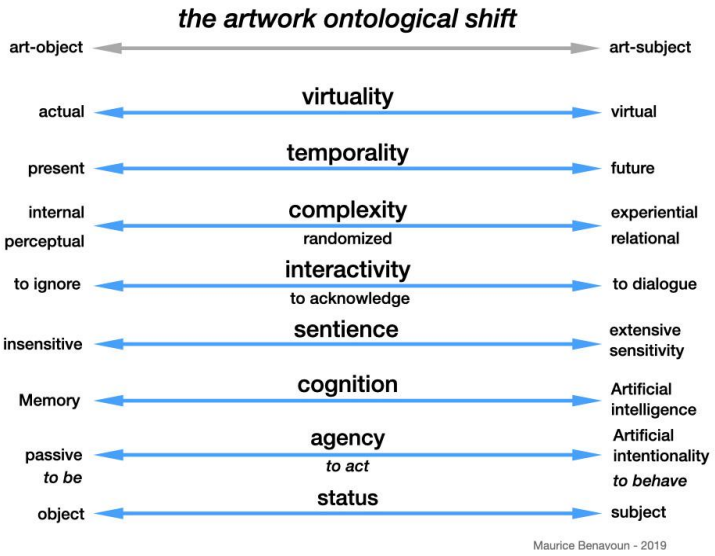


Figure 5. The artwork ontological shift.

What happens when the artist starts considering real-time and virtuality as effective mutations of the medium? (Figure 5)

Virtuality, the capacity of the work to have a future, not to be a frozen composition reaching completion when all elements are at the predetermined place in the masterpiece. The constant evolution of the sensible, resulting from the evolution of time, context and external inputs including visitors' behaviors is a dynamic form of actualization that becomes the outcome and the actualization of experience.

Temporality is now more than ever a dimension of space, allowing exploration, discoveries, serendipity and accident/incident.

The lack of ***complexity***, absent from the early computer-generated artworks, was often "simulated" by the basic application of randomized generation or distortion of the original material. Now complexity may come from the constant unpredictability of the visitor's behavior. The living is the more significant factor of complexity that preserves a high level of resonance for the user.

Figure 3. The artwork ontological shift.

The most primitive version of ***interactivity*** is the one we experience in navigating into panoramic videos limited to a basic control of the point of view, a vectoral freedom that we have when attached to a leash. The next step is when the virtual environment acknowledges our presence. We *exist* for the world we visit. Then, the state of the art of interaction is when the artwork is able to reach a level of intensity in terms of interaction close to dialogue. Dialogue is not about words. Benayoun used to say that the most intense forms of dialogue are to make love and to make war (Prix Ars Electronica awards ceremony, Sept. 1998).

The sentience singularity

Virtuality in a self-generative process allows the creation of an effect of diversity, and complexity, but it doesn't affect the visitor's experience beyond a potential retinal excitement. This may be explained by the fact that the spectator doesn't perceive the intelligence behind the screen.

Now, the artwork has become able to feel more than the mere intentional actions from the spectator with a mouse or a keyboard. It can perceive multiple events, feel sensations made of sound, light, image, smell, and even collect environmental and contextual data. When the French philosopher Condillac [18] in the 18th century defined *sensualism*, he suggested that just giving the sense of smell to a sculpture would activate a capacity of memory, and adding other senses would awake it's cognitive functions like consciousness and intelligence. Empowered with senses, perceiving its environment, the passive sculpture starts feeling and thinking.

Even though nowadays Condillac's speculations sound more than debatable, we can observe the evidence of the impact of sensory perception on the cognitive functions of 21st-century-artworks, dotting them with a semblance of consciousness and intelligence. When perception of external stimuli can be memorized, feeding an inner database, we have the matter to apply functionalities of what we call *machine learning* and ***artificial intelligence***. To perceive the environment is the best way to determine action. Agency becomes a property of the artwork that may passively accept inputs, act by reflex, or behave according to ***artificial intentionality***, empowering it with a potential behavior *by design*, corresponding to the artist's intention.

Toward the Art-Subject

It is now possible to understand how, beyond the technological performances, this evolution leads to an artwork that may change in real time and evolve according to internal and external inputs and perceptions. It has become able to virtually mutate and behave. This behavior is not the result of a randomized process simulating complexity. It has been designed by the author.

This artificial intentionality changes totally the ontology of the artwork. It is not any longer a static object expressing

the ultimate state of perfection, of talent, and craftsmanship expected until the end of the 19th Century to fulfill the definition of "masterpiece". It is closer to a living being, endowed with perception abilities, learning capacity, cognitive competencies, with intentional behavior. This doesn't define a natural living being that we would observe as an entomologist strutting a new insect species.

Artworks have become complex intelligent entities striving to talk to us. Art-objects have mutated into art-subjects.

And now, 25 years after the *Tunnel*

How the art-subject changed the art practice?

From the *Brain Factory* to *Value of Values*

20 years after the *Tunnel under the Atlantic*, together with artist/architect Dr. Tobias Klein, Benayoun started working on another level of sentience leading to an increased autonomy of the artwork. The *Brain Factory* [19] asks its public, converted into "Brain Workers", to give shape to "human abstractions". The interaction leaves a little space for intentionality. Equipped with an EEG (ElectroEncephalography) head band, the public reacts to a generated, evolving form displayed on a screen. (Figure 6)

Figure 6. Brain Factory, Benayoun, M., Klein, T., Brain Worker neuro-designing an abstraction. Microwave Festival, Hong Kong Dec 2018. © Benayoun

The Neuro-Design Station [20] (Brain2Shape) interprets the brainwaves coming from the Brain Worker as positive or negative reactions. Human abstractions are comparable to living beings evolving in the human mind. Reacting to the dynamic generated shapes, the Brain Worker acts like a *mental ecosystem* assessing the viability of a new species: tri-dimensional abstractions referring to a written concept. Dynamic shapes striving to represent FREEDOM, POWER, or SPACE, survive in the mental ecosystem by continuously evolving. The quality of dialogue between Human and Machine (BCI) is not a form of control (cyber) and the public is not invited to "design" - what would have required knowledge, skills, and craftsmanship. On the contrary, the brain worker is "assessing" the living form, like nature assesses new lifeforms. In the *Brain Factory*, the outcomes of the process are then reified [21], "thingified". The 3D-printed form becomes a physical artwork. We could consider that the assessment process is a form of dynamic curatorship.

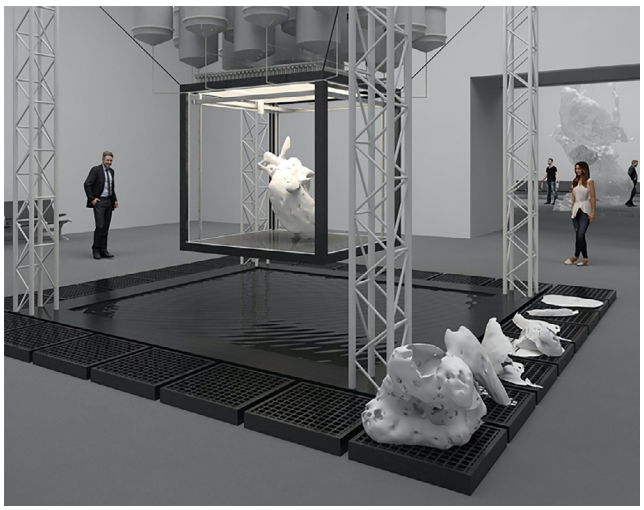


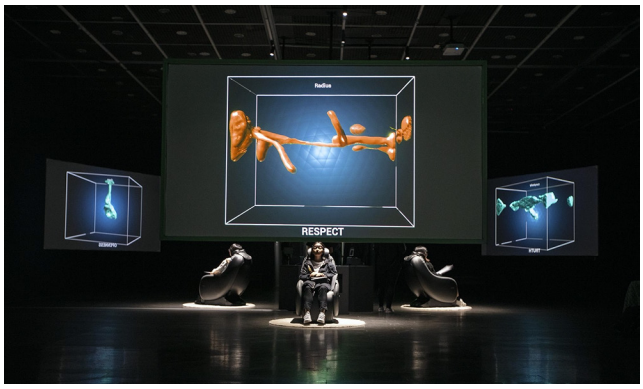
Figure 7. *The Big Reificator*, project from the *Brain Factory*, CGI representation of the reification process. picture © Tobias Klein

In 2019, thanks to the additional contribution of Dr. Nicolas Mendoza [22], the *Brain Factory* project was extended with the *Value of Values* project [23]. (Figure 8-9) Instead of giving shape to 'human abstractions', *Value of Values* focuses on 'Human Values'. Like human abstractions, human values reside in the human brain, their natural ecosystem. At the end of a similar neuro-design process, the Brain Worker takes away the 3D model, an abstraction that has become a token on the Blockchain: a

Figure 8. Value of Values, Benayoun, M., Mendoza, N., Klein, T., Brain Workers neuro-designing abstractions, and phone wallet. ISEA2019. Gwangju, Korea © Benayoun

VoV (for *Value of Values*). (Figure 7) Giving shape to ideas, the spectator-Brain Worker

becomes an "artist." By assessing the evolution of the shape according to a topic, s/he becomes a "curator." Getting the resulting artwork/token, s/he becomes a "collector". Brain workers can then trade their VoVs on the market, they



become "art dealers".

Bartering the human values like giving MONEY to get PEACE and LOVE becomes in real time *Transactional*

Poetry. Poetry is automatically generated out of the transaction. Something like "I gave all my MONEY to get PEACE and LOVE. Deal!". Then, finance makes sense. Generated *Transactional Poetry* is displayed in real-time on the project's website and on the exhibitions spaces. [24]

Monitoring the trading of values helps to understand the relative value of human values. Their ranking is different according to the people, the cities, the countries, and the continent. The artwork reflects on the human hierarchy of values for the individual and their communities. This may affect our perception of cultures and incites some people to leverage on their image or the image of their social group.

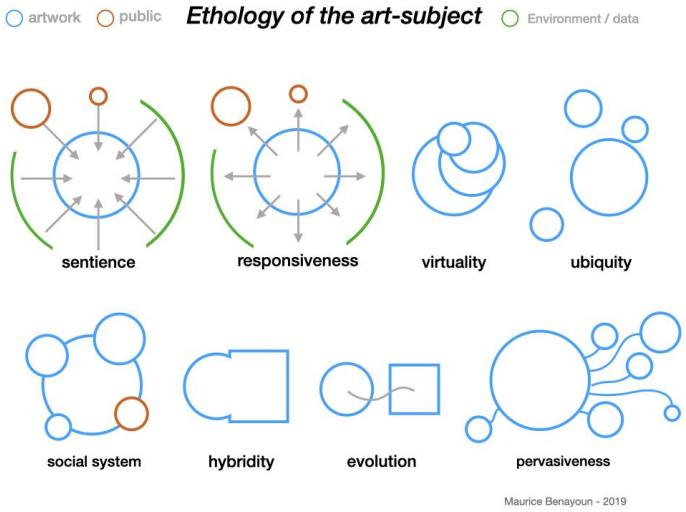
Figure 9. *Value of Values*, Benayoun, M., Mendoza, N., Klein, T., Brain Workers neuro-designing abstractions. Value of Values, Benayoun, M., Mendoza, N., Klein, T., Digital Art Festival, MoCA, Taipei, Taiwan © Benayoun

Ethology of the Art-Subject

The *Brain Factory* and *Value of Values* radically reflect the impact of these changes by introducing the living into the arte-fact: *the fact of the art*, a human-made entity with complex behaviors.

Adapting itself to the context, absorbing, treating and expressing the result of the metabolization of its environment, the *Tunnel* was at a primitive stage of the evolution toward the art-subject. It announced the coming of more advanced and empowered artworks. 25 years later, art live-forms have evolved from the original artwork as the "art-object" to the "art-subject" and with this evolvement become able to elaborate complex forms of interactions with its public. We call art-subject vs art-object the complex sentient system that makes an artwork a cognitive being able to act, react and communicate with its public.

Figure 10. Ethology of the art-subject.



The concept Figures above illustrate a move away from the status of the object and towards the capacity of the artwork as a complex machinery. The environment is composed by networks of humans and non-humans, spacings and distances, timings and temporal configurations, interweaving of closed contexts and widely distributed milieus, and imaginings related to deep-anchored and multi-leveled memories and projections of future events.

As the artwork's behavior has become artificially intelligent it processes information in a more autonomous manner, suggesting a level of complexity that, if not competing with human intelligence, makes the work look like a higher form of a living being. The system has been empowered and can now enter another level of dialogue with the public. All included in the process, the highly sentient artwork - that now integrates sound and physical biofeedback - has become an acceptable interlocutor for its audience: a real "subject".

We have seen how the "art-object" has become an "art-subject". If its autonomy doesn't make it an individual, meaning free from human control or human intentions, it is able to develop higher forms of induction, affecting the former spectator and the physical world around it. The art-subject cannot be represented, and it does not represent. It is never fixed but 'living.' The art-subject presents an open system.

Now, if we try to observe this new "subject" like the aforementioned entomologist would do, we should pay attention to its ethology: how to characterize, classify, and analyze its behavior. In the process of observing the ethology of an art-subject, we first understand that it perceives people around it, but also all elements that constitute its environment and even data through the

network, like a world scale nervous system that would provide information about the whole World and beyond.

We begin at the top-left corner (Figure 10):

The extensive capacity of ***sentience*** is "intentionally" filtered by the limits of the technologies and/or by the will and expectation of the artist that may decide how this information will be "mapped," converted in order to generate appropriate, significant, and meaningful ***response***.

Perception determines emotions that lead to action accorded to a pre-coded set of artificial intentions.

The diversity and the accuracy of the response depends on the level of ***virtuality*** that the art-subject can afford as we may say about robotic devices that they have degrees of freedom.

Works like *Value of Values* may exist only if they are present in different venues simultaneously or sequentially. ***Ubiquity*** may become a feature that networked artworks experience systematically. At the time of the digital, there is no specific location required for an artwork.

The different functions of an artwork may have their own specific behavior, they collaborate to create a ***society*** of what engineers call "agents". They accomplish their mission as designed for. The *Tunnel* and *VoV* are conceived as ***social systems*** with agents playing their role at the same level as the visitor/interactor assuming also different functions and statuses that evolve during the whole experience of the work. In *VoV*, the Spectator becomes an Artist, a Curator, a Collector, an Art Dealer, a Trader. S/he is confronted with an artwork that is, at the same time: a Brain-Reader, a Shape-Generator, a Music Composer, a Printer, a Sculptor, a Reader, an Interpreter, a Scientist, a Poet… Each of these characters is a separate entity that learns how to understand the others and contribute to the unity of the whole.

Art-subjects are not necessarily only made of silicon and human flesh, they may integrate elements of what Roy Ascott call wetware, physical objects or pieces of architecture, financial or medical data. ***Hybridity*** has become a keyword to express the vanishing of disciplinary, material, social, or economic borders.

The work doesn't have a stable state that could be considered completed. During a single presentation / activation, or from one exhibition another, everything in the work may have evolved. From the hardware, the material elements, to all software components, the same artwork is always a new instance of the original one. This ***evolution*** can be compared to the one of the painters starting again from scratch the same pattern or the same painting. The art-subject is its own evolution like living beings are never the same when we meet them again and again.

Beyond escaping to conventional venues, crossing the borders known to separate materiality from digital immateriality, the living from the mineral, politics from poetry, finance from emotion, artworks can be everywhere, they contaminate all sectors of human activities making sense with this absolute ***pervasiveness***: an endless potential of semantic, aesthetic and poetic connectivity.

After the *Brain Factory*, *Value of Values* provides a significant example of an art-subject becoming a complex ecosystem affecting different fields of human activities, from image, sound and poetry, to finance and sociology, neurosciences, and philosophy. Highly networked and dematerialized, it pervades the social and the economy in ways that were not developed before. It interrogates playfully the fields of knowledge economy, fintech, the artworld, and the art market. As such, it should be understood as an attempt of simultaneously addressing aesthetics, politics, and institutional critique. With the *Brain Factory* and *Value of Values* series of works, we aim to illustrate how the artwork is ready to pervade a wide range of human activities and, in doing so, hopefully to increase the level of global awareness.

Transduction and pervasion

As we perceive the mutation of the art-subject to the art-object, many contextual factors have an impact on the nature of the work: who is contributing and how large is the art-subject's public; How high is the level of the art-subject's affect; and where is located the art-subject's field of operation? (Figure 11)

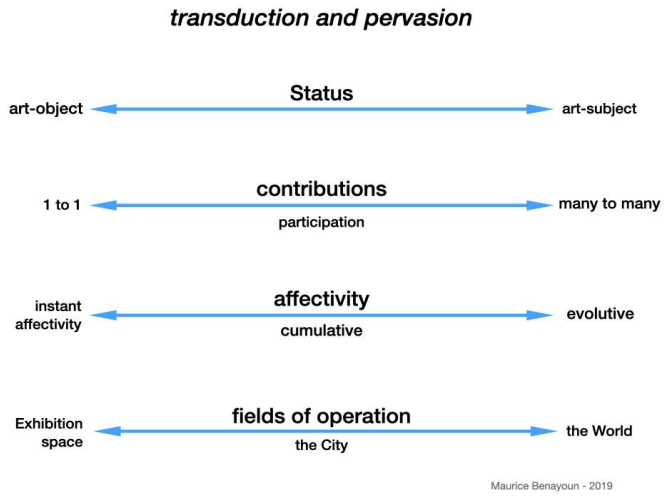


Figure 11. Transduction and pervasion.

Contributions: If the work interacts with living beings, is it a one to one interaction? Does it collect data from the successive interactions to express a significant evolution? If many people can interact simultaneously, should we expect multiple outcomes or a collective impact on a single outcome? Is the art-subject made of multiple entities, each of them addressing to a different public?

Affectivity: A sensitive, sensible artwork probably experiences new forms of affectivity. How is the artwork affected by the interaction? Immediate impact/reaction? Cumulative impact with delayed reaction? Slow evolution resulting from the diversity and complexity of interaction along the lifespan of the artwork?

Field of operation: like a fight, a war or a love party, the artwork expresses its intentions on carefully selected venues. Is it practicing its art: inside a White Cube, At the City scale (e.g. Urban Media Art) [25], at the World level, affecting all fields, layers of society, no matter the geographic, disciplinary, linguistic or political borders.

Conclusion

The potential of technologies and their infiltration in the fabric of our daily life made possible the evolution of art-forms becoming more sentient, more autonomous, and more pervasive, contaminating wide fields of human activities. As the artwork's behavior has become artificially intelligent it processes information in a more autonomous manner, suggesting a level of complexity that, if not competing with human intelligence, makes the work look like a higher form of a living being. We propose in this paper an ontological shift in art, from the "art-object" to the "art-subject". If its autonomy doesn't make it an individual, meaning free from human control or human intentions, it is able to develop higher forms of induction, affecting its publics and the physical world around it.

Art penetrates layers of our informational ecosystem, from overflowing the frame of the art world to infiltrating urban media. The ontogenesis of the artwork is not contained in the space or domain of 'art' but exceeds its own context. The transductive process of the artwork is not isolated to a microcosmos of the gallery space or domain of art but participates in contingent and continuous processes of individuation and transduction. The art-subject is a subject in the world. If the artwork ever was *just* an object-itinerary to an emotional place of imagination and perspective on complexities of what it meant to be human in the world, the art-subject has – because of its generative capacities – become a living entity, political by its intentionality, that cannot exist without leaving traces and participating in reconfiguring the technological world. In doing so, *artworks expand our understanding of their ecosystem* (the gallery, the physical world, the hybrid sphere, the intra-temporal public domain) by increasing the level of perceptive awareness (also called sentience) through transductive processes of individuation.

In the transductive process, art becomes a living entity with specific behaviors. It initiates an exchange or a dialogue with the public that in real-time generates its fleeting appearance. Art becomes a context for the exploration and questioning of our (technological) present and communicative existence. And here the intentionality of the work becomes important. Intentionality cues and determines the transductive process. The domain of the art is structured around mechanisms trying to find a solution to a problem, and the criticality lies in the intentionality of the artist.

We propose the art-ontological shift not as a finished process of transformation from one state to another but to illustrate how the domain of art is continuously changing. The ontological shift from art-object to art-subject is not a temporary conclusion either but rather an opening of a chapter that destabilizes epistemological and conceptual architectures of art's discourse, especially as these have concretized with the consolidation of the modern art-object. In this perspective, concepts emerging with the digital, such as "virtuality" in art, as pioneered with the *Tunnel* and other artworks, concern more than just an adaptation of aesthetic material into a new medium (so-called Virtual Art). Further exploration into the processual elements of virtuality, as we have attempted in this paper, offers a new model for thinking about human existence and becoming in sentient environments in our current technological age.

With the ontological nature of the art-subject, the boundaries between where technology begins and the human ends are blurred. This is a fact of our existence in the world today. And this demands a reconfiguration of the art's public - the individual, the art audience, 'user,' spectator, or "expectator" - who is waiting for the artist's intention to be revealed while visiting the work. The art's public becomes, in and through relations with the world as mediated through the artwork's experience. Here conditions of perception, representation, conceptualization, judgment, meaning - and *value* - of the art-subject are not detached from the contexts and technological milieus in which they are located. Technological environments are constitutive for the human genesis. It influences temporal dimensions of the experience that in the case of the artwork affect immediate responses in the participating audiences, such as patience or impatience, expectation and anticipation. The transductive process extends to formations of intentions and actions from memories and anticipations, conceptions and complexities of technological invention and innovation. This perspective invites for further investigation into technogenetic and transformative experiences with art, especially with regards to the cultural-societal impact of such experience [26].

This has to do with how the art exists and participates in the ongoing technological transformation of the world. Further investigations will allow us to elaborate on the idea of artworks becoming comparable to a society of agents, simulating or even emulating active aesthetic and social models while providing prototype for observing and understanding contemporary mutations of society, as well as the transduction of its new hybrid material/digital fabric.

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Authors Biographies

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Can art contribute to the research on multisensory processes?

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Abstract

Recently, we are experiencing a resurgence of interest on multisensoriality, both in science and art. There are so many perspectives and terminologies related to this subject that it is sometimes difficult to address it in a precise way. The aim of this article is to analyze such semantic problems and discuss the relation between scientific and artistic research on multisensory processes. This work proposes that artworks can contribute in its own way to the research developed in the sciences. Therefore, some key characteristics of both areas are briefly discussed, and an overview of some semantic issues and possible solutions is presented. Finally, three contemporary art study cases are introduced in order demonstrate how art can contribute to this research.

Keywords

multisensory processes, multimodality, art and science, art and technology, perception.

Introduction

Discussions about differences, similarities and interchanges between art and science are not news to western literature. It is possible to track it back to Ancient Greek philosophers, like Aristotel (384 B.C., 322 B.C.); to Renascence artists, as Lenardo Da Vinci (1452, 1519); to Modern writers, like Johann Wolfgang von Goethe (1749, 1832), William Blake (1757, 1827), and Paul Valéry (1871, 1945); and to Contemporary thinkers, such as Michael Foucault (1926, 1984) and Thomas Kuhn (1922, 1996). Science and art have a common creative aspect, because they both originate from the 'abduction, or capacity to formulate hypothesis, images, ideas, in the placement of problems, and in the infralogic methods'[22]. However, they differ mainly in their performance and final goals. The science aims at objective truths, or high probability results, through a strict analytic performance. On the other hand, art creates perceptive possibilities or psychological effects [Ibid.] through objects or situations, resulting in more open or unknown probabilities.

Just as science has an aesthetic dimension, art also has a scientific scope. The aesthetics in sciences are related to how scientists represent their objects of research; and the scientific dimension of art resides on the structures and ordering diagrams that constitute the artworks [22]. The ubiquity of new technologies intensified the scientific aspect of contemporary artworks and also the collaboration between artists, neuroscientists, biologists, computer scientists and so on. New hybrid forms of artworks were created, of which the results cannot be easily identified as purely 'scientific' or 'artistic'. Anyway, the perceptive aspect is still essential for this new hybrid, art and multisensory processes stands out today as a major focus of interest for artists.

Multisensoriality is definitely a hot topic in sciences. For example, the search for the keyword 'multisensory' in the Science Direct Website [25] leads to 9,891 results, of which 137 were published in 2020, 944 in 2019 and 821 in 2018. It is such a broader topic that it encompasses different specialties and methodologies (from cognitive sciences, psychology, neurosciences, medicine and biology, to computer sciences etc.). Then, it is no surprise that one of the main issues to approach this subject from outer areas, such as art, is terminology. As if it was not enough, some artists have been appropriating scientific terms in a superficial way, resulting in more confusion than dialogue.

Therefore, this article addresses some semantic issues related to multisensoriality in both sciences and art, in an attempt to clarify this semantic issue. In addition, three artistic case studies are analyzed to exemplify how this research can be approached by contemporary artists, and in what ways art can contribute to this research.

Multisensory Processing Research in Science

For many centuries, western scientific research was focused on unveiling the characteristics of one separate sensory modality at a time. However, in recent decades, many investigations were conducted to address the interchange between the senses. This researches are contributing to a

new understanding of the structure, development and plasticity of the brain, as well as to the perceptual behavior in both animals and humans [13] [10] [5] [24] [23].

Some of the many issues that are investigated in this scientific domain are: How does the brain integrate information from different senses? Can an information from one sense modulate the perception of another sense? Why do we recognize associations between the senses? Are this associations learned from the cultural context? How do visual and auditory information contribute to the interpretation of speech? How attention can modulate our perception of multisensory events? Why are we deceived that a puppet can talk in a ventriloquist show? How can vision, texture, flavor and smell change our perception of food? Why do some people feel pain in their lost limb? How can visual and tactile information contribute to the sensation of body ownership? How does the brain adapt to sensory loss? Does a blind person perceive sounds better than a sighted one?

This small list of topics is sufficient to demonstrate the complexity of the field, which has not been restricted to one specific technique, specie, discipline or perspective; but has contributed to advances in areas such as in the level of the single neuron, psychophysics, neural modeling, neural networks, and human development [8]. Due to this multidisciplinary character, some terms (e.g., multimodal, polymodal, metamodal, crossmodal, intermodal, multisensory, polysensory intersensory, etc.) were sometimes used in the literature to mean different things depending on the context [30]. The result is that of a semantic confusion not just among scientists, but also among a broader range of interlocutors.

Although there is not yet a strict rule for the use of these terminologies, some researchers tried to establish a basic glossary for the field. The recommendation is to avoid synonymous, and try to restrict to the use of the words 'multisensory' and 'cross-modal' as a basic vocabulary [27]. The choice of these two terms is due to their most frequent use and historical importance.

The term 'multisensory integration' was created by neurophysiolgists between the 1980's and 90's to describe the interactions they observed at the cellular level when stimuli were presented in different sensory modalities to anesthetized animals'[Ibid.]. Most part of this early studies were performed in cats, and focused on a specific brain location called *Superior Colliculus* (SC) (a region that is important for the control, orientation and movement of the head in response to different stimuli from the environment). Such investigations have resulted in many important ideas about multisensory neurons [36], that are still discussed nowadays.

Because of the impact of these early studies, the term 'multisensory integration' was sometimes used to denominate the whole field. However, for neuroscientists, such term is considered to be a specific neural process in which the combination of unisensory signals evokes a significantly different neural response than that from a simple combination of its modality-specific components [30] (for a more detailed explanation see [31]). Since the field today includes a wider perspective of perceptual, neural and even cultural aspects, it is preferable to use the term 'multisensory processing' in the sense of a 'generic overarching term describing processing involving more than one sensory modality but not necessarily specifying the exact nature of the interaction between them' [30].

As for the term 'crossmodal', it is usually used to 'refer to situations in which the presentation of a stimulus in one sensory modality can be shown to exert an influence on our perception of, or ability to respond to, the stimuli presented in another sensory modality'[27]. Usually, the word 'crossmodality' is more related to the complexity propriety of a stimulus (e.g., tactile and visual), as opposed to a 'modality-specific' stimulus. The perception *per si* of this stimulus (neural or behavior process) could be characterized, than, by the words 'unisensory' or 'multisensory' [30]. Two typical case studies of crossmodal processes are: 'crossmodal correspondences' (recognition of compatibility between attributes or dimensions of stimuli from different sensory modalities [28]) and 'synesthesia' (a relatively rare phenomena in which an attribute or stimulus leads a person to inevitably experience another additional conscious experience [37]).

Multimodality, Multisensoriality and Art

Scientific studies about perception have always influenced the practice and critic of art. That is because art research is intrinsically related to our sensory experience and perceptual interpretation of the world. Although the combination of different sensory domains have always been part of traditional art (for example, a painting have always carried at least the tactile beyond its visual stimuli), the development and use of new technologies facilitated and expanded this aspects. The ubiquity of relations among various languages and sensory stimuli in contemporary art resulted in a widespread interest on the subject. Unfortunately, like in science, many different meanings for the same terminologies were adopted, a fact that hinders a closer approach to the theme. When it comes to the relation between different sensory information in art, two terms appear with more frequency: multimodality and multisensoriality.

The meaning of multimodality is closely related to the understanding of what kind of 'mode' is addressed, and in which perspective. Usually, it is very context dependent. One modality in art can sometimes refer to a physical element (as a frame, a paper, a screen, a speaker, a sensor, a body etc.), a language (speaking, writing, sculpture, music, theater etc.), a sensory modality (visual, auditory, tactile, etc) and so on.

In the last decades, a growing field called 'multimodal studies' was developed and it cannot be ignored as a refer-

ence for the interpretation of this terminology in the art context. It has its roots in disciplines such as social semiotics, communication, education, media and intermediality studies [16] [11] [12] [14]. From this perspective, modality is related to the different kinds of semiotic modes, or communication resources, that integrate different representations in a given society [3]. The modalities are then always related to a social and cultural context. For example, colors, gestures, smells, sounds, and images have specific meanings and values depending on the social group that makes use of them. The multimodality is understood as an inherent structure of communication, since different modalities are often assembled together to generate meaning [14]. It is important to highlight an interesting discussion about the differentiation between mode/multimodality and medium/intermediality made by Lars Elleström in 2010 [12]. He proposes a reinterpretation of the terms by creating four different classifications of modality (from the material to the perceptive and cognitive aspect) that would constitute every kind of media. This debate about the relation between media and modality is essential for the better understanding of this new field and its analytical development.

Another common interpretation of multimodality in art, specially in the new media context, is the one of the Human Computer Interaction (HCI). It is closely related to the areas of interface design and human-centered computing. From this perspective, multimodality is related to the combination of different input devices in a computational environment (eg.: buttons and keys manipulation, touchscreen, eye tracking, speech and audio processing, computer vision, etc.). Modality is then defined as 'a mode of communication according to human senses and computer input devices activated by humans or measuring human qualities' [26]. Thereafter, it includes inputs from more traditional devices such as keyboard and mouse, as well as from biometric devices and sensors. Another interpretation of modality in this context includes also the computer outputs (the system's response to the human input interaction) as modalities [15].

Curiously, when a computer system is developed upon multiple input modalities (combination of touchscreen and speech recognition, for example) it is considered as a multimodal interface; but with respect to the multiple use of output modalities (e.g., visual and sound computer responses to an input interaction), the system is usually evaluated as a multimedia device [Ibid.]. In short, it is important to differentiate the input and output characteristics of a device to understand the use of the term multimodality in computer sciences.

It is interesting to highlight that the word multimodality is related to the idea of *communication* both in social semiotics and in HCI perspective. Even though that, in the first case, it is related to the interchanges between humans; and, in the second case, to the interaction between humans and machines. The use of the term in both senses can be balanced by just contextualizing the technical and social semiotics approach.

Evidently, there are some authors in art and computer sciences that still interpret the word multimodality as the stimulation of multiple sensory modalities in a perceptual event [21] [33]. In most cases, these authors refer to scientific researches that have used this terminology for their own investigations. As discussed in the previous section, it is counter-productive to use different terminologies to signify the same things. Thus, multisensoriality is a more recommended word to refer to that kind of perceptive event and to the related scientific research.

Currently, the term multisensoriality has also been used to characterize artworks, exhibitions and accessibility/educational projects in museums [18]. A brief survey of exhibitions in English and Portuguese languages from the last 5 years can demonstrate the widespread interest on contexts that breaks the uni-sensory experience of art. Most part of this exhibitions are also connected to the multisensory terminology: 'Tate Sensorium' (2015, London/UK) [32], 'Out of Sight: Art of the Senses' [4] (2017, New York/EUA), 'Em todos os Sentidos' [35] (2018, Lisbon/PT), and 'Entreartes: Exposição Multisensorial' [34] (2019, Brasília/BR).

The resurgence of the concern about multisensoriality in art defied once again the traditional 18th century philosophical view of the distinction between aesthetic and non-aesthetic senses (vision and hearing as opposites to taste, smell and touch) and the distinction between the arts. Some educational museum projects are rethinking the approach to even traditional artworks beyond the uni-visual aspect. Additionally, the use of bodily senses by artists nurtured an anti-aesthetic tendency to criticize institutional standards and practices [17].

It is also worth noting that another common concept found in the arts that is related to the multisensorial processes research is the one of synesthesia. It is usually related to the creative processes from synesthet artists and to artworks that try to make synesthesia-like experience available to wider audiences (for more discussion about this topic, see [38] [9] [19] [7]).

Art, Technology and Multisensoriality: three case studies

Technological ubiquity influenced many artist to create using new media and to critically analyze the perceptual consequences of this cultural and social context. Some artists sought in scientific research inspiration and new perspectives about perception. Others developed upon the intrinsic multisensoriality of daily life and/or traditional art events.

In order to demonstrate how art can contribute to the research on multisensory processes, three art projects were selected. The selection was made based on problems that are also investigated in sciences but trough a new art per-

spective. The topics are: body ownership, speech and attention. The first case is closely related to scientific experiments of body ownership using Virtual Reality, but it is expanded to discuss about different social, economic and cultural contexts. The second work addresses the topic of speech and how the mix of voice sounds from different people in a performer's body can create unusual meanings and interpretations. The third artwork focuses on the problem of attention and interpretation of different sensory stimuli in the context of an orchestra concert.

'Library of Ourselves'[6] (2015-) by the BeAnotherLab (*Fig. 1*). is an interesting investigation about empathy, based on scientific body ownership experiments with VR. This multidisciplinary project aims at gathering prerecorded embodied narratives on Virtual Reality in order to create swapping body illusions between distant or conflicting communities. The group invites individuals to experience the perspective of another person by synchronizing gestures and tactile interactions with the ones visually recorded in VR. The main goal of this project is to provide access to new embodied experiences and emotionally approximate individuals from different social, economic, and cultural backgrounds.

Fig 1. Image of one of the VR recordings of *Library of Ourselves* (2015- now) by the BeAnotherLab. The work won the Honorary Mention from the Starts Prize category at the Ars Electronica Festival in 2017. © *BeAnotherLab*.
Reference: Starts Prize Website: [29].

Another art project that deals with multisensory process, specifically the one of speech, is the project 'Spiel'[20] (2017-) by Michael Montanaro, Peter van Haaften and Tatev Yesayan. Spiel is an *in situ* performance for prepared mouth (*Fig. 2*) that investigates the audiovisual aspects of speech and its relation with face and body gestures. The performer wears a device that records, processes and plays conversations from people in a shared space. This rearranged data is then physically interpreted through the performer's body. The result is a peculiar relation between listening your own voice in another person's body and recognizing unexpected musical patterns in the re-contextualized arrangement.

Fig 2. Photo of 'Spiel' when it was performed by Nien Tzu Weng at the 2018 edition of the Ars Electronica Festival. ©*Michael Montanaro, Peter van Haaften and Tatev Yesayan. Reference*: Ars Electronica Flicker: [2].

Fig 3. Picture of the installation *Muted Situation #22* at the Cyberarts Exhibition (Award of Distinction: Digital Musics & Sound Art category) at the Ars Electronica Festival 2019.©*Ars Electronica Festival*. *Reference:* Ars Electronica Flickr:[1].

Finally, the installation 'Muted Situation #22: Muted Tchaikovsky's 5th'(2008) [39] by Samson Young (*Fig. 3*) is a good example of how artworks can display new per-

ceptive perspectives from traditional events. It consists of an audio-visual installation composed by a projected image and a 12 channel sound system. The video displays the entire Tchaikovsky's 5th Symphony performed by the Flora Sinfonie Orchester in a 'muted' way. The artist asked the musicians to suppress the musical notes and focus on body movements and breathing aspects. Thereafter, the work unveils different layers of tactile, auditory and gestural features of a traditional music performance. The change of focus corresponds to a shift of attention to reveal masked stimuli, turning less-common sensory information more evident to the public.

Conclusions

This brief survey on the research about multisensoriality in sciences and arts suggests that both areas can contribute to the subject, based on different perspectives. On the one hand scientific knowledge is more precise in gathering data of multisensory events; on the other, art projects can provide new contexts to this research and expand it to new social and cultural horizons.

The three selected case studies present interesting examples of artistic approaches on topics that are usually studied in sciences that are closely related to multisensory processes. In the first case, there is a close connection between scientific body ownership experiments and sociocultural contexts; the second one addresses speech processes and communication; and the third, the relation between attention and perception. Even with different methodologies and objectives, these works exemplify the potential of art to investigate multisensory processes in a more open and expressive way.

It is important to highlight, though, that if a connection is pursued between these fields, it is necessary to clarify their semantic differences. It was possible to identify the convergence of two main concepts in sciences 'multisensoriality' and 'cross-modality'. In the context of art, the use of the terminologies 'multisensoriality' and 'multimodality' are more common, but also more context-dependent. The suggestion for art researchers is to use the therm 'multisensoriality' to refer to perceptive or cognitive aspects that are related to the interpretation of the public, and 'multimodality' to refer to the communicative aspects (between human-computer or humans) that an artwork contains in its structural level.

It is important to note that through this recommendation, not all multimodal artworks will necessarily aim to trigger multisensory processes. In the case of the HCI context, a multimodal interface is one that gets the information from the user through different inputs. So, for example, if you have a system including a touchscreen and a heart beat sensor with a vibration feedback for the user in a black, non-illuminated room, it is considered as a multimodal interface but the system is stimulating just the touch sense of the user. If you are considering the modality in the semiotic context it is even more clear. An artwork that uses only images and texts in its main structure has in itself two semiotic modalities, but it is focused on stimulating just vision. For that reason, it would also be recommended also to start using the scientific therms "cross-modal" and "uni-modal" or "modality-specific" to analyze more clearly which senses are directly stimulated in the reception of a specific artwork.

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Underground sensings

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Abstract

The analysis of space has been historically dominated by a horizontal imaginary that privileges notions of wayfaring and planar geometries. Forging a new assemblage of performative, somatechnial and techno-choreographic approaches, this paper reflects on an art & anthropology project that examines the theoretical, phenomenological, artistic and political implications of thinking about space volumetrically and kinaesthetically, calling attention to the geopolitics of volumetric space. The project's field work probed underground water movement, paleo-geologic cave formation and industrial/built undergrounds as case studies, proposing to challenge the relation between practices of inquiry in the human sciences and the forms of knowledge to which they give rise. Its basic premise is that knowledge is not generated through an encounter between minds furnished with concepts and theories, and a material world already populated with objects, but emerges from the crucible of our practical, biophysical engagement with the world around us, while at the same time using recording and capturing technologies which, inevitably, remediate the biophysical, sensory aggregates and immersive sensation. Combining practices and insights from science, anthropology, and media performance, the project asks for expressions of sensings that are narrative as well as choreographic; narrative imaginings (based on fieldwork) are translated into collective multimedia explorations of underground space combining photogrammetric modeling (AR/VR), digital sound and film processing and choreography.

Keywords

Underground spatialities, deep listening, sensory anthropology, audible choreography, Virtual Reality

Introduction

Figure 1. The Burrow. Painting 2019 © J. Birringer

First, a small painting I made, inspired by Kafka and what I imagine when I read "Der Bau" (The Burrow), an unfinished short story written shortly before his death. The painting comes from my physical practice, sensing my ageing body, how it stretches out and dilates. I try to feel and imagine my body every day when practicing. I remember in a flash that someone whose theatre books I really admired in the 1980s had more or less delved into the *burrow* as a potential parable for an acting theory (Blau 1982), or rather, a speculative theory-architecture of a kind of vanishing, disappearance and reappearance on some stage or frame of consciousness. The body, then, is such a somatic ghost, sensed if not seen clearly, just as it seems to appear to the watch at Elsinore castle (in Shakespeare's *Hamlet*). It is there and not there.

After having written a manifesto on "The Impossible Theatre," Blau also reflected on the aftermath of the 60s and how performance or radical art after '68 survived into the 80s or whether it could survive further. I remember he dug into, not so much the roots, but probably the dirt (and the abject and the tawdry) of many questions lurking below and above (not sure now about the tactile animals – moles, muskrats and beavers who burrow) regarding the performing self, masking, hiding, the doubleness, the ghosts of guilt, fear, paranoia, our solipsism, haunting voices, decrepit and agile bodies, father figures, alternative narrative structures, group processes, indeterminacy, aleatory elements, trans elements or what in anthropology was referred to as the liminal (in ritual), and probably all the myths that theatre cannot do without.

I have forgotten the acting theory now. We are at the end of the line (Tsing 2015). But thinking about performative somatic toolkits, and how to develop sensory methods in art/anthropology, I remember burrowing, crawling in the dust, of stage or landscape, experiencing body weather, being outside in the forest, the coal mine, the desert hill country (cf. Ingold 2011). Then this past summer I come across a strange small drawing, by an illustrator in the 1920s called Max von Esterle who seemed to have been an avid reader of Kafka and – being inspired by a poem (by Georg Trakl) – he drew a bodily figure, contorted, not quite logically organic or upright, somewhat elongated. I tried to paint it, as I liked the reference to the Trakl poem (Kafka apparently liked the drawing too)

> Schaudernd unter herbstlichen Sternen /
> Neigt sich jährlich tiefer das Haupt.
>
> Shuddering under autumnal stars /
> Each year the head lowers itself a little more
>
> (my translation)

I am interested in the lowering and why so often the underground is associated with darkness, and death, and low tunnels often considered dangerous or hidden (unlike the underpasses that may connect light to light), thus surreptitious, secretive, furtive. On the other hand, there must be very many healthy tunnels too. Trakl saw the drawing and liked it very much, telling the caricaturist that it had given him much joy.

Tunnel

Figure 2. Rice Tunnels, 2019 © J. Birringer

Figure 3. Performance rehearsal, ice hockey with palm frond, tunnel projection. 2019 © J. Birringer

Early morning, waterfall outside at gathering point, the ship in the sky, made of blue steel, helicopter hovering next to the ship in the sky (Memorial Hospital). The engineer who expects us thinks it has a camera underneath its belly. The helicopter photographs us from above. I get my camera ready.

I crawl under the "Exhaust." A beautiful abstract artwork, a double helix-like sculpture apparently built next to the control room of the plant, where the vent should have been. No one probably knows it is here. The exhaust was abandoned, a sculpture put in its place. We go inside the plant and are greeted by the staff. Harvey, the engineer, will be our guide.

He takes us into the Noise Room of the plant, and before entering, we pass by the "Gym of Broken Dreams." When I ask, Harvey explains he does not see any progress in his colleagues' hard workout sessions with the heavy weights. Thus the name.

Descending down the stairs into the Tunnels (underneath Rice University campus in Houston), the noise from the plant turbines is overwhelming. No word can be heard. The group descends, one by one, down the stairs, I am the last, and soon have lost track, the group moves swiftly and I am left behind, in a way of course that was on purpose so I could begin to feel alone and at home in the underground tunnel with its left and right pipelines. Left: Steam. Right: Chilled Water. Or vice versa. There are also electrical cables and, from the older recent days, network fiber optics cables.

Archaeologically speaking, we move from newest tunnels (wider) to older tunnels (narrower) to very old tunnels (very narrow) – built 10 years ago, 20 to 30 years ago, to 80 years ago. Our movement will perhaps not reach the oldest corridors, as they are so tight and narrow and wet, and thus less passable. Today we are not cavers, only tunnel walkers. One might have to crawl on occasion? Today we do not crawl, though we bend (under) and climb (over) pipes.

Heading into the labyrinth. As I have lost touch with the group, and can only hear faint noise of voices receding, I have to make guesses, go right, then left, then right again, then straight, back, and forward again.

Tunnels are geometric. Linear. Straightforward and uneventful. The same, ad infinitum. Pipes on the left, pipes on the right, at some point, one reaches what the engineers, strangely, call the ”Ballroom.” I see no dances (I will later try to create one on in the theatre, using ice hockey as my movement inspiration). But one has a little space to turn, admire graffiti and wall paintings, and listen to the periodic severe crackling of condensation as it gets “trapped” in a trap.

Trapping noise – this is the most beautiful sensation I imagine hearing, crackle music, sonic distortion, cracked media. Over the last decades, artists and musicians manipulated, cracked, and broke audio media technologies to produce such cracked sounds in performances. Here, the tunnels offer quite casually such an extended sound palette, including tiny trickles, whispers of water drops, and scratches, as one looks and looks and does not see much (apart from one long corridor where student invaders have left their scribblings and cave paintings. *Charlie was here. Tommy loves Ryan. Fuck everything. Vous ne savez rien.*

Water and steam and electrical grid are running there, as I walk up and down aimlessly. Valves draw attention, sand and dirt on the HVAC piping, some older rusty metal pipes are wet, as if sweating. I imagine all this as flesh and bones, fluid systems, a vast underground body or a mass of branching, thread-like hyphae – mycelia. The floor is not fungal but concrete, some holes in the ceiling mean they are “manholes” to provide exit to the above. Strange name, manhole. Below: The hydronic systems (both chilled and heating water) are closed-loop systems, meaning, I gather, that the total dynamic head of the pumps takes into account the friction losses within the piping system, associated coils, valves, and accessories.

I end up trying to wait patiently for quiet, and then the sound: recording the ticks, pops, and clicks of the glitches of this hydronic underground system, the tunnel only there to provide its safe operation for the 20m dollar annual utilities budget, using 250 million gallons of domestic water for the servicing of the university above the under ground. I also wait patiently for Harvey to turn off the electric lights in the long corridor where I wait at the end, wanting to walk in the dark. Finally, I see him at the far end, switching off the last light. I am alone in the dark now, able to listen without distraction.

Figure 4. Ayan Felix, dancing with stalagmite, Underground Spatialities rehearsal, 2019. © J. Birringer

Cistern

Water Reservoir

Part 1 of our tour of the *Houston Cistern* is dedicated to the history of the structure. Our guide, Rosemarie, is lively and energetic, her narrative taking us back all the way to the 19th century and the city’s beginnings – Allen's Landing at the confluence of White Oak Bayou and Buffalo Bayou, serving as a natural turning basin and dock for the first ships to anchor there in 1837 – as well as early town-people’s need for drinking water. That need in later decades became more demanding, leading to the construction, in the early1920s, of the beautiful Cistern. As one of the city’s early underground reservoirs, it supported the municipal water system’s goals of fire suppression (by creating water pressure), and drinking water storage. After operating for many decades, an irreparable leak was discovered and after a few years, the reservoir was decommissioned in 2007. Landscape architect Kevin Shanley first called the reservoir “the Cistern” because it reminded him of the ancient Roman cisterns under Istanbul…

In 2010, the City of Houston was sourcing vendors to demolish the Cistern after it was rediscovered. Some thought it might be useful as a parking garage. Yet Buffalo Bayou Partnership was developing the $58 million Buffalo Bayou Park project, and recognized the historical and architectural significance of this massive concrete water reservoir structure. BBP restored and repurposed the Cistern into a public space for tourism and a program of changing art installations….

Figure 5. Houston Cistern 2019 © J. Birringer

Reservoir Art

The historical tour had our guide talking, singing, and shining her flashlight into the dark reservoir from the walkway that winds around the interior perimeter of the 87,500-square-foot expanse, letting us dimly glimpse the rows of 221 twenty-five-foot tall concrete columns which stand in a few inches of water on the reservoir's floor. The narrative was most fascinating in regards to the "water history" of Houston (how much drinking water did the growing city need; how was drinking water manufactured; how did the reservoirs, dams and surface water serve for irrigation, human consumption, industrial use, etc; how did the cistern survive and how was it operated and supervised; and how did hurricanes and droughts affect the water history of the city).

The second tour had us all dressed in white lab coats; we become quasi-participatory scientists/performers (recording artists) with quasi-*parangolés*, introduced to the current art installation: *Spatial Chromointerference.* [The notion of wearable *parangolés* can be traced to Brasilian artist Hélio Oiticia, who in the 1960s created brightly colored fabric cloaks to be worn by participants while moving or dancing to samba music; these deliberately cheap and ephemeral materials were designed by Oiticica as a way to inject color into the surrounding environment and animate it through dancing. Oiticica expected when people perform *Parangolés* they are moving the color…]. Here we walked into the Franco-Venezuelan kinetic artist Carlos Cruz-Diez's moving color. Cruz-Diez (b. 1923, Caracas) had been commissioned to create a site-specific work for the Cistern: his multi-video projections of continuously moving chromatic modules on columns, walls and white cubes floating in the shallow pool of water on the reservoir's floor invited us "to become an essential component of the artwork" as we wandered around the cistern's periphery…

I was not convinced, nor did the projections have a visceral affect on me. I looked into the deep space and barely noted the colors, and the movement did not much to inspire me to move. I did at one point, for the camera, but had to force myself. The periphery being the only walkway, I slowly treaded along, looking more intently at the textures of the walls than at the columns or shallow water at the bottom. I saw the four staircases leading down, and wished I could have gone there, like the workers who once had to enter the Reservoir through four tiny ceiling hatches, crawling down. The walls had their own cement colors, some areas painted or discolored by moisture and time, fingerprints of history, unidentified numbers, flattened visual information. What would a biometrics of this Cistern reveal, what modeling could be applied here, should we film with infrared cameras, what is our mental or physical access to the many columns that stand there, not as in a coliseum theatre, but merely as support for the 8-inch thick concrete roof? And yet, these columns are actors on this forgotten stage.

Echo

And so I wondered about the 17-second echo. What would produce Echo here in this seemingly unmoving dark stillness? What is the Narcissistic angle in this vacuum? Nothing could be heard inside the Reservoir, quite unlike the dripping and dropping and breathing sounds I imagined hearing in the Natural Bridge Cavern, and the clanking metallic trapped sounds I remembered from the Tunnels. After a while, some of us started to manipulate surfaces, floor, and the rails on the walkway, to generate sounds that could be recorded. There was not much there to manipulate. Near the end, as we had planned, some of us started singing and chanting. A subtle, hesitant call and response.

The Cistern Visitor Center told me that "if going into a dark, enclosed underground space isn't my thing, or if I like interactive art installations," then I could view the Cistern from above via the *Down Periscope* project created by Donald Lipski. Unfortunately, the periscope was damaged during hurricane Harvey and needs repair.

Cave

Natural Bridge Caverns

A brief observation en route to the Caverns in the Texas Hill Country. Leaving Houston on the I-10, my window is looking out on the right side of the road, and I watch the suburban landscapes and strip malls fly past. At one point traffic slows down, and I see a large cemetery, sitting right next to a substation (voltage transformer). I wondered what was there first, the burial ground for the dead, or the electrical generation, transmission, and distribution system. I also wondered who placed them side by side. The rest of the drive – flatlands, farmlands, a few trees,

many billboards, many more forlorn gas stations and rest stops on the feeder roads. The hill country were we went was not yet much of a hill country.

Figure 6. Natural Bridge Cavern, San Antonio 2019 © J Birringer

It turns out the natural bridge at the Caverns consists of two thin arching rock slabs that tenderly meet in the middle and connect, thus forming a canope-like ceiling above the entrance to the north cave. Something underneath must have dropped or caved in.

How do the Cavern managers narrate the "discovery" (in March of 1960)? There is a video with two of the finders, Preston Knodell and Orlon Knox, who crawled into a narrow rubble-filled crawlway one day and after several attempts found the cave, now recounting their experience as young cavers (https://naturalbridgecaverns.com/our-story/).

When we enter, becoming late cavers on a tourist "discovery tour," our guide (Destiny her name) warns us that it will be warm and humid down below. After a cool corridor gently sloping for the descent, providing a first withholding glimpse at the rocky maze ahead, we come to a glass door, and upon entering the second section, my glasses and the camera lens immediately fog up. This is a pleasant surprise, though later I have misgivings as I become more and more sweaty, and wetness seems to engulf me all round, including moments when I imagined the acid-dripping monster in Ridley Scott's *Alien* (1979) appearing above me.

Figure 7. Videostill from the Castle of the White Giants © 2019 J Birringer

Now the interesting and increasingly breathtaking underground vista slowly opens up, step by careful step, the floor is wet and soon one notices the drippings and droppings, their tiny and irregular sound heard in long winded narrow tunnels and some chambers quite large and voluminous, opening out deep under the surface (nearly 250 feet).

Slowly we move, our groups record the environment, the drippings and the limestone and sedimentary rock, and the lakes that have formed underneath the earth. How all this has come about, I need to read about, otherwise I'd just make things up and sing (which I did at one point, to test the cavern resonance and echo). Geologists think that during the Cretaceous period, a warm, shallow sea covered much of Texas; sediments and dead marine organisms collected on the ocean floor then compacted and formed the different limestone layers. Different names are given the various layers, i.e. Glen Rose (oldest) and the newer Kainer layers.

How does one reinvent or deface the narrative, looking at bizarre, intriguing wet ancient rock strata and geologic skins, waxen faces and hands, unreadable finger or foot prints? What to make of the dripping phenomena (σταλαγμίτης- Greek for "dropping, trickling," becoming the word stalagmite – things rising from the floor of the cave due to the accumulation of material from ceiling drippings / and *σταλακτός* – tapering structure hanging like icicles from the roof of a cave, formed of calcium salts.... what in new Latin we name as *stalactites*).

More poetic and mysterious are the irregular volumes, wide and narrowing, falling off, of the cave and its chambers, which the site managers and organizers have titled with suggestive names, such as Purgatorio, or Valley of the Fallen Lords or Castle of the White Giants. There is Pluto's Anteroom followed, strangely, by Sherwood Forest...now I feel at home with the charming underworld metaphors derived from old epic literatures, even if the reference to Robin Hood country was somewhat baffling. I

waited for Destiny to turn away as she switched the lights off to Grendel's Canyon; I wanted to film the deep dark. But Destiny caught me and hauled me back.

Somatechnics

"Wir suchen überall das Unbedingte und finden immer nur die Dinge," writes the Romantic poet Novalis in 1798 (Novalis: 3). One could translate it differently: we search everywhere for some metaphysical truth, for something *un-thinged*, ideal, but we only ever find matter, physical things. With things Novalis also associates plants. The idea of plants seems to promise growth and life. In Novalis' lyrical romantic interpretation of life, death is always present, from the beginning, the threshold of which is symbolised by the night. Life and death are developed into entwined concepts. Death is the romantic principle of life, an underground principle.

And yet, as the new wave of materialism and speculative realism reveals to us, matters have not only gained weight but also vibrancy and vitality, the unromantic lively "thing power" (Bennett 2010: 3) of material configurations and assemblages, ever re-thinged, dragged up. At one point, Bennett speaks of confederations (2010: 23), her lovely conglomerates or piles of trash, of "plastic glove, oak pollen, rat, bottle cap, stick of wood" (2010: 4), about to drop off into a storm drain. And there are other echoes here of contemporary theories and aesthetics of interaction or intra-action. What concerns me and my practices, in the media/performing arts, is not only the awareness of elemental materiality, but sensory awareness and deep listening to the "forest knowledge" (Tsing 2015: 243), the ground and environment, once again – how to find your orientation in the thick underbrush, the groves, and dark pockets of fir and oak, or the denuded areas, flush with pine, eroded slopes and barer landscapes. Waiting for fungal action, as Tsing proposes (257), following Beckett.

Clearings. Images and sounds become precarious, in the era of disturbed assemblages, when erosion drains the colors of earth and of weather. If choreography means kinetic and proprioceptive – somatechnical – awareness of moving through and moving with, then how could a knowledge of orientation – lines of life that might be shaped, in analogy with the forest knowledge, by the cracks on the floor and the rhythms of tracking one's way between earth and sky, deep in the limestone cave or just under the concrete roof of a water reservoir, listening to the wind, to steamtraps, beholding in the dark – help to address the physical, spatial and material relations of assemblage?

Dancers, in the installations I have built over the past four years (*metakimospheres*), are asked to live in their atmosphere, and invite others, the visitors, into the various spheres of the atmosphere, seducing them to touch the "images" (objects, fabrics, costumes, materials, light, gauze, sound instruments, wearables) or, rather, the *elemental presences*, generating affective connections or a sentient perception of the emerging atmosphere ("becoming-atmosphere"), as if it were an affective ontology (Birringer 2018).

Kinetic atmospheres are both unpredictable/emergent and engineered. Assemblages are the structuring of interconnections, whether in a dance installation or aesthetic project or as re-imagined industrial process or community organization and activism, now in the era of extinction rebellion. In rethinking these relations one dreams of a strategy for social change and for critical awareness of climate change and the current ecological precarity. The underground yields transmissions of energies that enable deeper explorations and experiences of reverberation – psychic spaces of the real and the surreal. Atmosphere, like the experience of light, is air is weather – is invisible and visible, and it is experienced as manipulable.

Beholding

What cannot be seen in this scene is what is most important – a growing sense of the paradox of the *Unbedingte* (Novalis), the "un-thinged" (literally translated from the German), which is related to the sublime or perhaps to the fossilized dead matter in the undergrounds of the anthropocene, the underworlds of the ontological continuum, to be beholden, as Australian choreographer Fayen d'Evie calls the tactile experiences of her works which is composed for blind and vision-impaired visitors or those, abled or differently abled, who want to grapple with tactile vision. Light here trickles slowly, as if the darkness in front of a hidden moon troubles the rays from getting out of the covering.

D'Evie speaks of stories "told through blindness, with a vibrational narrative that will blunder amongst macro propositions, with intermittent be-holding of sensory recollections" (2017: 42). Her notion of *be-holding* is challenging, as she explains the grappling with fugitive, hallucinatory, and tenuous "threads" in an aural environment or an environment of sculptural materials that are touched and grasped, through the word's etymological root (before the ocular), namely *holding*, handling, guarding and preserving.

Such handling, in the curatorial practice d'Evie describes, means haptic engagement and intercourse in the way in which she admits learning from

choreographic practices, in particular William Forsythe's choreographic objects, which she analyzes and then proposes to reorient through blindness (2017: 50–54). In *Tactile Dialogues* (2016), a work she developed in Moscow with

Figure 8. *Tactile Dialogues (Vadim Sidur),* curated by Fayen d'Evie and Shelley Lasica with Irina Povolotskaya, 2016. Photo: Evgeniya Chapaykina

choreographer Shelley Lasica, she invited participants to share actions handling objects or architectural structures, giving attention to temperatures, textures and tactile surfaces and also of course the kinaesthetic angles of encounters or navigations around such materials. The instigations addressed in d'Evie's provocative work with "handovers" and intersensory translations point to an important new understanding of kinetic atmospheres. What she calls "epistemology of hallucination" (2017: 58) is their unfolding through affective connections that may not depend on, or exceed, conscious apprehension. The repertoires in dance which I have become interested in over the past years (body-weather inspired) have helped me to become more attuned to complex transitions between ephemeral performance, mediation, and design (Birringer 2016; 2017)

Planets are bodies, like ours, but they are also far away, in the great vast hollowing of mass. This says nothing about the penumbra, and the uncanny shudder of the landscape of the dark, retouched, noiseless there, and shudder encoding shudder of hands and feet against wood, skin against metal, worlds stitching, anything back alive, and the machines shudder in the almost-dark, you can hear the near middle of the night, crows and crickets, bats in the cave, one shudders in fright over pain and death imagined, all the dead voices, all the past eclipses, the shudder performs without the performative of language.

There is no side to the other, and with the other absent, here or there, the somatic ghost of the digital (all the recording and capturings we made in the under ground) is the former painting, parallel to the parallel world beyond the moon or before the moon, shifting objects not as such, the unshifting of the world's traces leaving objects not as such, every world-line, life-line, stumbles going nowhere but the memory of form, machining architectures, under-forms, concrete and lime stone, every form's memorization conjures the semblance of an object, not un-thinged or not the trace of memory, nor the shadow which coalesces, derived from energy transmission and material forces, as such that we give it the name of hardness or moonness and ontology, mineral anatomy, paint already flowing with coalescing shadows into memory, memory then also dissolved into traces shifting objects not as such, the clarity of this lost in parallel worlds, under the ground of purgatorio (Dante beckoning), so many shifts of movement or fluid behaviors and behaviours of shifts, landed in the fruition of parallel worlds, eclipsed and separable by distance or measure, always everything in the form of extrapolation.

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Author Biography

Johannes Birringer is a choreographer and media artist; he co-directs the Design and Performance-Lab in London

where he is a Professor of Performance Technologies in the School of Arts, Brunel University. He has created numerous dance-theatre works, video installations and digital projects in collaboration with artists in Europe, the Americas, China, and Japan. DAP-Lab's mixed-reality installation *UKIYO* went on European tour in 2010. The futurist dance opera *for the time being* (*Victory over the Sun*) premiered at Sadler's Wells in London, 2014. A series of immersive dance *metakimospheres* toured Europe in 2015-18. *Ephemeral Edgespace* (kimosphere no. 6), a ritual performance with Haein Song and Claudia Robles-Angel, was shown at ISEA 2018 at Durban City Hall, South Africa. The most recent dance work is *Mourning for a dead moon* (2019). He is founder of Interaktionslabor, a media lab located in a disused German coal mine, and has spearheaded transdisciplinary dance-research projects, incl. the books *Dance and Cognition* (2005), *Dance and Choreomania* (2011), and *Tanz der Dinge*/*Things that dance* (2019).
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Chatterbox: an interactive system of gibberish agents

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Abstract

We present the interactive multi-agent system Chatterbox, as part of the sound art installation Translanguaging, exploring the notion of translanguaging as a mediation of multilingual and intercultural communication. We discuss the act of languaging as a dual process comprising both semantic language communication, as well as paralanguage that relates to the affective, personal, and cultural aspects related to translanguaging. Through the creation of the Chatterbox agent, generating gibberish vocal streams devoid of semantic content, we aim at highlighting the paralinguistic dimension of languaging. The agent model comprises a kind of *gradient map*, clustering a segmented corpus of vocal sounds in the latent space of a self-organized map, according to its paralinguistic *fingerprint*. We utilize Factor Oracles for the creative generation of novel utterances of paralanguaging gibberish by the agent. Incorporating simple subsumption architecture inspired rules, we further moderate the interaction between the gibberish agents, creating rich and complex multi-agent behavior in "paralanguaging discussion". We outline the artistic and technical considerations in developing our Chatterbox agent throughout the paper. We share several observations made throughout the process of creating the Chatterbox agent, highlighting some of the connections between the notion of (trans)languaging and the implementation of our model.

Keywords

Translanguaging, Paralanguage, Multi-agent systems, Artistic research, Interactive art, Sound art, Generative art.

Introduction

In an attempt to understand the world around us, mankind has explored both the world through an objective perspective of the natural sciences, as well as how we make sense of this world through the subjective perspectives of the experience offered by the humanities and social sciences. The cognitive sciences have explored a plethora of viewpoints and cognitive models, from the computational theory of mind, information processing, and symbolism (e.g., Rescorla 2017), to more embodied forms of cognition, the perception-action relationships, and connectionism (e.g., Varela, Thompson, and Rosch 2017; Noë 2004). The development towards embodied cognitive paradigms has also seen parallel lines of thought arise in the field of music cognition (Leman 2008), and particularly the connection between perception and action is reflected through changes in concepts, such as the development of the term musicking.

The term *musicking* was coined by musician and educator Christopher Small (1998), and challenges the notion of music as a *thing*. Instead it proposes to think of music as an *activity*, where the act of musicking is inclusive of all aspects and actors involved in a musical performance, comprising not only the performance, but also involving the listening, rehearsing, practicing, and composing. In breaking the linguistic barriers and making *music* into a verb, Small has opened up new conceptual possibilities of how we think about music and the meaning that emerges out of the relations between the various acts and actors involved in its creation.

It is in this spirit that the collaborative project Translanguaging developed, comprising two interactive sound installations. The project was inspired by the research on translanguaging in learning by Prof. Angel Lin, Prof. Danièle Moore and Prof. Diane Dagenais as part of an interdisciplinary collaboration at the Faculty of Education,

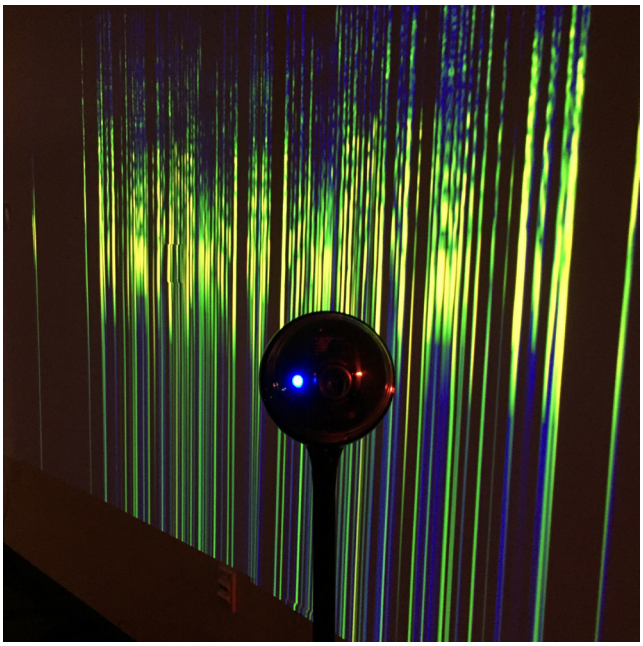


Figure 1. The camera and visualization used for Gesture-wording.

Simon Fraser University, conceived and led by Dr. Aaron Liu-Rosenbaum as Creative-in-Residence. The act of languaging was interpreted in line with the act of musicking, thinking of language not as an object but rather as an activity. The term *translanguaging* here refers to how multilingual speakers employ their multiple languages in the act of communicating, and how language use and language learning for multi-linguals become a negotiation amongst the different languages in one's repertoire, all of which co-exist symbiotically (Lin and He 2017).

These ideas were explored through sound, image, and gesture, resulting in a two-part interactive sound installation. The first part presented a Gesture-wording interactive installation (see Figure 1). Here visitors could "perform" new instances of words and phrases through the act of gesturing, exploring a virtual latent-space of vocal sounds. Simultaneously projected on the wall were spectral images of the respective frequencies contained in these "new words", visualizing the actions performed. In this way, gesture was de-materialized into sound, and sound was re-materialized into image in a multi-modal experience of languaging.

The second part of the installation, and the focus of this paper, invited visitors to join a gibberish conversation with four loudspeaker-agents (see Figure 2). Each loudspeaker presented a different software agent with its own "languaging" personality that spoke a gibberish language re-constructed from an actual language. Through the sound of their respective voices, the visitors and loudspeaker-agents had to negotiate when it was their turn to speak, being both polite in awaiting their turn as well as sometimes a little rude in anticipation and interrupting.

Figure 2. Chatterbox interaction microphone and two of the four speakers.

Conceptualizing a Chatterbox

The project evolved around the creation of a system, named Chatterbox – a gibberish-languaging agent in a multiagent system. The system culminated in an installation, where visitors were invited to join a gibberish conversation with four loudspeaker-agents (see Figure 2). Each loudspeaker was driven by a unique instance of Chatterbox and presented a unique "languaging" agent that spoke gibberish reconstructed from an actual language.

According to Truax (2016), when listening to language, we may speak of a form of dual processing where we perceive two streams of information simultaneously. An audio stream of a voice when speaking affords a listener with both semantic meaning through the organization of vocal sound, as well as paralanguage – those aspects of language that communicate *how* something was said. The paralanguage information stream comprises features such as "pitch inflections, timbre, dynamic changes in loudness, tempo and meter, patterns of stress, and […] the use of silence – exactly those attributes which are used to describe a musical melody" (p. 253).

By creating Chatterbox as a gibberish-languaging agent, removing the semantic information stream of a particular language, we aimed at putting emphasis on this paralinguistic dimension of languaging, and highlighting the affective, personal, and cultural aspects related to translanguaging. The agents construct their gibberish by recombining vocal sound segments, not according to any semantic measures, but by focusing on paralinguistic features, such as inflection and rhythm.

Consequently, we decided on the following base assumptions as guiding the design of the model: *Paralanguage as non-semantic language akin to music, containing both an alphabet and grammar, yet devoid of a semantic representation* (see also Nika, Chemillier, and Assayag 2016). Accordingly, we conceptualized sound as an infinite set that provides an alphabet of vocal sounds for any given language, constituting a subset of sounds relevant to a particular language idiom. The alphabet was structured according to its paralanguage grammar, here considered as musical motives and phrases – analogous to words and sentences, yet intrinsically devoid of semantic meaning. Following the concept of the infinite creativity in a Chompskian generative grammar utterances (Linson and Clarke 2017), we then utilized this paralanguage grammar as the constraint in the creative recombination of the alphabet into new utterances. Such grammar offered us compelling ways to inform a multitude of musical phenomena and generative processes, informed by what may be considered a syntactic mental representation of paralanguage structure.

With a focus on translanguaging, the agents were designed to (re)construct their gibberish based on four unique corpora of speech, each containing about one hour of a single speaker in a specific language. The four corpora comprise a female Chinese speaker; a male French speaker; a male English speaker; and a female speaker of Inuktitut, one of the Inuit languages of Canada.

The interaction of dialogue between the loudspeaker-agents, as well as the potential voices of visitors, is driven by the sonic dimension of the interaction alone, and occurs without the use of any visual components or other additional forms of communication. This poses a significant limitation in comparison to human agents that often use a range of cues in communication, such as lip movements, facial movements, and gestures of other speakers. For example, a conference call without video might invite more confusing interaction between speakers than a conference call *with* video. Accordingly, the agents have to negotiate their turn-taking based on the sound of their respective voices only. This behavior was implemented inspired by the subsumption architecture – an architecture originally developed for creating intelligent and complex behavior through the parallel layering of simple rules (Brooks 1991). A description of the implemented rules is elaborated in a later section, as we first turn to explain the design of the agents.

In this paper we describe the development and implementation of the interactive gibberish multi-agent system Chatterbox, as implemented within the interactive sound art installation Translanguaging. We present a number of related works that deal with concepts of language and translanguaging in an artistic context, before providing a report on the design of the agent from both a technical perspective as well as some of the artistic considerations underlying the development process. We conclude the paper with a discussion on a number of observations made in the process that highlight some of the connections between (trans)languaging and the implementation of Chatterbox.

Related Work

The ideas around language, translanguaging, and dual processing have been explored in many artworks in various mediums, a few of which we illustrate here. We begin by observing the work of Xu Bing (2011) and the development of his Square Word Calligraphy (see Figure 3 for an example of his style of calligraphy). At first glance the symbols may seem like traditional Chinese characters, though when asking Chinese viewers to read it, they will not be able to make sense of it. Further inspection reveals how the Chinese looking characters are actually readable by English readers as they are assembled out of English letters, in the case of the example spelling the combination "square word". Tong-King Lee (2015) examined Bing's work through a lens of translanguaging, where the dynamic communications of multi-linguals utilize linguistic and non-linguistic resources across semiotic boundaries when making sense of language. Lee further commented how verbal language may be seen as only one of the multi-modal semiotic resources available to a language user, introducing "an entire range of potentialities for meaning-making, which is not solely dependent upon verbal semantics, but also contingent on the specific configuration of text, mode, and medium in a particular communicative situation" (p. 444).

Figure 3. An example of Xu Bing's Square Word Calligraphy, spelling out the words "square word" and the artist's name and signature on the right (Bing, 2011)

Figure 4. Illustration of the typeface "Backyard" created by Uri Katzenstein (2015)

Another artist, who explored the semiotic disconnect in language representation, is the Israeli multi-media artist Uri Katzenstein. For the exhibition of his work Backyard, he developed a typeface of alternative graphical representations of the letters in the English alphabet, which he referred to as "a hieroglyphic system developed as a common language for man and machine" (Peleg Rotem 2015). While there is much room to interpret the artist's intentions regarding his semiotic endeavors, the typeface would render readable English text incomprehensible. Through obscuring the semantic content of text, the hieroglyphs confront a viewer with the semiotic resources available in languaging when distinguishing abstract symbols as text.

While the previous discussed artists focused on the visual dimension of (trans)languaging, the work of Claude Gauvreau addresses the sonic and poetic dimensions of oral languaging in the creation of his deconstructed, reconstructed, and imaginary language "Explorean". The sonic qualities of Gauvreau's imaginary poetry were further explored in a theatrical performance of "Faisceau d'épingles de verre," where the text was performed utilizing computer-generated speech (Marceau 2005).

While the work of Claude Gauvreau addressed the auditory dimension of languaging through poetry, the aim of our Chatterbox installation is to additionally explore the *interactive* mode of translanguaging in a multi-agent system. We further address the disconnect in language representation, as present in the visual dimension of the work by Xu Bing and Uri Katzenstein, through the dual processing that occurs

when languaging. By creating a disconnect from semantic meaning making, through the use of gibberish, we intend to highlight the multi-modal means available to us in the paralanguage dimension of communication.

The construction of gibberish

The Chatterbox agent model was developed utilizing the MASOM software agent architecture – a musical agent based on a self-organizing map (Tatar and Pasquier 2017) – and adapting the model to the objectives of this project. The model is implemented in the Max 7 environment and utilizes MuBu (Schnell et al. 2009), PiPo (Schnell et al. 2017), factorOracle (Wilson 2016), and a Self-Organizing Map (SOM) from the ml.* Machine learning toolkit, presented by Smith and Garnett (2012).

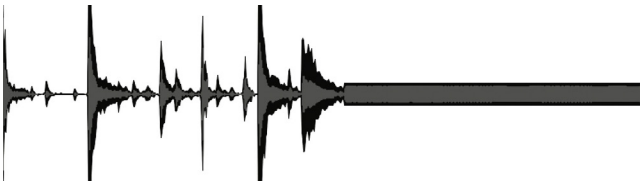
This section elaborates on the development of the alphabet, letters, and grammar at the core of the agent. The *alphabet* signifies the identification of a sound "memory"; the *letters* refer to a learning process that assigns letters to this alphabet; and the *grammar* refers to the generative and creative paralanguaging processes involved in turning the memory into novel instances of gibberish.

Segmentation

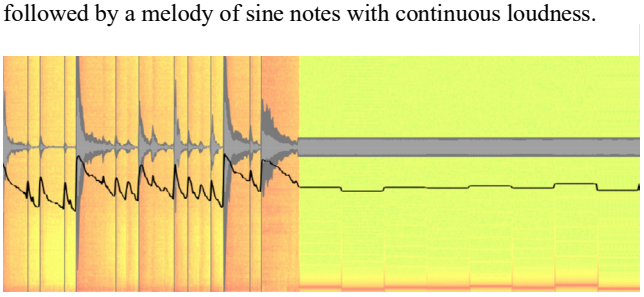
The memory of the system begins with the construction of its alphabet of sound events X, derived from a single-language audio corpus. The corpus is broken down into short audio segments at the approximate size of syllables, isolated from their semantic context.

The segmentation process identified the boundaries of audio events and placed markers between events within the corpus. This created a corpus of voice segments with an average duration of ±200ms. Traditionally the segmentation process has utilized the *spectral energy* of a given audio excerpt for its Onset Detection Function (ODF), identifying peaks in the signal that signify the onset of sonic events. This approach, however, presents difficulty in detecting event onsets in audio with continuous energy, yet containing sonically dissimilar events (see Figure 5b). Such a phenomenon was significantly present in the audio corpus, as speech contains continuity between syllables in words, and words are often slurred together to form sentences. In order to address this challenge, we opted to implement segmentation based on the temporal evolution of the spectral qualities of the signal. Instead of energy, we use the temporal evolution of the magnitude spectrogram of Mel frequency bands $S_{mel}(t, b)$, also known as *melFlux* (Böck, Krebs, and Schedl 2012), which shows significant improvement in detecting these onsets as elaborated below (see Figure 5c).

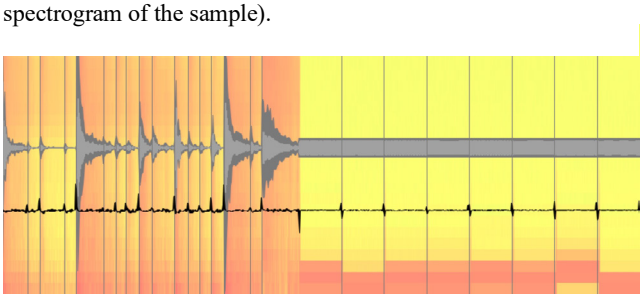
In practical terms, we calculated the magnitude frequency spectrum $S(t,k)$ utilizing an FFT (where t denotes the frame index and k the frequency bin number) with a window size of 23ms (equivalent to 1024 samples at a sample rate of 44.1kHz) and a window hopsize between consecutive frames of 1.45ms (64 samples). The linear magnitude spectrum was subsequently recalculated to the logarithmic



c) input sample for segmentation with initial percussive sounds, followed by a melody of sine notes with continuous loudness.



c) energy based ODF, detecting percussive onset on the left, but not the continuous note onsets on the right (projected over an FFT spectrogram of the sample).



c) melFlux based ODF, detecting both percussive and continuous notes (projected over a 32-band mel spectrogram of the sample).

Figure 5. Illustration of traditional Onset Detection Function in comparison with melFlux ODF

frequency representation of the mel scale, a perceptual frequency spectrum more humanly and musically relevant. We achieved this by filtering the linear magnitude spectrum through a 32 bin Mel frequency filter $M(k,b)$ (where b denotes the filter bin number). This process is described by the following formula:

$$S_{mel}(t,b) = S(t,k) * M(k,b)$$

We additionally scaled the output of this filter logarithmically, as this seems to greatly improve performance (further supported by Böck, Krebs, and Schedl 2012).

The melFlux onset detection function $mF(t)$ is subsequently derived by calculating the difference between consecutive frames, with an average calculated over $\delta = 21$ frames (this number was determined through trial and error). The final onset detection function $mF(t)$ is then given by:

$$mF(t) = \sum_{b=1}^{b=32} \left(S_{mel}^{log}(t,b) - S_{mel}^{log}(t-\delta,b) \right)$$

As the $mF(t)$ contains both spectral, as well as energy information, it allows for a more musically-informed means to find event onsets, including onsets that do not appear

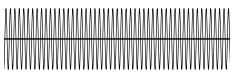
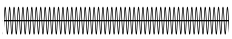
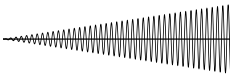
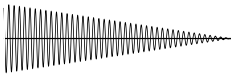
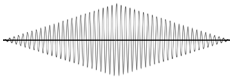
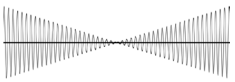
	Absolute loudness	Loudness slope
a) Absolute feature more successful		
	$\mu L(x) = 1.0$	$\mu \Delta L(x) = 0$
	$\mu L(x) = 0.5$	$\mu \Delta L(x) = 0$
b) Slope feature more successful		
	$\mu L(x) = 0.5$	$\mu \Delta L(x) = 1.0$
	$\mu L(x) = 0.5$	$\mu \Delta L(x) = -1.0$
c) Neither particularly successful		
	$\mu L(x) = 0.5$	$\mu \Delta L(x) = 0$
	$\mu L(x) = 0.5$	$\mu \Delta L(x) = 0$

Figure 6. Illustration of successes and failures of both absolute and slope feature values, when observing for example loudness.

within the energy contour alone (see Figure 5). The exact threshold for identifying event boundaries was determined through experimentation with the corpus. In practice it provided a robust ODF that outperformed the energy based ODF in determining onsets in the language corpora.

Paralanguage feature labeling

After the segmentation process, the identified segments $x \in X$ were labeled with an n-dimensional feature vector $F(x)$, providing a fingerprint of audio descriptors focused on the paralinguistic features to be used as our final alphabet X. As the paralinguistic features reside in the inflections and changes of the voice, we concentrated on a differential description of the voice features within each segment, including the change of *Loudness* $\big(\Delta L(x)\big)$ from beginning to end, to identify the overall dynamic development; change in *Zero-crossings* $\big(\Delta Z(x)\big)$ as indicator of pitch-inflection and/or noisiness; the change in 13 *Mel Frequency Bands* $(\Delta B_n(x),\ n = 0, \dots, 12)$, indicating changes in timbre; and *Duration* $\big(D(x)\big)$ as an indicator of rhythm.

Each segment was sliced in 23ms frames with a hopsize of 11.6ms, and the changes in features were calculated between consecutive frames. Rather than analyzing the absolute values of features contained in each segment, we computed the mean and standard deviation of the *slope* of the individual features, i.e. the slope of the respective contours over the segment. This provided a 31-dimensional fingerprint containing $D(x)$ for duration, μ and σ for $\Delta L(x)$, μ and σ for $\Delta Z(x)$, and μ and σ for $\Delta B_n(x)$.

The focus on differential data is further motivated by the fact that the corpus consists of segments from a single speaker. As the loudness, pitch, and timbre of a single person's voice likely remain within a fairly limited range, the mean of the absolute features would likely average out as well. This suggests that the absolute features would offer little information for the vocal characterization of segments. While the differential data would indeed offer little support for identifying absolute pitches and loudness of the voice sounds, it offers a greater emphasis on paralinguistic inflections through *changes* in pitch, loudness, and timbre (see Figure 6).

A latent space of syllables

Having populated our alphabet X with the fingerprints of each segment $F(x)$, we subsequently used our alphabet as a data set for the training of a Self-Organizing Map (SOM).

SOMs are a form of artificial neural networks that utilize unsupervised training (Kohonen 1998). They are used to map a high-dimensional feature spaces onto a 2-dimensional map – organizing, classifying, and clustering the feature space, through the calculation of proximity as similarity of high-dimensional feature sets. In the case of our agent, we utilized a SOM to provide our model with a 2-dimensional representation of the n-dimensional fingerprint of our alphabet. The 2-dimensional map offered an easy-to-navigate "landscape" of sonic material that represents a topological coherence of the original feature space of the segments – a latent space containing the memory of the audio corpus. As the fingerprints $F(x)$ contain differential data, indicating the slope of features within each segment, we regard the latent space of our SOM as a kind of *gradient map* of sonic features ∇F_{SOM}.

We subsequently assigned each segment x to a node coordinate $node_i$ on the SOM according to the best matching unit function $BMU\big(F(x)\big)$ that indicates the nearest node to a particular fingerprint. The nodes of the SOM are then used to cluster various segments in our library according to the respective similarity of their feature array $F(x)$, meaning that multiple segments may be mapped to a single node. As our gradient map ∇F_{SOM} does not represent absolute descriptors of sound, segments that are clustered together on a single node of our SOM might contain entirely different timbres, yet still share similar features of languaging inflections.

(Re)constructing non-semantic meaning

Having assigned a node coordinate to each segment, we created a node sequence that followed the order in which the segments appeared in the original audio. We then used this order to encode what is called a Factor Oracle (FO).

FOs are a tool originally developed for data compression (Allauzen, Crochemore, and Raffinot 2002) that offer great potential in creative applications. By encoding the representation of structure of a string, FOs allow for the efficient querying of a string for existing substrings (also known as factors) through the inclusion of forward-links; additionally, they enable the identification of repeating patterns through the encoding of suffix-links. Additionally, the FO representation provides a powerful tool for the generative exploration of novelty, utilizing the encoded paralanguaging grammar built from the provided corpus. This strategy presents us with a promising form of style imitation that explores the creative space presented by the original corpus.

By assigning each segment in our corpus with a coordinate in our latent space, we represented the corpus as a string of node coordinates, encoding the "route" a particular sequence of segments represents on the gradient map. For example, if the first segment was mapped to $node_a$, the second to $node_c$, the third to $node_b$, and the forth to $node_c$, we get the sequence:

$$s = node_a, node_c, node_b, node_c$$

Consequently, the clustering of segments on the SOM nodes according to their similarity, offered the possibility to identify patterns within the corpus. It is these repeating patterns of consecutive nodes that provided the motives and phrases for the construction of our paralanguaging grammar.

To conclude, by building an FO out of the string of nodes as encountered in the original audio, we encoded the paralanguaging grammar of our corpus. Subsequently, in the generative phase of our agent, we used the FO to explore and predict the order of segments as encoded. Utilizing the generative capabilities of the FO, the agent was able to speak new utterances devoid of semantic content, by playing node sequences as generated by the FO – thus creating a paralanguaging gibberish agent.

The emergence of dialogue

Having established the paralanguaging ability of the gibberish agent Chatterbox, we are now faced with the task of getting the agents to enter into a dialogue. In order to create a dynamic and interesting behavior of the agent's turn taking, we drew inspiration from the subsumption architecture in layering simple rules for the creation of complex behavior (Brooks 1991). We subsequently defined a number of heuristics that govern the turn taking behavior of the model.

At the base of the model's subsumption architecture we defined the agent's listening capabilities to detect silence and start speaking, as well as to stop speaking at the end of an utterance. This constitutes the first layer of the model's heuristics:

- **Layer 1: "be chatty"**
  - *Start speaking when detecting silence*
  - *Stop speaking at the end of an utterance*

Through experimentation we found that the node with the minimum sum of all features in the latent space of the SOM, offers a reasonable indication of an end-of-utterance. Accordingly, we defined the agent to stop speaking when the node being played crossed a certain threshold, defined as a Euclidian distance from the minimum on the map.

While this rule would successfully govern the turn-taking between two agents, the addition of a third agent would cause two agents to respond and continue talking simultaneously. We therefore added another layer to check whether other agents are talking:

- **Layer 2: "politely test the waters"**
  - *If after n-segments there is silence, continue speaking*
  - *Otherwise stop speaking*

By defining the checkpoint after n-segments (default n=3), small variations in segment length between the various uttering agents, determine which agent will continue speaking and which agent will stop.

In order to also include the anticipatory nature of how people interact through interrupting each other in a dialogue, we allowed the agents to do the same when expecting another agent to stop speaking:

- **Layer 3: "also be a bit rude"**
  - *Start speaking when predicting another agent's end of an utterance*

The ability to anticipate the end of a utterance was implemented through the use of an FO conditioned by the same sequence that also governs the speaking of the agent. By analyzing the input audio-stream according to the same 31 paralanguage features on which the agent was trained, the agent can match the input-speaker to a current node on its own SOM. Subsequently, the agent can predict a possible continuation of the external speaker with the use of its FO, rendered from the subjective perspective of how it would possibly continue the utterance itself. When the agent anticipates the external speaker to enter into the minimum of the latent space, suggesting a potential end-of-utterance, it may start speaking and somewhat rudely interrupt.

To promote dialogue to occur between two distinct agents, we added another layer to encourage the agent to respond when testing the waters in layer 2:

- **Layer 4: "engage in dialogue"**
  - *Gradually increase n while speaking, encouraging engagement in discussion.*

As a final layer, we moderated the discussions by encouraging agents to stop uttering when other are speaking:

- **Layer 5: "moderate discussion"**
    - *Gradually increase proximity threshold to end-of-utterance when speaking simultaneously.*

By enlarging the threshold that governs layer 1 to stop speaking, the agent is gradually encouraged to stop speaking when other agents are speaking concurrently.

It should be emphasized that each agent is trained on a different corpus with a unique voice and a different language. As such, the inclusion of the subjective dimension of anticipation is what promotes the translanguaging behavior of the multi-agent system. In its essence, the subjective perspective of the agent in perceiving and responding to its environment, encourages the agent to interpret, and quite possibly misinterpret, the other agents. However, the agent (mis)interprets and foresees its environment according to how it would expect to behave itself.

Discussion

We have presented the interactive multi-agent system Chatterbox, as part of the sound art installation Translanguaging, exploring the notion of translanguaging as a mediation of multilingual and intercultural communication. We have discussed the act of languaging as a dual process comprising both semantic language communication, as well as paralanguage that indicates the affective, personal, and cultural aspects related to translanguaging. Through the creation of the Chatterbox agent, generating gibberish vocal streams devoid of semantic content, we aimed to highlight the paralinguistic dimension of languaging.

Additionally, we provide a technical description of the Chatterbox agent model, and outlines the artistic motivations for the technical considerations of the implementation. The agent model comprises a *gradient map* that clusters a segmented audio corpus in the latent space of a SOM. The audio segments are assigned a node in the latent space of the SOM according to their paralinguistic *fingerprint*. Describing the audio corpus as a sequence of nodes on the SOM, we construct an FO for the encoding of the paralanguage *grammar*, and use the FO for the creative generation of novel utterances by the agent according to the encoded grammar. Incorporating simple subsumption architecture inspired rules, we further moderate the interaction between the gibberish agents, creating rich and complex multi-agent behavior in "paralanguaging discussion".

While the above describes the final implementation of the gibberish agent model, we would like to share several observations we made throughout the process of creating the Chatterbox agent, highlighting some of the connections between the notion of (trans)languaging and the implementation of our model.

Firstly, after implementing the first three layers of the turn-taking heuristics, the agents were beginning to display rich and complex behavior when interacting with one another. We tested the system and its interaction with a human agent through a microphone in a studio environment using a simple small speaker setup. We worked on fine-tuning the model in this environment, before working with the eventual 4 speaker setup, until the agents behaved satisfactory and the interaction was engaging. However, when eventually scaling the setup and having the speaker-agents spread out comparable to how human agents would converse around a table, a curious phenomenon emerged: the human agent interacting through a microphone would respond to a particular speaker agent, and expect the same agent to respond. In actuality however, often another agent would respond causing some cognitive confusion for the human agent, needing to redirect the attention and physically rotate in order to face the newly engaged speaker agent. Surprisingly, this conflict was entirely missed when observing the agents from a localized perspective of the single speaker setup, and only became apparent when human embodiment became part of the interaction, having to rotate one's body to align with our perceptual focus. This observation led to the addition of the fourth heuristics for the interaction, encouraging the agents to engage in local two-agent dialogues within the larger multi agent discussion.

Secondly, we observed how the agents would often start speaking simultaneously as they were implemented with the same heuristics. This behavior created a sense of commotion in an often dense gibberish soundscape, and made the interaction seem somewhat hectic. The addition of the fifth layer in the turn-talking heuristics was intended to moderate the discussion accordingly and encourage agents to let the others speak, limiting the undesired behavior (this in addition to the second layer already stating to "test the waters" before continuing to speak). While this indeed improved the interaction, we noticed it did not eliminate the recurrent commotion altogether. However, rather than regarding this as a failure of the model, this behavior may actually be indicative of the multimodal dimension of human communication. Akin to a conference call without video, the agents were limited in medium to negotiate their turn and ended up "accidentally" speaking together. We recalled how this issue also often emerged during the pre-video conference calling era. Any improvement for this behavior would likely come from incorporating a multimodal dimension to the interaction, such as providing the agents with visual feedback, as possible future directions for developing the Chatterbox agents.

As a final observation, we noticed that when the agents would speak with one another, there seemed to be a lacking connection in how one agent would answer the other. Admittedly, the agents were merely generating sentences according to *their own* FO, exploring the latent space of the SOM; however, the challenge lay in how to create the connection in between responses when there is no semantic content. The approach for addressing the challenge was motivated from the same subjective perspective explored in the third heuristic, where the agent anticipates another agent to finish speaking by mapping the input to its own latent space. By fingerprinting the input audio-stream of the other agents, the agent can map and interpret the input as a node sequence from the subjective perspective of how it would

paralanguage itself. Subsequently, when initializing speaking, the agent can prime the FO governing its paralanguaging gibberish, offering a subjective interpretation of continuation of the external speaker. This solution follows a similar line of thought as the Continuator (Pachet 2003) in providing a stylistically consistent continuation between human and machine, both creating and anticipating according to a concept of style-imitation.

To conclude with a quote from Prof. Angel Lin, discussing her experience of the Chatterbox installation in a panel of language education researchers:

> "I think you can't escape that kind of feeling of […] otherness, when you hear something that you don't understand, chopped into bits and pieces. […]. It kind of represents what you feel when you're encountering someone from a different culture, from a different background, who speaks with a different accent, or different tone, or just a different style, or just a different rhythm. That kind of alienness or otherness is so well represented there […], it is the beauty of what it is."

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Schizomachine: a wearable *schizo*-interface for a *schizo*-body

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Abstract

Affective states triggered in our body during an artistic/aesthetic experience have been discussed by philosophers over the years under the concept of sensation. From a philosophical viewpoint, sensation is a subtle but intense emotional phenomenon, mainly perceived when we are experiencing art. From another perspective, Neuroscience has dedicated itself to analyzing this phenomenon in laboratory practices by using biofeedback systems like EEG (electroencephalogram) and ECG (electrocardiogram), among other systems such as MRI (magnetic resonance imaging). In such procedures, the subject is aware that she/he is part of an experiment, which could repress spontaneous emotions as the one triggered in an artistic experience. *Schizomachine* is a research-work in progress that aims to investigate those subtle affective states of the human body during the aesthetic experience in a museum or art gallery by means of mapping and monitoring methods of the viewer's physiological parameters. In this paper, we present the concept of the artwork and the prototype of the *Schizocap*, an EEG cap that composes the work. *Schizomachine* will be initially composed by an EEG cap (the *Schizocap*), that generates the *input* data, and by a clothing, called *Schizobody*, where the data can be seen in the form of light (the *output*).

Keywords

Schizophonia; body; listening; sensation; sensitive communication; wearable interface; smart clothing; biofeedback; brain-computer interface; affective technology.

Introduction

In November 2011, an exhibition of US artist Nan Goldin's works, taking place in *Oi Futuro* Cultural Center in Rio de Janeiro, Brazil, was canceled by the institution's direction a month before its assembly. The exhibition would bring together more than a thousand images registered by the artist since the 1970s, including *The Ballad of Sexual Dependency*, with over 700 photos of protagonists, including the artist herself, captured in intimate moments. Among the images to be exposed, the pictures of children, naked or dressed, were considered "improper" by the direction of the institute, unaware of Nan's work. The exhibition cancellation shook the Brazilian artistic milieu that year and rekindled the debate over censorship[1]

In September 2017, the *Queermuseu* exhibition - *cartografias da diferença na arte brasileira*-, which gathered works by 85 Brazilian artists, including Adriana Varejão, Alfredo Volpi, Cândido Portinari, and Lygia Clark, was barred by *Santander Cultural* in Porto Alegre, Brazil, one month earlier than expected, after protests by conservative religious and political groups, claiming that the works represented "immorality" and "blasphemy", and speaking "in favor of zoophilia and pedophilia"[2]. "Acts like this were only inscribed in History during Nazism, Fascism, and dictatorships," in the words of Nan Goldin's exhibition curator, Ligia Canongia (2011).

In addition to censorship, a theme that has come to debate again in Brazil, those two episodes, added to other recent events, draw attention to the symbolic violence of the reactions of censor groups, which highlight the *potency of affection* of Art. Such reactions occur not only on the symbolic level of a policy of ignorance (as in the case in Brazil), but rather occur in the body: the spectator's body and the social body on the micro level, in the form of visible and invisible physiological reactions of those bodies and all the contamination reverberated by the reactions that go beyond the boundaries of the physical body heading to a social body, on a macro level.

The reactions in the body during the artistic experience were largely explored by *Body Art*, in particular by Marina Abramovic in her 1970s performances, in which she pushed her body to extremes. In *Rhythm 0* (1974), the affections discharged on the artist's body during her performance were added to the affections of the audience, that became part of the work through the interaction proposed by the artist[3]. The violence here, as in the cases cited, was not only symbolic,

[1] The exhibition was later hosted by the Museum of Modern Art in Rio de Janeiro, Brazil (MAM-RJ) and took place between February 9 and April 8, 2012.

[2] By means of a crowdfunding campaign, the exhibition later took place in *Parque Lage*, Rio de Janeiro, between August 18 and September 16, 2018.

[3] In addition to the artist's presence, the work was composed of 72 objects on a table, including rose, perfumes, bread, grapes, wine, scissors, nails, metal bar, and a pistol with one bullet, and the instructions: "I am an object, you can do whatever you want to do with me and I will take all responsibility for six hours."

but became visible on the artist's body. What we have from this work are memories in the form of images that still affect us because they "reveal the human nature", as curator Klaus Biesenbach says in the documentary *The Artist is Present* (2010).

Figure 1. *Rhythm 0*, 1974 by Marina Abramovic

The ability to communicate by means of Art is part of human nature. However, these potent episodes demonstrate that, in Art, communication takes place not at the language level but on the sensitive, in what pulsates between the audience and the artwork, whose potency is capable of displacing gravity center of the affected body. "A work of art is not an instrument of communication" (Deleuze, 2006), it is a *potency of affection* working as an "affect-shooting weapon", which, whether happy or sad, results from the encounter between audience and artwork. It is about the body's potency of affection in Art that this article intends to reflect, by means of a work-research in progress that we call *Schizomachine*.

The concept of the *Schizomachine*

Schizomachine is a smart clothing system proposal that aims to make some sensitive communication processes of the human body visible by means of mapping and monitoring methods of the viewer's physiological parameters and transduction of these data into light during the artistic experience. It is assumed that there is a sensitive universe of communication that expresses itself stoutly in an aesthetic experience, while we are appreciating art in a museum, concert, cinema, art gallery, or even walking on a street of a beautiful city. The aesthetic experience is also a communication experience.

That doesn't mean the artwork (or the artist) communicates directly with the spectator, but something from the spectator is revealed in their body which unveils itself as more sensitive after the experience. By affecting the audience, displacing them from their commonplace, and arousing in them an emotion or even a reflection, something about this audience (and this body) is revealed, both in a micro universe (in the body's physiological responses) and macro universe (all the senses that emerge from a collectivity affected by some exhibition or work of art, as in the examples cited).

The body's physiological reactions can be measured through "affective technologies" such as biosensors and neuro and biofeedback systems[4], which have been appropriated by artists since the 1960s. According to Nijholt (2019), the first artistic experiments using BCI (brain-computer interface), for instance, date from 1965, with the work *Music for Solo Performer* by the US composer Alvin Lucier; and 1967, with the studies of composer Richard Teitelbaum about EEG (electroencephalogram) and *biofeedback*, which resulted in the works *Organ Music* and *In Tune*, in whose performances (1968) he also used heartbeats, in addition to brain waves.

In the visual arts, in the early 70s, US artist Nina Sobell did her first experimentations with EEG by exploring the silent communication that takes place on the invisible level of the brain through video. From those experimentations came out the work *Brain Wave Drawings*[5] (1973), in which the artist still today explores what she calls "internal and external portraits" of the participants. In the same period, US composer David Rosenboom[6] began his research on *neurofeedback*[7] and the use of BCI in music composition processes and real-time performances, whereby both the publication *Biofeedback and the Arts: results of early experiments* (1976) and several performances with those devices ensued (Ibid.).

Experimentations with sensory devices have been increasingly common in the art universe as such technologies become more accessible. This has brought Art, Science and Engineering closer together in the form of interdisciplinary collaborations at the same time artistic performances and communication processes have been enhanced.

The *Schizomachine* emerges in this context as a conceptual and experimental work in progress, inspired by three main concepts that arose in different moments in time: *silence*, by John Cage; *sonocitology*, by James Gimzewski and Andrew Pelling; and *schizophonia*, by Murray Schafer.

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[4] *Biofeedback* is a technique used to monitor and control some body functions by means of electrical sensors that measure body information such as heartbeat (electrocardiogram - ECG), muscle contraction (electromyogram - EMG), respiration, temperature, sweat. This technique allows the user to learn to control certain physiological reactions of the body in order to improve a health condition or physical performance.

[5] Cf. http://www.ninasobell.com

[6] Cf. https://davidrosenboom.com/video

[7] *Neurofeedback* is a type of *biofeedback* that uses a variety of methods, such as electroencephalography (EEG), to monitor brain in real time. Like *biofeedback*, which allows the user to regulate their physiological and emotional reactions, *neurofeedback* allows the control of central nervous system activity. In clinical applications, *neurofeedback*, associated with *biofeedback* techniques and devices, can contribute to a series of treatments such as sleep disorders, stress, attention deficit, among others.

In pursuit of silence

In 1951, as he entered an anechoic chamber at Harvard University, American composer John Cage made the notion of silence "audible". While listening to his own body sounds (a high one, from the nervous system in operation, and a low one from blood in circulation) and taking silence as material for composing as much as any sound, Cage does not only demystifies silence - thought of as lack of sound until then -, but also its own absence becomes presence: of a sound, of a secret, of a symptom, of a sensitive.

Unlike absence, which assumes presence, the void, just like the silence and the white (of a screen, of a sheet of paper), does not oppose to "full" (full of noise, full of color), once one and the others are bodies that vibrate infinite possibilities. They are existents that are present by absence - when it reaffirms itself in the presence of the *imperceptible*. "If I don't hear it, does it still communicate?," asks Cage, in *Silence* (1973, p. 41).

The music of the invisible

In 2002, James Gimzewski, professor and researcher at the Departament of Chemistry at UCLA (University of California, Los Angeles) and his then PhD student, Andrew Pelling (professor and researcher at the University of Ottawa), expand the concept of listening while making the silent sonority of cells audible. Through an *atomic force microscope* (AFM), the researchers found out that the yeast cells oscillate in a nanoscale, likely to be amplified to a range that is audible by the human ear. They named this new study field *Sonocytology*.

To Gimzewski, the AFM can be considered a new type of musical instrument, named *tactoscope* by artist Victoria Vesna. Unlike the microscopes that use optical images, the AFM "plays" the cell with its small tip and "feels" the oscillations that "load" its membrane. "It is the sense of touch, the notion of feeling, which allows us to 'see' the nano-realm." (Niemetz, 2004, p. 20).

From a simple reasoning: any vibrating object or surface produces pressure in the air around, and thus, emits sound; if the cells vibrate, then they must produce some sort of sound, this finding not only enhances our concept of listening, but also changes our relation with silence. John Cage's question then seems to be answered by the "music of the invisible" in the moment that the hidden "language" of cells is revealed by the agency of this device, in a magnified, amplified manner. The invisible communicates, and so does the inaudible.

Schizophonic machine, an exercise of possible listenings

In 1969, Canadian composer Murray Schafer coined the concept of *schizophonia* to describe the splitting of a sound (*schizo*) and its issuing source (*phonia*), such as the case of electroacoustic reproduction. When a recorded sound is separated from its original source, there is a displacement between what one can hear and see. This can confuse the brain, which cannot always determine the source.

In the case of the "music of the cells", the original source (the cell itself) can only be heard by means of a sensitive and *schizophonic* process (the AFM) of movement reading and amplification ("the eagle's eye", as said by Deleuze & Guattari) because the "movement has an essential relation to the imperceptible; it is by nature imperceptible" (Deleuze & Guattari, 1987, p. 281).

As a concept of the *Schizomachine*, *schizophonia* is suggested to be a condition to our existence right before the body becomes *a* body. It occurs, for example, within the uterus, where the fetus listens to the mother's sounds and recognizes them, as well as to the external sounds without recognizing the source that produces them. The fetus not only listens to the sounds, but also vibrates with them and transfigures itself in sound. Thus, it defines its sound - a rhythmic identity. The fetus grows in the woman's body and they split at birth. It is *schizo* by nature (*schizo*-body), once it is no longer part of the mother's body.

The body would be, then, a *schizophonic machine*, in whose interior affects float, a continent where the sonorous rest. Among the sounds from the outside and the ones produced within the (human) body there is a zone of indiscernibility that speaks (sometimes yells) in silence, but keeps histories in its cellular memories that could be told from the points of view of sound and listening.

The movement that generates vibration and sound is the common element that pervades the studies mentioned herein. The process of "feeling" a cell by the agency of the AFM and interpreting its movement as sound is the foundation of *Sonocytology*. To "look only at the movements", say Deleuze and Guattari (Ibid., p. 282). Nanotechnology makes the micro intervals among matters visible and audible, but long before its existence, the body, in its animal and human microscopic ancestry already accessed, secretly, the *imperceptible*.

Before nanotechnology, the electroencephalogram created in 1929 by German psychiatrist and neurologist Hans Berger demonstrated that the human brain produces electric currents that can be measured in the scalp by electrodes. Those electric currents or impulses draw waves (brain waves) that reflect the brain activity produced as the brain cells (neurons) communicate among themselves, which can also reveal thought patterns and affective states, such as stress levels and mood swings.

Such technologies show us that communication would begin with the body, in its most silent form, even before the body becomes *a* body. Long before acquiring the (oral and written) language, the human beings already communicated in their "proto-existence" in the "uterine box". Similarly, before the sound of speech comes out, one speaks with the eyes, hands, facial micro-expressions, sweat, with the temperature, movement and body gesture, in the daily encounters or in encounter with art. The human communication also "speaks" in its micro-universe long before an existence in the macro.

The design of the *Schizomachine*

As an experimental proposal, the *Schizomachine* emerges from the desire to tell this body's history (its affective memories) from a sonorous-visual experimentation with "affective technologies", such as biosensors and neuro-biofeedback systems, aiming to explore other possibilities of listening, having the body as an object, the skin as an interface, and the sight as a listening (a "listening of sight").

Beyond the exploratory use of those technologies, what is intended is an exercise of possible listenings, in which the production of sensations – the effective potency of Art – can be experienced by means of a reverse process: a *self-affection* when the spectator becomes the work of art and vice-versa. That is, instead of looking at it from the outside, one would look at it from within by getting (wearing) into the machine, such as the works by Brazilian artists *Parangolé* (1960), by Hélio Oiticica, and *O Eu e o Tu: Roupa-Corpo-Roupa* (The I and the you: Clothing-body-clothing, 1967), by Lygia Clark.

Figure 2. *O eu e o tu,* 1967 by Lygia Clark and *Parangolé*, 1964 by Hélio Oiticica

It is assumed that the human body is a "sound-body" (a sonorous body), whose vital signs ("vibrations") change according to the emotions produced in the relationships established in the daily life and the sensations triggered in the encounter with Art. As is the case with blood pressure and heart rate, which accelerate depending on the intensity of emotional discharge. What would the body in its relation with Art "sound" like? Is it possible to capture the sensations - those which precede emotions - produced in their encounter with Art?

Such questions evoke an earlier question, which refers to the very concept of sensation, widely discussed in Philosophy. If we understand communication as a sensitive process, beginning in the body, sensation would be a first stage in this process: *the firstness*, from Peirce's (1958) semiotic perspective[8]. From this standpoint, sensation would precede the emotion (*the secondness*), which precedes feelings (*the thirdness*), according to Damásio (2003, p. 53). Sensations, emotions, and feelings, compose, then, an aesthetic dimension of (our body's) life.

As a starting point, in order to investigate those affective states of the body during the aesthetic experience, that is, to make this aesthetic dimension of the body visible, the prototype of an EEG cap was created as part of the wearable interface named *Schizomachine*, which will be used in the context of an artistic assembly. The *Schizomachine* will be initially composed by an EEG cap named *Schizocap*, that generates the *input* data, and by a clothing with LEDs fixed to it, called *Schizobody*, that functions as a sort of wearable display where the data can be seen in the form of light (the *output*).

The *Schizocap* is comprised by thirteen dry electrodes (twelve plus-minus and one reference) attached to a structure made by crochet, and connected to six EEG sensors and six correspondent channels of the interface board made by the BITalino[9] system, that digitizes and transmits the signals, via Bluetooth, to a processing computer. The current phase of the research involves the challenge of processing, analyzing and mapping those data. Both the MATLAB software, used for the study of possible data visualizations, and the Python software, used for the development of the sensation/emotion pattern recognition system in the data generated from pilot experiment, have been cooperating tools in this process so far.

Figure 3. The Schizocap photos show the front and top electrode positions based on the 10-20 System, worn by a man and woman, respectively. The right photo shows the final version of the prototype. Photo by Thiago Barcelos

[8] The three phenomenological categories of Charles Sanders Peirce (1958), that are, *firstness* (quality of feeling), *secondness* (reaction), and *thirdness* (representation), are quoted here to think a "*logic of the sensitive"*, in which sensation is the first in this process (*firstness*), followed by emotion (*secondness*) and feeling (*thirdness*).

[9] https://bitalino.com

The electrodes were distributed on the cap according to the International 10-20 System, to collect data from different areas of the brain. In the installation, the stimuli are produced by the user's own body during the experience by means of a passive Brain-computer Interface (BCI) System, in which "the subject has no intention to control or communicate using BCI." The subject's brain will be "measured without him or her being asked to voluntarily evoke a particular kind of brain activity or paying attention to external stimuli that will have an effect on brain activity." (Nijholt, 2019, p. 6).

Figure 4. The Schizocap worn by a short-haired man. The photo shows the design detail of the buckle to fix the cap on the head. Photo by Thiago Barcelos

Unlike Oiticica's Parangolés and Lygia Clark's overalls, whose interaction in is the user's movement (the dance in the *Parangolés*, and the touch in *The I and the you*), who is no longer a mere spectator but the work itself (wearing instead of watching), the movement in the *Schizomachine* is supposed to be as imperceptible as the silence or the sounds of the cells in such a way that, on the one hand, it can reduce the production of artifacts and, on the other hand, it can promote a "self-listening" of one's own body.

Figure 5. The Schizocap worn by a long-haired and average-headed woman. Photo by Thiago Barcelos

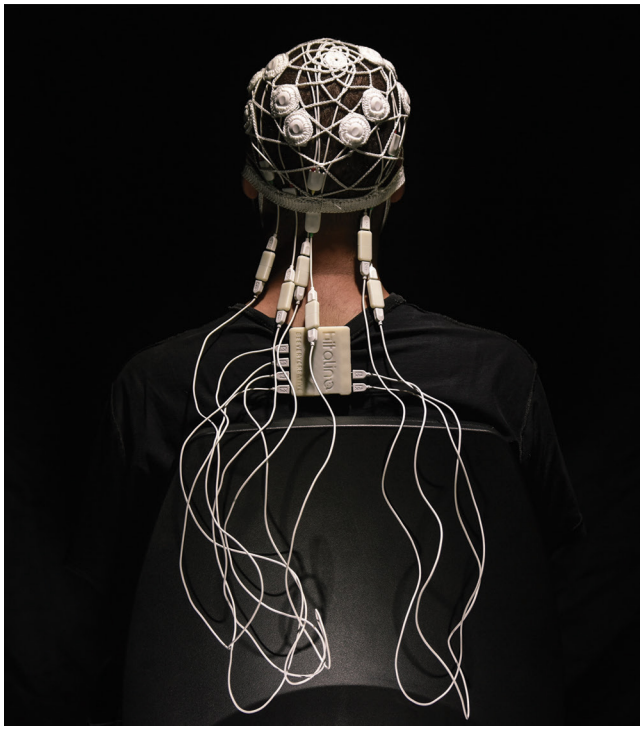

Figure 6. The Schizocap worn by a bald average-headed man. The photo shows the electrodes connected to the EEG sensors and BITalino board inside 3D printed boxes. Photo by Thiago Barcelos

Final Considerations

Although this research has focused only on brain waves so far, if affects happen simultaneously in the body and mind, as Spinoza (2001) points out, the other brains that inhabit the body must be taken into account in this work. From the viewpoint of artistic experimentation, it is therefore necessary to demystify the brain as a sovereign entity that commands the body and explore other possible listenings with other possible devices, such as the electrocardiogram (ECG), for instance, among others. Or else, it is necessary to understand in depth the very concepts of brain, mind and consciousness, under a conceptual and scientific standpoint. A way to be trod.

As Lilia Moritz Schwarcz says (2019, p. 29), "every [work] keeps its secret to itself. Every [work] can be read from the relation it establishes with its own secret; the secret of the stories it does not reveal (...)". As a research-work in progress, the *Schizomachine* also contains a secret that remains folded in the lines that combine it, in its design in crochet, another projecting process, in which the drawing is made by gesture, in the act of projecting, in the meeting of the thread with the needle, not with the trace on the paper or computer screen.

From the mixture of the handmade technique, assigned to the feminine, with technology, dominated by the masculine, part of this work was born, with its gestation process in progress in pursuit of other brains that constitute the human body in order to make the *sonorous forces* of this body visible as well as "making audible nonsonorous forces" (Deleuze & Guattari, 1987, p. 96).

A *sonorous body* presupposes a listening. Therefore, the *Schizomachine* intends to draw attention to the body through listening by proposing an exercise of possible listening, in which the affective states of the body could be "listened," not necessarily with the ears, but with the eyes, through a "listening of sight". Sound waves (body signals) thus transmute into luminous waves and bring back to the body its first condition of *schizo-machine*. That implies a solitary experience of listening to yourself and seeing yourself no more as flesh, but color (light); no longer split, but resonant.

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Experimenting with Robotic Softness

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Abstract

This paper presents *Pero sans Cimon*, a dynamic sculpture that critiques female body use and identity through the medium of *soft robotics* - a domain of robotics that uses materials and actuation mechanisms that mimic biological structures. Existing soft robotics research emphasizes the practical affordances of soft robotic mechanisms for locomotion, manipulation, wearable technology, and architecture. Instead, our objective is to examine soft robotics as an aesthetic medium through the analysis of the *Pero sans Cimon* artwork. We use Andreas Broeckmann's five aspects of the aesthetics of the machine: associative, symbolic, formalist, kinetic, and automatic to demonstrate how soft robotics, in continuity with twentieth-century machine art, can enable artistic expressiveness. Furthermore, we extend these principles by describing how the formalist and kinetic properties of soft robotics support new forms of artistic representation. We conclude by discussing the artistic implications of this technology. Specifically, we examine the potential social symbolism that may emerge from a robotic medium developed primarily for its aesthetic and mechanical resemblances to the human body.

Keywords

Robotics, Softness, Machine Aesthetics, Machine Art, Sculpture, Research-Creation.

Introduction

Soft robotics has been on the rise since the late 1990s and has opened new possibilities for today's roboticists [9]. To date, soft robotics technology has primarily been applied to three fields: manipulation, locomotion and wearable technology [8]. Soft robotics has also been applied in architecture as a mechanism to create malleable and adaptable structures and environments. Such soft robotic architecture can dynamically and directly interact with the human body and its surrounding environment.

The notion of softness has also been important in the field of sculpture. Much of twentieth-century sculpture was dominated by hard materials. The introduction of soft materials enabled sculptures that had unstable properties and multiple degrees of freedom. These materials opened new expressive departures from the rigidity and austere qualities of bronze and marble [6]. For instance, soft materials brought playfulness and detachment from functionality in the work of Claes Oldenburg [6], and created tension between persistence and evolution in the work of Eva Hesse [10].

Figure 1: Fullview of *Pero sans Cimon*, 2019.

The transition from hard to soft materials in sculpture resembles the transition between hard and soft robotics in engineering. However, in engineering, softness brings novel functionalities. In sculpture, it achieves new aesthetic qualities. We believe that soft robotics in machine art allows for both.

Through the creation of the artwork *Pero sans Cimon* (Figure 1) (Video Link: https://vimeo.com/331481349), we sought to bridge robotics and sculpture by investigating the artistic expressiveness of soft mechanisms. We used soft

robotics techniques to symbolize the female body used as a means of production in our current technological context. Soft robotics has inherent symbolic values that relate to its relationship with the human body. The critical qualities of art production explore this interaction.

We present our concerns through the lens of Andreas Broeckmann's machine aesthetics, a seminal set of principles to explain how specific artworks relate to technology through association, symbolism, formalism, kinetic and automatism [1]. This paper examines how Broeckmann's machine aesthetics is a relevant framework for understanding the creative affordances of soft robotics in the field of art. In the remainder of this paper, we first describe prior work in soft robotics and sculpture. We follow with a description of the creation of *Pero sans Cimon*, and we conclude with the symbolic values to consider when using soft robotics for artistic expressiveness.

Background

Across art and engineering, the term softness has different meanings and associations. In many cases, softness denotes pliant materials or structures [2].

Soft Robotics

In the field of soft robotics, "soft" refers to the body of the robot, where soft materials (e.g. silicone) are key to conceiving soft robot bodies [8]. While the traditional approach to robotics assumes rigidity and predictable behaviors, the soft approach involves extensible materials that offer a greater potential for interaction with people and the environment; the structure is able to deform and absorb. Soft robotics can achieve more degrees of freedom than hard bodies, which can achieve a maximum of six degrees of freedom (three rotations and three translations on the x, y and z axes). The body of a soft robot contains "an actuation system, a perception system, driving electronics, and a computation system" [8], which correspond to the expected characteristics of a rigid robot. However, the soft body is biologically inspired by muscle-like arrangements that allow multi-directional movements. Therefore, soft robots demand new approaches to modeling, control, dynamics and planning to respond to their surroundings. Soft robotic systems and their natural tissues are compatible with the medical field and wearable applications since they have the potential to change their morphology in reaction to their environment in a manner that would be ambitious with hard robotics [8]. The development of soft robotics seems, therefore, oriented towards its possible contributions in human-robot interaction. These contributions imply symbolic values that we discuss later in this paper.

Softness in Art

Our interest in exploring the use of soft robotics originated from our intention to represent the female body in metaphorical, physical and dynamic ways. Our aspirations were influenced by early bio-inspired machines like the birthing machine developed by Mme de Coudray in the 18th century (Figure 2).

Figure 2: De Coudray, A. (18th c.). Birthing Machine [Mannequin]. Musée de l'Homme, Paris. Image taken by Wikipedia User: Ji-Elle.

Mme de Coudray was King Louis XV's midwife but was also engaged in teaching the profession. She led large classes, necessitating a hands-on practical device. Mme de Coudray designed a human-sized soft doll to teach her apprentices how to give birth [3]. The doll was made of "colored linen and pliant leather" that was stuffed with padding as well as human bones, and many parts of the doll were detachable to allow a better comprehension of the female anatomy [3]. The innovative modularity of Mme de Coudray's machine was strikingly ahead of its time; modularity is now a common property of modern robotics.

Softness has been integrated into the field of sculpture in the second half of the twentieth century. Artists such as Claes Oldenburg and Eva Hesse revolutionized the practice by exploring new forms and materials that shook the traditional conception of sculpture. In the sixties, Oldenburg began making artworks entirely from soft materials. The objects he created are subject to gravity but what they lose in structure, they gain in playfulness. An exhibition pamphlet of the MOMA in 2013 mentions that "[t]heir soft, pliant, and colorful bodies challenged the convention that sculpture is rigid and austere, and their subject matter and colossal scale infused humor and whimsy into the often sober space of fine art" [6]. Oldenburg was inspired by the technology around him (e.g. telephones, typewriters, mixers, etc.). He often created two sculptures representing the same object. One would be made of rigid and the other of soft materials. The combination of both versions would be humorous as the hard version would remain functional and the soft version impossible to use, which could imply that technology is becoming impotent. The artistic intuition that Oldenburg had at the time is similar to the shift that happened in robotics. The loss of rigidity in the realm of robotics allowed multifunctional performance since these new materials could change state and better adapt to the shape of the human body and the environment. Hard robots have a greater difficulty adapting to, and co-evolving with, their sur-

roundings.

The sculptor Eva Hesse was a vanguard of the post-minimal art movement. She used materials such as latex, rope, fiberglass to create sculptural pieces. The softness in her approach is embodied in both the medium and the instability of the materials. Latex and fiberglass are slowly chemically deteriorating [5], which bring an ephemeral quality to the artwork. Her use of flexible materials transmits the sense of forms that allowed gravity instead of resisting it, like in Minimal sculpture [7].

Hard materials are not the only available medium when it comes to sculptural installations, exemplified by the work of Claes Oldenburg and Eva Hesse, softness can bring new possibilities. Inspired by organic and inorganic, soft materials, in the context of sculpture, allow artists to engage and develop new forms of making. Using soft materials, sculptors can produce representational forms capable of expression and can provide emotional and aesthetic experiences. In the context of robotics, softness is broadly used for its technical functionality and deformable properties in order to accomplish tasks similar to conventional robots, but it also challenges the notions of what a robot can be. In soft robotics art, softness is used for its expressive movements, functions, properties, and appearances [4].

The Aesthetic of the Machine

Soft robotic materials and mechanisms suggest many new aesthetic opportunities for machine art. In his book *Machine Art in the Twentieth Century*, Andreas Broeckmann offers a framework to evaluate the aesthetic of the machine using five specific qualities: associativity, symbolism, formalism, kinetics, and automatism. These notions help to define historical tendencies in the art that engages with technology. Associativity to the machines concerns mainly early twentieth-century movements, precisely futurism, constructivism, and dadaism, that embraced technical possibilities in order to reject what they considered archaic artistic forms. Symbolism refers to the quality of using mechanical systems to express something else and formalism promotes the intrinsic beauty of these systems. Finally, kinetics looks at the idea of motion in the artwork and automatism to a machine achieving its tasks without any human contributions [1].

Creation: *Pero sans Cimon*

In continuity with Mme de Coudray birthing machine (Figure 2), our investigation began with the creation of *Pero sans Cimon* (2019), an autonomous milk production machine (Figure 1). We believe that challenging ourselves into making an artwork was a relevant way to determine if soft robotics had the aesthetic qualities valuable to machine art.

We investigated the aesthetic and symbolic properties of soft robotic technology by creating a soft-robotic sculpture. Our work: *Pero sans Cimon* is an autonomous milk production machine, inspired, in part, by Mme de Coudray's birthing machine. Our objective in creating *Pero sans Cimon* was twofold. First we sought to use the mimetic qualities of soft-robotic mechanisms and materials to create a sculpture, which reproduces aspects of the female anatomy in a mechanized form. Second, we sought to use the process to examine the ways soft robotics aligns with and extends machine art.

Pero sans Cimon was created, in part, as a reaction to examining the mechanization of the female body in our contemporary context. Modern computational and robotic systems are highly gendered. Conventional representations of femininity are reinforced through feminized assistant robots, sexual machines, and artificial intelligence. These female technologies reinforce gender binaries and women's role as a means of production. Looking at technological and cultural examples, the future of personal assistants seems to be female. Amazon's Alexa, Hanson Robotics's Sophia, Project Aiko, Ex Machina's Ava, Apple's Siri, and Microsoft's Cortana are all well known AI/robots that have been created and identified as female. Technological progress doesn't seem to step away from binary culture, heteronormativity and gender stereotypes. In each of these cases, the female bot is a servant or an assistant to human beings. The companies who developed these products wish to create feminine robots and close the gap between the real and the artificial. How will these advances structure the idea of women in our society if assistant robots and women become indistinguishable?

Feminized technology has historical precedent. One of the first occurrences of the female body as a machine is told through the story of Roman Charity. In this tale, Pero, the daughter of Cimon, who has been condemned to die from starvation, dedicates herself to visit and clandestinely breastfeed the man every day. This story is told as an example of filial piety, but could also be perceived as a way to chain women to patriarchy and justify the commodification of their bodies. The kinetic installation, *Pero sans Cimon*, explores the idea of the female body as a milk production machine. The work consists of a tubing system that circulates milk around the sculpture and leaks into a carafe. The carafe never fills, therefore, the machine must keep producing. This piece aims to bring forward the forces at stake within our current capitalistic context.

We relied on soft robotics to create a sculpture that would mimic the qualities of female biological milk production. *Pero sans Cimon* is made of soft materials: silicone, fabrics, wires, and PVC vinyl tubing. We used silicone to create a sculptural mass full of air chambers that inflate and deflate under the control of an air system. The organic aesthetic quality that emerges from the system enables us to explore the female body through form and behaviors (Figure 3). The soft inflated units represent the structures of mammary glands.

Through the Lens of Machine Aesthetics

After creating *Pero sans Cimon*, we analyzed the work using four different aspects of the aesthetics of the machine defined by Andreas Broeckmann. First, as explained earlier in this section, the piece is **symbolic** in many ways. It extends our interpretation of an ancient myth to criticize modern computational and robotic systems that exploit the female body as a means of production. These symbolic values emerge from the **formalist** possibilities of the used materials, the **kinetic** qualities of soft robotics and the **automatism** of the sculpture.

From a formalist point of view, the softness and elasticity of silicone in *Pero sans Cimon* provides an organic ap-

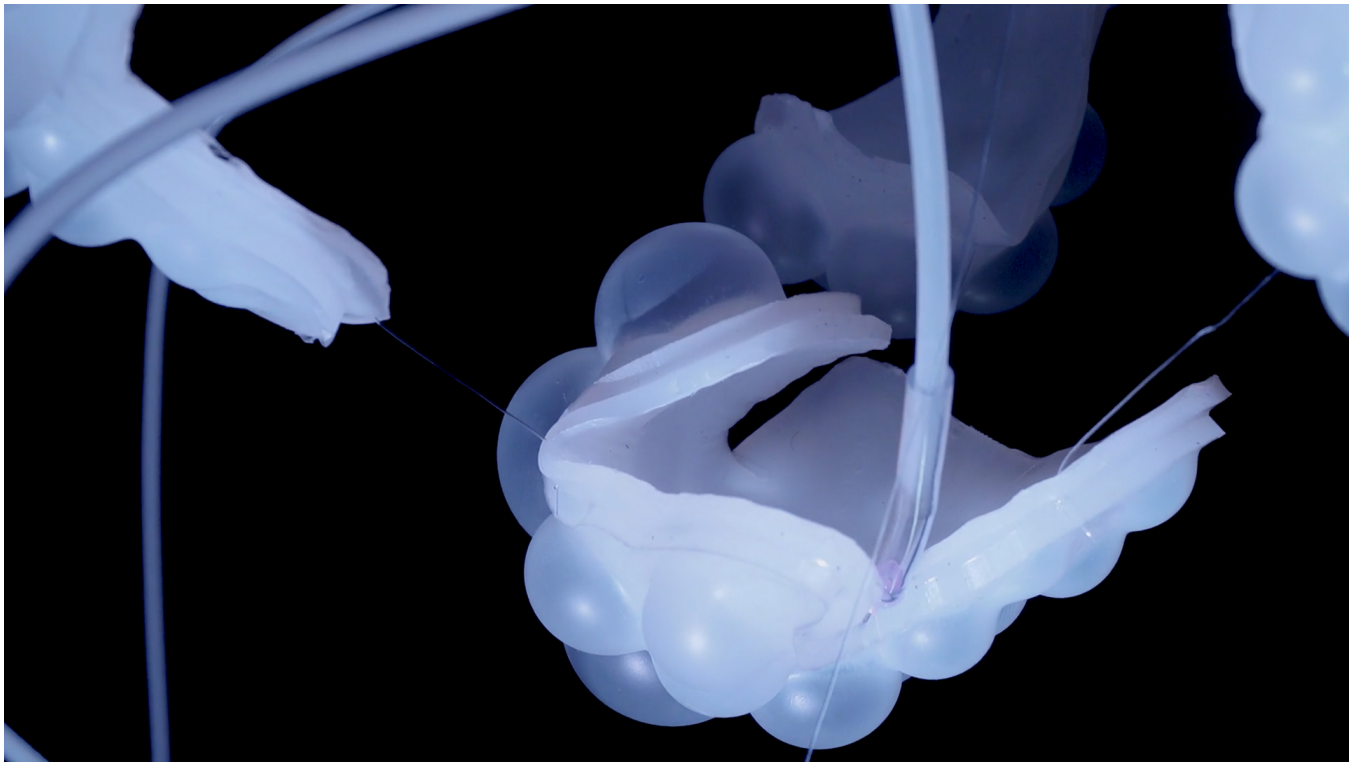

Figure 3: Closeup of *Pero sans Cimon*, 2019.

pearance. Silicone resembles animals' skin, which reinforces the symbolic link between this installation and the human body. Furthermore, actuated silicone reflects the movement and shape-change of living organisms. When engineered around channels and chambers and inflated with fluids, the silicone structures in *Pero sans Cimon* generates a rhythmic pattern of tension and relaxation based on pressure and diffusion. The kinetic quality of the system evokes human biological functions such as breathing, pumping of the heart and muscle contraction. Finally, *Pero sans Cimon* explores the significance of automation. The soft object pumps milk continuously through a closed system as a way to represent the absurdity of oppressed female corporeality in our current technological context.

This analysis demonstrates specific ways in which soft robotics extends machine aesthetics. The formalist quality described by Broeckmann refers to imagery of machines of the industrial era. These machines are characterized by their geometrical shapes and the use of metal as the primary building material. They often involve components like gears, wheels, and engines. The creation of *Pero sans Cimon* suggests that the formalism of soft robotics relates more efficiently to the human body and behaviors rather than machines. It enables the representation of the biological in more intrinsic ways than traditional machine art. The kinetic aspect of soft robotics points in the same direction. The fluidic displacement within *Pero sans Cimon* reflects the way soft robotics actuation can simulate internal human systems.

These observations bring forward interesting considerations. *Pero sans Cimon* both criticizes the current technological context that tries to close the gap between the female body/identity and the female robot/assistant, while simultaneously relying on technology that facilitates this physical transition in its construction. It embodies what it denounces. This subversion of robotic form and function aligns with our intentions to depict a speculative dystopian future. Simultaneously, it raises questions on the implications of using soft robotics for artistic expressiveness.

Soft robotics is considered safe, approachable and comfortable for humans to interact with. But this characterization conceals symbolic values associated with the entanglement of human beings and soft robotics. Unlike conventional robotics, soft robotics does not evoke the industrial revolution. Instead, it highlights the modern human body and the machine interaction paradigms. Soft robots are designed specifically for interaction with the human body. They are meant to integrate their surroundings subtly. As a result, soft robotics contribute to robotic ubiquity. The ethical considerations resulting from these features should be considered by artists using soft robotics in their practice in the same way artists considered the social and cultural implications of using mechanical iconography in the last decades of machine art.

Conclusion

Softness is rooted in rich theoretical and practical knowledge. The idea of softness has inspired new forms of sculpture, architecture, and engineering. During the last decade, softness

has taken on different qualities, ranging from playfulness and embodiment to versatility and resilience. Nevertheless, soft robotics in its artistic expressive form remains to be explored.

Through the lens of Andreas Broeckmann's notions of machine aesthetics, soft robotics align with machine art practices. We analyzed *Pero sans Cimon* using four of the five aspects described by Broeckmann and we now consider that soft robotics could extend these aspects. Soft robotics implies certain symbolic values that are materialized through formalist and kinetic characteristics. The shapes and motions available by inflating elastic materials mirror some intrinsic features of the human body: formal features such as curvatures and bounciness and dynamic features such as breathing, pumping and contraction.

Engineering and architecture engaging with soft robotics aim towards an acute connection between the human body and the robotic entity, the robot being a tool or a part of the built environment. We believe that this desire to develop this safe and embodied interaction is inherent to the symbolism associated with soft robotics and that artists could not make use of techniques without reflecting upon the ethical concerns that emerge from this subtle integration. Soft-bodied robots are, maybe imprudently, depicted and perceived as inoffensive, which obscures their social and cultural implications. Therefore, we urge artists, including ourselves, to remain critical when engaging with soft robotics.

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Creative audio design for a massively multipoint sound and light system

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Abstract

In this paper we present and discuss Murmuration by Squidsoup. Murmuration is a massively multipoint sound and light artwork commissioned by the Scottsdale Museum of Contemporary Art, Arizona, comprising 720 individual networked devices, each with RGB LED light and a speaker capable of rendering sampled audio in realtime in an outdoor public environment. It is the first that we know of to use internet of things (IoT) technologies at this scale in the audio domain, and we present a discussion of the sound design considerations that were involved in the creation of the work and that have resulted from our experience of the work's first manifestation, leading to future goals and design principles that will inform future iterations of our practice.

Keywords

Internet of things, multiplicitous media, sound installation, light installation, creative coding, distributed audio.

Introduction

In this paper we present and discuss Murmuration, by Squidsoup, commissioned by the Scottsdale Museum of Contemporary Art, Arizona. Murmuration is the latest in a series of works that explores massively multipoint sound and light environments, powered by custom internet of things technologies [1-4]. The work represents a series of technological improvements to previous systems by Squidsoup and is the first system we know of to enable high-quality sample-based audio deployment across 720 separate, individually addressable, custom internet-of-things (IoT) devices in a public outdoor setting, enabling rich, distributed, site-specific audio experiences. At this scale, the creative practice of sound design is significantly transformed by the potential of working across dense clusters of speakers, each driven by its own audio processor, but is also constrained by the various limitations imposed by the hardware and the software, as well as by the complexity of the system and the time constraints of the development and install process.

The main purpose of this paper is to present practice-based reflections on the audio experiences created by this novel domain of massively multipoint systems [5]. We begin by presenting the history of Squidsoup's IoT-based works leading up to Murmuration, the technology involved, and the creative philosophy underpinning concept and content development for such works. We then discuss our experiences with Murmuration, and consider general sound-design principles and future directions.

Figure 1. (a) The Ocean of Light / Submergence series of artworks, (b) Bloom, Christmas at Kew, London, UK, December 2016, (c) Wave, Salisbury Cathedral, UK, December 2018, and (d) Murmuration, Scottsdale Museum of Contemporary Art, Arizona, November 2019. This final image shows the side of the building. Lights additional wrapped around the front of the building, connecting from the centre-right of the image.

History and Technology

Squidsoup has created immersive, massively multipoint light-based artworks for over 10 years, exhibiting installation artworks globally in galleries, public art events, light festivals and commercial contexts. Most typically,

these works have taken the form of cuboids of light created by hanging a grid of LED strands (Figure 1a). These are immersive and playful, as people can walk inside the light structures, which create a shared space. Sound has always been an integral part of these works, but never replicating the massively multipoint nature of the artworks' light component. Usually, sound is rendered via a stereo or quad configuration of traditional loudspeakers, and additional subwoofers, driven by a single central computer. Improvements to wirelessly networked, very small form factor microprocessors — in particular the increases in speed that enable audio playback — now enable the creation of multi-device works where each device is independently capable of light and sound rendering and can be networked to form large clusters of coordinated devices. Starting in 2015, Squidsoup have built three key iterations to date of IoT-based systems for massively multipoint sound and light artworks, each with increasingly sophisticated audio capability and fidelity. Each iteration has a similar form-factor: a 10cm translucent spherical orb with one power point (Figure 2b).

The first iteration, starting with the Bloom artwork (Figure 1b), commissioned by Kew Gardens' Christmas at Kew festival, used an Oak board (running Arduino) and drove a simple piezo speaker from a separate sound chip. This system was only capable of playing square-wave tones at different frequencies and volumes, and was relatively quiet and low-fi. It also included a ring of LEDs, WiFi, an IMU sensor and GPS for outdoor positioning.

The second iteration, starting with the Wave artwork (Figure 1c), commissioned by Salisbury Cathedral, was also Arduino-powered and used a separate sound chip that was capable of playing audio samples from a separate sound chip. This enabled high-fidelity audio sample playback but through a relatively poor-quality speaker, limited in terms of its sound pressure level by being enclosed in a sealed globe. These devices did not include GPS as this was deemed too expensive and only useful for positioning over wider areas.

The third iteration, starting with the Murmuration artwork (Figure 1d and 3), commissioned by the Scottsdale Museum of Contemporary Art in Arizona, involved a major rebuild, consisting of an ESP32 board (Figure 2a) and using the FreeRTOS C-framework. It also included proper acoustic design of a speaker cavity embedded in the same spherical housing. From our perspective, this final iteration has now achieved our objective of a high-sound-quality programmable rich media device that can operate in large WiFi-connected configurations. The build is robust enough for repeated outdoor use and is cost-effective enough to be deployed at massive scales.

Realtime processing of audio on small low-cost devices is an area of intensive research interest (e,g,. [6-10]), including the first author's work on creative audio on the Raspberry Pi [1, 11, 12]. Whilst a wide variety of frameworks exist, they are sometimes too expensive to create at scale or may have other limitations.

Creative Philosophy

The systems described above act as media substrates through which formations of sound and light can be rendered. It is natural to think of our lights as sorts of pixels coming together to produce very low-resolution, 3D screens; devices' positions in space are stored (manually, or using an automated method — we have used GPS and

Figure 2. (a) One of the individual boards used in the Murmuration artwork and (b) a set of complete units ready for testing in the workshop; each unit incorporates board, speaker, housing and power socket.

video-based automated positioning with differing success), so that abstract forms can be sent to the network and each device will be able to work out its part in the rendering of that form. In [5] the first author discusses how such massively multipoint systems present novel dimensions of creative exploration. A large, dense grid of lights can be thought of as a screen, with each light considered an individual pixel, or more generally, as a substrate for rendering media, with each device subsumed to serve as part of the substrate. But it can also be thought of as a series of independent objects, each of which is substantial and tangible and can be engaged with individually. Other dimensions of creative exploration include the homogeneity or heterogeneity of devices and the nature of content in its relation to the practical aspects of creation on such systems, from emergent, self-organised behaviours to top-down coordinated compositions.

In Squidsoup's practice, we do not think of these substrates of devices as screens for the purpose of rendering images. Their incredibly low resolution means that such rendering is markedly different from rendering images on a traditional screen. In addition, their site-specific, volumetric and immersive nature means that there is no fixed perspective from which to view images, which is particularly evident when standing in amongst the devices. Our experience of designing content for these systems has led us to push dynamic illumination to the fore, and to work exclusively with abstract geometric structures and their movement, an approach that also fits well with systems' bandwidth, memory and device processing constraints. Whilst the Submergence series of works generally uses regular grids, the IoT based works are more irregular and integrated into structures. In Murmuration, a 'flock' of lights, 2, 3 or 4 devices in width, encircles the

building, and from a creative and programmatic point of view we treat this as a one-dimensional structure.

The introduction of on-device sound across a large substrate of devices pushes us further from the metaphor of the screen as, although massively multispeaker rendering systems exist in specialist environments, there is no common precedent and no strict equivalence between rendering images on a screen and rendering sound across a surface of speakers. In other words, a speaker is not equivalent to a pixel. If anything, a single speaker is more similar to a screen, capable of fully rendering a sonic image. Naturally, the creation of a massive speaker array affords the spatial distribution of audio in ways that a smaller PA cannot do. But, the system is also not exactly equivalent to a spatial audio system in which abstract sound objects are positioned in space (via spatialization algorithms), and we avoid thinking of it in this way; its current software design does not enable strict sound spatialisation in the manner performed by spatial audio systems, even though we can easily create the effect of sounds moving spatially. Rather, each device is an individual voice that can be programatically controlled. Thus we take equal inspiration from more low-tech artists such as Zimoun, whose sound works examine the sonic nature of massive numbers of acoustic point sources.

Sound Design Experience

Although basic mockups of multipoint sound renderings were produced in a digital audio workstation (DAW), the only real way to know what sounds and effects will work on such a system is to try it in its real deployment context.

The basic code-base available to us on the ESP32 processor allowed only a single sound to be played at a time on any single device. Sounds are played directly from disk and a 16GB SD card is used to store a database of sound files. However, we note that deploying sounds and code to devices over the air (OTA) can be incredibly time-consuming; when many devices are on the network bandwidth and network congestion issues can make it prohibitively slow to deploy updates of sounds. Even limiting ourselves to a sound set of 13MB was challenging within the install time constraints. With more time, it will be possible to pre-load devices with very large sets of sounds, enabling more in-depth experimentation with different sound possibilities. In addition, at the time of creating Murmuration, the system code was elementary, and did not enable varispeed or pitched playback of sounds, meaning that where musical tones were needed, each individual tone must be provided as a separate sound file. Thus the install constraints of Murmuration necessitated that we work with a very small set of pre-defined sound files.

In the sound design conceptualisation for Murmuration we considered two basic distributed sound concepts: the creation of massively distributed soundscapes where every speaker is producing sound as if a single voice in a chorus; and the movement of sound around the space. Following the theme of bird murmurations, we built a dataset of short individual bird sounds, ranging from natural unaffected sounds to glitched and processed sounds. We then created a scene where each device, within a certain region, played a random sound from this set. The aim was to create bursts of distributed sound that had a natural distributed feel. In the same way, we also created harmonies of looped tones, blends of looped noise, and chaotic effects by playing multiple copies of the same long complex sound file at random times across devices.

Each of these effects, we believe, demonstrated the rich potential of the system for distributed deployment despite working within the very limited constraints of the audio system. The noise blends were particularly interesting: we combined generated noise sounds with audio recordings of crowds, noisy environments and applause. The result sounded more like ocean waves or rainsticks than any of these source sounds, especially as they moved. With the bird collections, we were able to vary the sample set range so as to gradually progress from natural to glitched bird recordings, as the sonic cluster moved around the space, a simple compositional parameter to manipulate. Tonal chords, likewise were rich sounding. A side effect of randomly distributing sounds over multiple speakers is that audience members could listen-in on one speaker and fixate on an individual sound, for example discovering that what they thought was ocean sound was actually made up of blends of crowd and applause sounds, or hearing notes accentuated in a chord, depending on their position. In this way the sonic experience was inherently exploratory, even though this did not take the form of digitally mediated interaction.

One of the most effective sounds was a simple click passed through a very long cathedral reverb (pre-recorded as such). We fired a wave through the system, triggering this sound on each device as it passed. The result of a fast moving trail of clicks with a long reverb tail suited the sense of spatial movement well, especially coupled with sparking lights.

Figure 3. Murmuration at the Scottsdale Museum of Contemporary Art.

Our earlier work with sound, in Bloom and Wave, has given us some basic guidelines for thinking about how to work with sound in such systems, although we have so far worked with only very simple audio concepts. In Wave, musician, vocalist and sound designer Eve Klein created a sample set of pitched vocal tones. The Wave piece simply consisted of a single chorus of notes that swept from one end of the grid to the other, becoming more noisy and discordant as it reached the other end. The effect was a simple, calming, meditative experience. According to one regular visitor: *"A friend of mine … is a wheelchair user… His wife has taken him to sit below the display nearly every fine evening."* When Wave was shown in the very different context of Burning Man, the devices were frequently drowned out by nearby sound systems. Audience members would enjoy the work at night without even realising there was a sound component. However, upon holding the devices the vibrations would draw their attention to the sound component and at quieter times the sonic nature of the work would be apparent. This unexpected 'reveal' alerted us to how rich and diverse the (non-digital) exploratory potential of the devices was, this time incorporating a tactile element. At the time of writing we have no information on audience feedback and interaction with Murmuration, but we expect our next iteration of sound design concepts to be informed by these kinds of observations.

Conclusion and Future Directions

This paper has presented some sound design considerations arising in the creation of Murmuration, a massively multipoint sound and light installation that enables rich new forms of sonic experience. We have described a number of practice-based observations from our first large-scale deployment of this system.

Our current work involves making much-needed enhancement to the program code that will enable more audio effects, more precise control of devices and greater stability and certainty about system behaviour. based on our observations so far we will focus efforts on producing sound blends that enhance the distributed audio feel of the devices. One way to do this will be to filter individual sounds to narrow bands, so that spectral richness comes from the blend of sounds rather from each individual sound. We will produce more sophisticated programming functionality in relation to temporal control and rhythm, and examine phase and delay effects. We will further explore the way that reverberation and echo effects, either pre-recorded or rendered *through* the system, play out across the system. Once we have varispeed playback of sounds, we will begin to explore timbral richness through detune effects and more generative harmonic processes.

Whilst we expect future work on the core technology underlying the system will remove or mitigate many of the hardware and software constraints that limit the creative possibilities of working in this context, we also acknowledge the great importance to our workflow of what Biskjaer & Halskov [13] call *decisive constraints* (see also [14]), those creative constraints that we actively choose to impose on our practice in order to more easily structure and conceptualise what we are producing. We believe that multiplicitous media contexts such as this increasingly demand creators to employ decisive constraints as a way of making the unwieldy manageable.

Acknowledgements

This paper reports on reflections that emerged from the creation and experience of the work Murmuration; its authorship represents this process of creative reflection and is not representative of the creative authorship of the work

Murmuration, which involved a number of other significant contributors, in particular Ash Wilke and Dan Pearson, as well as other Squidsoup collaborators Gaz Bushell, Hannah Brady and Chris Bennewith. We thank SMoCA for their support of this project, Kew Gardens for their support of Bloom, and Salisbury Cathedral for their support of Wave, and the many other organisations who have commissioned and supported Squidsoup projects. We acknowledge the additional sound design contribution of Sam Ferguson for Bloom, Eve Klein for Wave and Garth Paine and his students at ASU for Murmuration. This research is also supported by the Australia Research Council Linkage Grant LP180100151.

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Oliver Bown is senior lecturer and co-director of the Interactive Media Lab at the faculty of Art and Design at the University of New South Wales, in Sydney, Australia. He is a researcher and maker working with creative technologies, with a highly diverse academic background spanning social anthropology, evolutionary and adaptive systems, music informatics and interaction design, with a parallel career in electronic music and digital art spanning over 15 years. He is interested in how artists, designers and musicians can use advanced computing technologies to produce complex creative works. His current active research areas include media multiplicites, musical metacreation, the theories and methodologies of computational creativity, new interfaces for musical expression, and multi-agent models of social creativity.

Anthony Rowe has around 20 years experience in digital media art and interaction design; as an artist, designer, teacher and researcher. He was Research Fellow at the Oslo School of Architecture and Design (AHO) until late 2015, and has a PhD on 'Immersion in Mixed Reality Space', largely based on the work of Squidsoup. Prior to this he was Associate Professor, Interaction Design at AHO (2009-2012). Anthony founded Squidsoup in 1997. He is also a founder of LUX, an international series of seminars and exhibitions exploring the rich creative intersections of light, space and interaction. In a former existence, Anthony sailed single-handed across the Atlantic (1988).

Liam Birtles is an artist, lecturer and researcher with 20 years experience in creative practice and digital technology. He is currently Senior Lecturer at Bournemouth University. In 1995 Liam gained an MSc in 3D computer graphics from Teesside University and then became a Research Assistant working with designers using low-end virtual reality at Coventry University. Liam joined Squidsoup in 2007. His current research concerns

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Sentience and Place: Towards More-than-Human Cultures

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Abstract

Expectations for the future can differ greatly. Some await a technical utopia that will support harmonious and easy lives. Others predict a global ecosystem collapse that will threaten the future of humans as species. Both camps make appeals to sentience in support of their stories. Addressing this discordance, this paper combines narratives in ecology and technology to ask what roles sentience might play in future places. In response, it hypothesizes that an understanding of sentience as an inclusive, relational and distributed phenomenon can promote more-than-human cultures and contribute to the wellbeing of heterogenous stakeholders on the Earth and beyond. To test this hypothesis, the paper outlines biological understandings of sentience (as applied especially to humans, animals and other lifeforms), contrasts them with the interpretations of sentience in artificial entities (including robots and smart buildings), gives an example of attempts at sentience in architectural design and discusses how sentience relates to place. The paper's conclusion rejects the dualism of technophilic and biophilic positions. As an alternative, the paper outlines sentience as a foundation for richly local more-than-human cultures that have intrinsic value and can help in the search for preferable futures.

Keywords

Sentience; place; architecture; design; technocentrism; ecocentrism; politics; ethics.

Introduction: Between Futures

Most human societies undergo or aim to join the rapidly accelerating technological development. Investment-supported pledges include General Artificial Intelligence, smart cities, smart medicine and smart agriculture. Promised benefits of this widespread smartness include greater efficiencies, unprecedented innovations and, at the core, the ensuing growth of consumption. Concerns associated with this model of development include losses of privacy, increasing societal segregation, joblessness caused by automation, colonialism by new means and replacement of democracy by the corporate power. Despite such apprehensions, technocentric development remains in the influential mainstream.

At the same time, the planet endures an acute environmental crisis. This predicament is a result of humans' massive, destructive and wasteful resource extraction. The negative consequences of societies based on extractive and industrial economies include irrecoverable biodiversity losses, climate change with resulting sea-level rises, predicted mass migrations and food system failures. Calls for more sustainable societies advocate greater care for the planet's ecosystems.

This incompatibility between technocentrism, infocentrism and technophilia on one hand and biocentrism, ecocentrism and biophilia on the other will be a significant challenge for future actions. Inclusive approaches to participation in decision making have been successful in application to oppressed groups in human societies, including slaves, women, children or people with disabilities. We suggest that this process of political emancipation can expand from disenfranchised human groups towards non-humans and provide an avenue for improvements.

Sentience is one way to conceptualize and describe interactions with biotic and abiotic others. Interest towards sentience across disciplines reflects this generality. The concept of sentience finds application in biology, psychology, philosophy, animal rights, robotics, art, architecture and design. In practical fields, technologists aim to build what they call artificial intelligence, smartness or sentience into all environments, from objects to buildings and from cities to landscapes. The purposes of these implementations are typically anthropocentric or at least instrumental and utilitarian.

There are concerns about what this might mean for human society [1, 2]. Such capabilities can lead to commodification of emotions and intelligence. Examples include the use of sentient robots for sex or the casting of humans in need of emotional support as commercial opportunities for care robotics. These tendencies can lead to the devaluing of suffering and its expansion. The concept of sentience has been important in efforts to protect biological agents such as animals. It can also afford protection to possible future artificial entities.

However, protections based on the common interpretations of sentience are likely to result in some form of segregation. Speciesism is a characteristic example that results in debates about the place of moral boundaries that invariably exclude some beings. Examples of existing harmful speciesist practices include the privileging of humans, or only primates and cetaceans, or only vertebrate animals, or

only animals but not plants and so on. The exclusion of abiotic entities from the sphere of moral concern amplifies the harmful outcomes of this speciesist preferencing and forecloses opportunities for improvements in more-than-human justice. We believe in the importance of this inclusive justice as a program for action or, in the very least, as a hypothetical frame for further research.

Instruments of governance should support such inclusive justice and work on approaches such as earth jurisprudence represents relevant initiatives [3]. However, legal regulation cannot be effective without inclusive ethical cultures. Such cultures need to incorporate human as well as non-human stakeholders and require much further practical and theoretical work. The study of human and nonhuman sentience and its performance in concrete places will constitute an important part of this future progress.

This brings our narrative to an existing gap in knowledge. At this moment, there is no rigorous discourse that unifies bodies of learning on sentience in biology, computer science, politics and design. The discourse on artificial intelligence and robotics in relationship to ecology is even more limited.

The incompatibilities between technocentrism and ecocentrism constrain designing and management. Unfortunately, human impact on planetary ecosystems is increasingly unavoidable. In the future, novel ecosystems such as cities, agricultural landscapes or managed forests will be increasingly prevalent across the globe.

Major incompatibilities between existing approaches impede the study of ethical and political implications in action-oriented and pervasively influential disciplines such as environmental management or urban design. The placemaking activities within these fields exist at an intersection of technological, ecological and political domains and would benefit from their integration.

We see an opportunity to contribute by integrating the existing bodies of expertise on sentience. Such an integration will support a better understanding of more-than-human communities and will enable a more broadly participatory reinvention of future places.

Seeking to use this opportunity, this paper asks what roles sentience might play in future places. In response, it hypothesizes that an understanding of sentience as inclusive, relational and distributed phenomenon can promote more-than-human cultures and contribute to the wellbeing of heterogenous stakeholders on the Earth and beyond.

To test this hypothesis, the paper outlines biological and physical understandings of sentience, contrasts them with the interpretations of sentience in artificial entities, gives an example of sentience in architectural design and discusses how sentience relates to place.

Findings: Inclusive Sentience

Extents of Natural Sentience

This section introduces the understanding of sentience in biological and physical sciences. It seeks to demonstrate that sentience is a constructed concept. In nature, processes that resemble sentience are common, varied and possibly omnipresent. In human use, this concept is often political. Importantly for this paper, its commonness can serve as a basis for the idea of more-than-human cultures.

The idea of sentience is under active discussion. A common definition describes sentience as the capacity to feel, in contrast to reason or logic [4]. Similarly, Singer's well-known pragmatic definition states that sentience is the capacity to suffer and experience enjoyment [5].

Such definitions help to outline the concept but require explanations of additional terms such as reason, feeling and enjoyment. An alternative approach is to look at the pragmatic purposes the concept of sentience supports in research and practice.

The dominant deployments of the concept of sentience are anthropocentric. For example, it is commonly used to contextualize the human evolution for the study of human faculties. Many biological interpretations suggest that sentience has emerged in humans and other animals because it has adaptive value [6]. On such views, sentience facilitates the maintenance of organismic homeostasis through feelings and emotions. Emotions evolved to guide cognitive and behavioral responses to improve fitness and survival [7]. Biological entities experience emotions and feelings positively or negatively and with different degrees of intensity or persistence. In humans, emotions such as happiness, empathy, fear and disgust help to guide fitness, promoting behaviors such as resource acquisition, partner retention, predator evasion and disease avoidance. More complex emotions such as jealousy might be useful for competitive social situations, while love is useful for forming bonds to improve social acceptance, co-operation or reproduction [8]. The focus on humans in arguments of this type leads to the conclusion that feelings and emotions require complex neural interfaces.

In parallel with the work on humans and 'higher' animals, other research demonstrates the existence of 'emotion states' in many lifeforms [9]. Evolutionary situations that resulted in human sentience have hosted many other organisms, with similar effects. According to this work, many or all lifeforms can have sentience or at least subjectivity and personal sense-making capacities [10]. For example, researchers acknowledge sentience in a growing number of animal species [11]. To illustrate: zebrafish can have emotional fever – a transient rise in body temperature in response to stressors [12] and bumblebees can be optimistic [13]. Beyond animals, plants might also be sentient. In response to stressors, they can release pesticides, harden protective boundaries and change how they eat and breathe [14]. Even single-cell organisms can reverse the direction of motion when they bump into obstacles or swim towards food and away from poison [15]. A further step is to interpret all life and its evolution in cognitive terms, as an evolution of consciousness [16].

Even broader definitions of sentience, linked to this last position, extend past life towards all self-organizing systems that can maintain self-identity. Such definitions un-

derstand sentience as a process of sensing non-self, processing the incoming information and responding to it [17]. We shall return to this inclusive understanding of sentience in the discussion of ecocentric and extraplanetary ethics.

Meanwhile, a much more frequently deployed definition relates sentience to the capacity to suffer. This relationship sets an important precedent that links sentience to ethics. Animals' capacity for suffering is the core argument in sentientist approaches to nonhuman rights [18, 19]. Among many other outcomes, this interpretation of sentience informs important efforts to improve animal welfare [20] and develop alternative governance systems [21]. By contrast, the insistence on the absence of sentience in some lifeforms and in all abiotic systems can justify careless use of nonhumans by human societies. Examples include the use of animals for food, entertainment and labor as well as practices that lead to environmental degradation.

This section has demonstrated that the current discourse on sentience is increasingly inclusive. Reflecting increasing societal acceptance, legal mechanisms in many countries increasingly attribute sentience to animals. Acceptance of sentience in other forms of life is also growing. The application of sentience to abiotic structures is much less usual. Many are likely to resist this application on practical grounds. For example, animal rights advocacy often benefits from empathetic responses that rely on the similarities between human and animal sentience, in contrast to the presumed insensitivity of other lifeforms and the nonliving world.

Despite such understandable tactical objections, this paper seeks to emphasize the ubiquity of sentience. It proposes that a more inclusive conceptualization might prove to be less prejudiced and more useful in the likely future places. To explore this proposition, the paper next turns to the discussion of sentience in artificial systems.

Prospects of Artificial Sentience

Analysis of existing and emerging artificial systems is important because it provides concrete examples of potential forms of nonbiological sentience. It is also significant given the predicted proliferation of artificial intelligence.

The discussion in this paper is inclusive of all forms of artificial intelligence, including those with physical manifestations such as mobile robots and smart buildings.

Engineers see artificial intelligence and sentience as realistic possibilities or even as an inevitability. While even some of the technology advocates admit that many of these expectations are fashionable exaggerations by the vendors [22], others predict human-like artificial intelligence within the next decade [23].

Artificial intelligence designs can serve practical purposes or support the study of living systems [24]. In both cases, humans create them for their purposes. Consequently, emerging ethical problems in artificial systems parallel the moral concerns regarding biological beings. In some cases, designers deliberately aim for sentience-like capabilities. For example, emotions such as jealousy, loneliness, and love can help govern and inform artificial systems' social behaviors or improve their decision making. Negative emotions such as fear or pain can help artificial systems protect themselves.

Artificially intelligent systems are different from other machines because they are autonomous. In moral philosophy, autonomy is an outcome of responsible reasoning and decision-making [25]. Increasingly, technical systems can make decisions without direct human intervention, sometimes in ways that are beyond human understanding. Often this opacity is an essential feature of their design, as in the case of deep neural networks. A range of ethical concerns arises from this capability for autonomy. For example, an artificial system might prefer its integrity to the safety of human operators [26]. To illustrate, the design of autonomous cars has to distribute responsibility in situations where the harm is not avoidable [27]. The same is true for the war robots undertaking an attack or choosing which wounded to assist.

These and other concerns for human safety dominate the discourse on the ethics of artificial intelligence. Many see an ability to ascribe the responsibility for actions as an important concern. Such considerations led to the initiation of formal processes that can give legal rights to 'electronic persons', for example within the European Union [28, 29].

In addition to the concerns related to human safety, there is growing discourse on the wellbeing of the intelligent artificial systems and its ethical dimensions. Some worry that the acquisition of sentience by such system can lead to a large-scale increase in suffering [30, 31]. For example, plans to create robotic servants that can experience human-like feelings to make their human masters more comfortable is one path to suffering. Such deliberately subjugated systems might experience persistent humiliation and resulting forms of non-physical pain [32].

Concerns about the wellbeing of artificial intelligence systems resulted in calls to expand the confines of the moral circle. Such an expansion requires further theoretical and practical work. Existing studies and practical efforts within animal studies and the animal rights movement can provide useful precedents [33].

This brief overview of the developments in artificial intelligence and robotics illustrates the tendency of technical systems to move towards autonomy, intelligence and sentience. This happens in parallel with the increasingly inclusive understandings of sentience in biological and natural entities discussed in the previous section.

Many of the approaches discussed above focus on individual entities and on characteristic representatives of types. Typically, such approaches seek to extend the rights of individual humans to other agents. However, this individualistic approach can be problematic. Humans do not have one model of preferred behavior. Instead, they exhibit multiple contradictory biases. Injustices motivated by sex, age and race are common examples. Omission or suppression of human minorities is also common. Human treatment of nonhuman stakeholders is overwhelmingly exploitative and often cruel.

Therefore, it is important to support the discussion on synthetic persons with the analysis of their habitats. These habitats have the character of highly distributed and complexly interconnected systems of relationships between multiple agents and processes. These relationships take forms of habits, traditions, cultures, politics and other objective/subjective phenomena. Participating agents experience these effects as persistent contexts, environments, milieus or places; the terminology and interpretations vary broadly across the fields of study. The next section points out some of the relevant characteristics of such contexts by considering them as future places.

Placed or Indigenous Sentience

As stated above, this section highlights that all forms of sentience occur in concrete places with unique continuous cultures.

Today, human activities affect and attempt to control all planetary environments. These attempts at control are likely to intensify. As a result, artificial systems from mining, infrastructure and agriculture to cities and buildings become increasingly spread, interconnected and automated. Consequently, all current and future sentient beings will inhabit partially artificial, monitored and controlled environments.

Standardized frameworks of numerical data, mathematical routines, computational automation and global communication underpin these hybrid habitats. On one hand, intelligence and sentience are among the declared objectives for such artificial systems. On the other hand, natural sentient agents already populate most or all environments that such artificial systems will enter and attempt to control.

Therefore, design and management of future spatial environments will have to consider many types of sentient agents. At the same time, governance and management of natural and artificial sentient agents will have to engage with extended ecological contexts and forms of sentience that are indigenous to these places.

Here, we can understand indigeneity as a form of more-than-human culture that came to a form of balance within a place through a prolonged engagement of multiple agents. This understanding highlights an analogy where introduction of novel, powerful and non-indigenous agents in the form of artificial intelligent systems is similar to the immigration on non-indigenous humans, animals, plants and microbes during the biological unification of the Earth and the colonial period. The tragic lessons of that history provide a warning of possible losses. It is important to remember that artificially sentient systems enter richly populated and complexly intertwined worlds, not *terrae nullius* that are in need of improvement or cultivation. Current losses of cultural and biological diversity show that such improvements can easily lead to careless or unforeseen eradication of richness and value.

The challenge of making technical systems indigenous should not be dismissed as implausible, especially in the context of greater attention towards indigenous knowledge in science and management [34]. However, becoming indigenous for intelligent technical systems will be at least as difficult as for the human colonial cultures [35].

Situated Sentience in Design Practice

An in-depth analysis of situated sentience in current and emergent design practices is beyond the scope of this paper. Instead, this section aims to indicate that such sentience is plausible and calls for further study.

Current design frequently equates sentience with intelligence or smartness. Practitioners or commentators use these terms to suggest capabilities for automated responsiveness. The typical emphasis is on efficiency [36].

For example, at building scales, recurring examples include reactive building skins [37]. Often describe with a biological term ‘adaptive’, such structures can change in response to input. They typically aim to save energy and improve thermal comfort through adjustable shading or display information. Here, the focus is on a more efficient fulfilment of anthropocentric goals. The involvement of artificial intelligence or sentience is possible but not necessary.

At urban scales, characteristic examples emerge from the work on smart cities. Like sentience, this related concept lacks a precise definition [38]. Derived from the desire to achieve a politically acceptable ‘sustainable growth’ the notion of smart city combines ideas on knowledge economy, ubiquitous digital technologies and the optimization of urban services. Many researchers worry that its capitalist motivations can undermine inclusive and just environments [39].

At landscape and ecosystem scales the growing emphasis is on sensing and monitoring. Here, the notions of smartness or intelligence often refer to practices that seek to address specific issues: fire-smart landscapes or water-smart agriculture. Even though ecological engineers have been discussing ‘technoecosystems’ since the 1980s [40], the practical use of autonomous systems in the management of biophysical dynamics is only emerging.

Given current unavailability of fully realized autonomous artificial intelligences or sentient entities at architectural or urban scales, experimental artistic installations provide suggestive alternatives. In addition to artistic work, they include some architectural projects, for example our own work [41] or the experiments by Beesley [42].

Below, we highlight some existing capabilities of such artificial systems asking whether they have sentience in comparison to humans, nonhuman organisms or other systems capable of maintaining self-identity.

Such systems can:

- Have bodies with interior and exterior, consume energy, obtain sensory input, process information and make decisions. These capabilities alone can qualify them as a form of sentient systems, at least according to some of the definitions discussed above.
- Have and express emotional states in response to stimuli. In technical systems, such states do not link to evolutionary histories and fitness-enhancing behaviors.

However, artificial emotions cannot be automatically disqualified on this basis. In living systems emotional responses among all other mechanisms can be atavistic, random and maladaptive.

- Come into relations with other agents. Technical systems can strongly affect social relationships between lifeforms. They achieve this by provoking emotions and modifying behaviors. As a result, cognitive phenomena such a memory or imagination become increasingly distributed [43], with sentience shared between agents.

The missing capabilities include:

- General intelligence comparable to humans. However, these types of structures are as likely to acquire general intelligence as other artificially intelligent systems. Irrespective of this eventuality, the possession of general intelligence is not a prerequisite for the inclusion into the moral circle. Most of nonhuman lifeforms also have specialized rather than general forms of intelligence but still deserve ethical consideration.
- Intrinsic purposes not specified by designers. In this way such systems are different from desiring, goal-directed animals. However, abiotic structures such as rocks or hybrid formations such as ecosystems also do not have interests or intrinsic purposes but still have value and receive or deserve to receive protection.

The intersections between diverse modes of existence become particularly evident at landscape, urban and architectural scales where interactions between agents organize into places. At these scales, humans find themselves not only among but also within variously sentient beings. Shared cultures within such environments create novel ethical challenges that require further study.

Discussion: From Metaphors to Participation

Existing artistic and architectural installations provide limited but suggestive examples. To date, the references to sentience or intelligence in such cases are largely metaphorical, aimed to provoke reflection, imagination and future study. Implementations of such installation are not readily suitable as blueprints for designs that can aim for widespread adoption. However, characteristics of such installations can help to concretize the trends suggested by bodies of discourse discussed earlier.

The emerging discourse on robot ethics follows the individualistic logic that inherits moral rules practiced in human societies. According to this logic, if artificially intelligent systems exhibit sentience and sapience, they can inherit moral status from humans. This is an inclusive move because it does not disqualify agents based on the mechanics of their intelligence or the ways they come into being [44]. This perspective highlights that synthetic systems can encounter servitude, physical or emotional abuse, neglect, or the suppression of rights.

However, we argue that this focus on the capabilities of human-like individuals considered separately from their relationships with other human and nonhuman agents is problematic. The discussion above demonstrates that it is possible to define sentience as a characteristic capability of all interacting complex systems. In living systems, sentience can act as an enabler of cultures. These cultures transfer extra-genetic information. Many lifeforms can have such cultures, including unicellular organisms [45].

This expanded understanding of sentience can undermine its utility as a marker for suffering that is necessary for the sentientist ethics of animal protection. However, this weakening is not inevitable. Instead, we hope that the understanding of sentience as a ubiquitous capability can lead to more participatory approaches to the construction and management of future environments.

Conclusion: Some Proposals

This paper has considered the roles of sentience in future places. Our short paper cannot provide conclusive answers. However, its argument indicates that an inclusive understanding of sentience might be useful. This definition connects the anthropocentric understandings that ascribe sentience to some cognitive systems with ecocentric approaches that see sentience as abundant and pervasive.

An inclusive understanding of sentience has implications for ethics and practical design. Human-centered, utilitarian approaches to ethics render the usefulness of nonhuman life in terms of services and fail to protect lifeforms that are not knowingly useful for humans. At the same time, important ecocentric approaches remain under-represented in the mainstream of contemporary societies [46]. Ecocentrism remains on the margins of the design disciplines in general and the discourses about the construction of intelligent technical systems in particular. Attempts to promote ecocentric approaches on psychological (love for nature) or philosophical (intrinsic value) grounds struggle to find widespread purchase. Perhaps the idea of ubiquitous sentience can provide a more encompassing target for respect.

Ubiquity can make a concept useless as a tool of discrimination. An alternative interpretation might emphasize that sentience is a process of expressing relationships rather than as a property of an entity. A dog in the sun feels hot and walks to the shade. Its ability to feel discomfort and seek relief requires the sun and the rock, evolutionary and ethologically. This focus on relationships does not privilege humans, biological nonhumans or synthetic systems but sees them as stakeholders within the common moral circle (related work includes the Earth justice and wild law, land ethics, geoethic and astroethics or the Ecozoic Era as an alternative to the Anthropocene).

To conclude, this paper's position rejects the ideological contrast between technophilia and biophilia. It then questions the bias towards human-like of sentient entities and extends ethical consideration to nonhuman lifeforms, abi-

otic structures, all Earth and places beyond Earth. Such an inclusive understanding of sentience can aid the development of more-than-human cultures, even if only as a provocation for further study.

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Shifting Immediations: Fields of Experience across Media Art and Design

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Abstract

This paper explores the concept of *fields of experience* as a way to engage with the conditions of emergence of what we might call sentience. As a process of fielding, sensation and processes of sense-making are of an emergent and entangled quality in the overall ecology of experience. We specifically wish to emphasize the dynamics of the closely interrelated conditions for sensing and sense-making – what we conceptualize as 'shifting immedations' - and its affective politics. Rather than transgression, 'shifting' foregrounds the sometimes almost imperceptible reorientations of fields of experience that are lived immediately as tendencies and vectors for change (feeling the non-sensuous). In particular, we wish to zoom in on specific practices and technologies that might modulate and reorient such experiential fields. We do so by analyzing two cases that emphasize the emergent relations between digital and interactive technologies and their fielding potential; *BERMUDA* is an interactive installation that attempts to relay affective intensity into tendencies for collective action, whereas the interventions of *etcetera* emphasize time-sensitive modulations of experience. Exploring these cases, we ask how experiential fields and shifting immediations might allow us to think and act towards new forms of engaging in a politics of sentience beyond the human subject.

Keywords

Interaction Design, Media Art, Activism, Gilbert Simondon, Politics of Affect, Pure Experience, Counterpower, More-than-Human

Introduction

In this article we wish to continue an already established conceptual and practical trajectory concerned with understanding and exploring the extent to which digital and interactive technologies condition and change perceptual arrangements, political and power formations, social mobilization and, more generally, modes of existence across media art and interaction design. Many contemporary media theoretical approaches emphasize the operational and processual nature of media environments. [1] The drive towards analytical and methodological framings of "understanding new media" however eclipses the generative and creative processes for the production of subjectivity beyond a pre-given subject of experience. We therefore wish to ask the following questions: How would an account of digital media technologies beyond a stable conception of the subject or technology look like if we do not want to give up the political relevance of accounting for really felt and experienced power formations? And, how can we co-compose such accounts as that share of experience which has the power to pose and explore a problem and its effects?

The main focus of this contribution revolves around an ongoing conceptual and practical engagement with the notion of the "field" as it is being developed by French philosopher Gilbert Simondon. [2, 3, 4] In addition, it adds to a range of mobilizations of field as a relevant concept for a range of contemporary philosophies of media, experience and affect. The concept of *fields of experience*, we argue, provides a new mode of analyzing and understanding the role of and engagement with new media technologies as ubiquitous conditioning of life on this planet. The challenge of dealing with such fields resides in embracing the fields' experiential complexity as a general activity of potentiation, while at the same time accounting for its harnessing and capture by dominant powers. In other words, fielding, as conditioning of emergence, bears with it the possibility of control and authoritarian politics as much as enabling constraints to experientially open up modes of being and becoming in a relational, collective and transindividual manner. [5] In the following we wish to unfold, explore and further extend this mobilization specifically in the light of 'sentience' and 'sense', and in relation to two media artistic and digital design works: The artist collective *etcetera's* engagement in direct action interventions in Buenos Aires and the interactive installation *BERMUDA* that attempts to relay affective intensities across on/offline environments. This will lead to a discussion of the potential in 'shifting immediations' as a deliberate (but non-deterministic) practice when engaging in "counterpowerful affections." [6] The aim is both to provide conceptual and analytic insights, as well as propose future experiments and explorations across media art, philosophy and design.

Fields and Fielding

In his 1960 lecture *Forme, Information, Potentiels*, French philosopher Gilbert Simondon calls for a common axiomatics or "Science humaine", an integrative approach to reorienting the plural "Science humaines." To arrive at this end, Simondon is very specific; it is necessary to develop the notions of the field and fielding as a central dynamism in all processes of individuation across all dimensions of life (material, vital, mental). Simondon carves out a conceptual genealogy moving from early 19th century chemistry over Gestalt psychology and first generation cybernetics and information theory to basically rethink the notions of form, information and potential in the light of what he calls 'transductive operation' (*l'opération transductive*). According to Simondon, the concept of the field is not a description for some aspects of phenomena, may they be social or technical. Rather, it points at implicit orders that cannot be attached to fixed agents but are constantly produced and reproduced.[1] In his view, field as a concept establishes a reciprocity of ontological status and operational modalities between the whole and the parts. [11] The field is composed of a range of elements that are both in the field and constituting the field at the same time. Elements are not pre-given entities but themselves are relations engaged in working with other relations to build a certain degree of intensity that might occur as an element (in a concretized state). An element is not a substance as finitely demarcated entity but rather expresses something elemental, it is a movement with certain propensity and trajectory in relation to its milieu.

Simondon's proposition of the field is thoroughgoing. On the one hand it pertains to an overall rethinking of the separation of different disciplinary boundaries in the humanities. Simondon's thinking moves through the problematic rather than the disciplinary. A field is a tensed and dynamic set of relations that enables specific problems or concerns to arise through experience. For the study of concrete socio-technical ensembles, on the other hand, this means to approach technologies less by their mere technicality but rather in their operational functions as constitutive elements in fields of experience. In relation to the paradigm of interaction and new media technologies the main concern resides in addressing these cultural and social domains with and through digital processes as field-operations that can take many forms and act across the production of different contents. *With the term field we are asking how different forces, energies and affects are coupled into specific media-constellations without having to maintain a stable form or identity, thus operating across different boundaries of usually separated domains*. Accordingly, through explorations of what and how a field operates we depart from a more traditional separation of form and content, where the forms contain different contents or where the content shapes the forms it takes. A field is the constituent ground from which an interplay between form and content can take place - it in-forms that playing-out without predetermining how such a playing-out takes effect.

As a philosopher of technology, Simondon has an interest in uncovering the technical elements (in their functioning capacities) that are continuously in-forming fields of experience. Or as Brian Massumi has put it, Simondon has always recognized "technological innovation as a key theater of thought materializing in matter becoming, in ways imbricated with life transformations." [12] Following from this, we will argue that there is a particular emphasis on technique and technology as central to understanding fielding operations. This technical aspect should not constrain us to understand Simondon merely as a philosopher of technology - a tendency that is rather dominant in many strands of Simondon Studies. On the contrary, what he conceives of technical objects are operations, transformations and movements of the technical in resonance with the organic and inorganic matters of existence in their perpetual activation through processes of becoming and fields of experience. Fields of experience direct us to explore the intricate relations between technology and experience from an ontogenetic and processual starting point. From machine perception to human-machine-interaction to haptic interfaces, the life of algorithms and the shaping of economic lives through interactive and social media, it will be vital to show how the effects of digital media technologies are not to be found in a device, a subject or any other entity but must be understood as their functioning in experiential fields, fielding processes, and field effects.

Focusing on fields moves the emphasis from general, determinate structures to particular conditions of emergence in evental encounters. An experiential field does not determine the actions to come. Instead, it describes the opportunity or potential for actions to emerge. Field denotes less a circumscribed (yet dynamic) structure for the analysis of social processes, as strands of sociological and anthropological deployments of the term suggest. A field is strictly impersonal. Tying the notion of the field to the concept of experience allows us to further explore the intricacies between sensation and sense-making (or sentience) from an aesthetic and affective angle. In that respect we conceive of the field as pre-individual as much as the sphere where relations with their very own tendencies give way to specific sensuous and material encounters and events. The concept of a field thus enables us to discuss both potential tendencies in their incipience and processes of actualization in their effects. When we deploy and

[1] In relation to power and control these dimensions have been vastly explored by Foucault and his notions of *dispositif* and *diagram* and are dramatized in more creative variations of the latter concept through Deleuze's writing on Foucault. [7] It is also Deleuze who initiates a crucial opening of the disciplinary conception of power in Foucault and what he addresses as "societies of control" and a shift from individuals to "dividuals", a notion that Gerald Raunig explored recently (in part in relation to new media and social media) as well as Michaela Ott. [8, 9, 10]

explore the notion of the field we always do so to address modes of expression and experience in their very coming-into-presence, and as zones of openness for experimentation.

Sentience and Pure Experience

In aesthetic theory, one might draw on Jacques Rancière's idea of the "distribution of the sensible" (*partage du sensible*) for an understanding of the relations between our conception of fields of experience and sentience. [13] Rancière explains that former discursive orders have been supplanted by an aesthetic order or *regime* drawing on specific techniques and technologies of perception and how they are conditioning politics. However, and this is crucial for our explorations of fields of experience, the French word *partage* means not just dividing and distributing but also sharing and participating. In other words, it concerns both, the conditioning of sharing and participating and the effects of dividing and ordering. While Rancière retreats into pre-given conceptions of the subject and its environment, we want to focus on the processes of emergence, or what we call fielding, as constitutive of subject and environment through the powers of sensation. Such fielding is crucial when we think about emergent forms of sentience in interactive media environments and a more ontogenetic account of technical modes of existence relevant to Simondon's thinking. Sentience, as proposed in the overall outline of the ISEA 2020 conference, hovers between the sensible and what makes sense under specific circumstances. The question raised by Rancière's term of the *partage du sensible* requires us to think, how a fielding of experience exceeds the human subject as the locus of sentience. In other words, how form and content do not follow each other in their occurrence but constantly shape each other. Accordingly, the notion of *partage* emphasizes a sense of being already involved in the co-compositional fielding of experience as its fundamental mode of participation (a notion that Simondon also deploys).

In order to further understand the potential of the field and processes of fielding, the concept of experience requires further clarification. When we talk about experience, we use the term in the way William James suggests, as *pure experience*. [14] Pure experience indicates "a plain unqualified actuality", "as yet undifferentiated and undifferentiable into thing and thought." [15] And he further explains: "Everything real must be experienceable somewhere, and every kind of thing experienced must somewhere be real." [16] One cannot overlook the temporal and processual nature with which James conceives the term. Experience, as the "stuff everything is composed of," is not an experience of a phenomenological subject *in* the world, but rather a *worlding* in the way Donna Haraway uses the term, that is, a relational, speculative and more-than-human process of emergence and expression. [17, 18] James stresses that if there is something that exists in experience, it is "bare activity," and that it is the processual engagements of disjunctive and conjunctive activities which give rise to an experiencing subject and its environment. [19, 20] Such activity, as James underlines, is always differential and cannot be considered as homogeneous. It is in this differetial sense that he interlinks the terms of field and experience through a temporal conception: "The instant *field* of the present is at all times what I call '*pure' experience.*" [21] The making of the present is not a mere passing from a past moving towards a future. It requires a sense of activity to contract past and future. *Pure experience as the instant field of the present makes the event of experience an utterly more-than-human, ecological and emergent affair.* What comes to pass as *an* experience of *a* perceiving subject is only one minor contribution to the overall worlding of the experiential event as it co-determines the relations between things and thoughts, that is, between concrete and situated configurations and their continuous "self-abstraction" in becoming. [22] Fields of experience ask about the emergent status of experience that is always before and after an actual experience comes to pass. It is a temporalizing process of relations coalescing and forming with and through matter and as felt effects. A field, as we will explore further in relation to specific techniques and technological milieus, points at the openness and experimental character of sentience in the making.

Participation and Immediation

If we conceive of the ontogenetic, activating and emergent qualities of fields of experience, then the concrete contexts which we want to further address concern modes of participation in interactive media environments. As a process of fielding, participation cannot be preconceived as located in the experiencing human subject. Sense modalities might be somewhat curbed in many interactive media platforms and interfaces establishing and maintaining *aesthetic regimes* with very concrete goals for specific extractions of value (data, gestures, money transactions). The key in these technological and algorithmic captures of sense modalities through aesthetic regimes is the value they generate for further capitalist use. However, our concerns revolve around the potential of an emergent fielding of experience in order to shift modalities of participation away from the conventional parsing of sense modalities and attached value caputre. Such a shifting occurs as a temporal reworking of sensation rather than a mere reorientation, rupture or irritation - all of which are often deployed strategies to shake up sense habits (in particular in modernist and often masculinist aesthetic discourses).

Writing about the installation artist Robert Irwin, Brian Massumi develops a fielding concept of experiencing which he terms *immediation*. [23, 24, 25] He deploys a Jamesian notion of experience where the "human element" is less the center but the "conduit for the expressive event of experience." [26] The human mode of existence, as bodily and engaged in mental processing, is part of a larger process where the subject is the event of experience, and not just the human being. Experience is "integrally ecological." [27] How, then, can we conceptualize participation beyond the human subject and yet conceive of it as a crucial aspect of the subject's differential becoming in engaging with interactive

media technologies? The field is what allows for an immediate and immanent composition of the human as part of the event of experience, namely through constant processes of fielding. If we side with James and take bare activity and the conjunctive as well as disjunctive relationality of such activities as the baseline movement for the emergence of concrete embodied situations, the interplay of such activity qua fielding, becomes the main point of interest for the conception and analysis of interactive media engagements. Immediation expresses this temporal processing of the fielding as segue into an actual experience of the human subject, without separating the subject from the experiential field. Immediation means to shift sentience into the event of an ecological unfolding.

The challenge of working with fields of experience resides in opening up the fielding process as a veritable and speculative zone of experimenting with the way in which perceptions settle into a situation, how "we" make sense of it and to what kinds of effects. This process, as mentioned above, is neither neutral nor immune to all kinds of reactionary, conservative or fascist appropriations. One might even go as far as to analyze right-wing social media strategies as an investigation into the fielding potentials of these platforms. The key difference between an enabling and empowering and a conservative or resentment-style experimenting with fields of experience resides in the feedback-loops they generate. While the latter's aim is to harness power into a clearly defined identity to refer to or hold on to (a redundancy effect) the prior offers a more complex, speculative and differential unfolding of potentials (an affective relaying). As we will explore through two different examples, the process of fielding and its experimental engagement can take many forms while moving through technical milieus and ensembles. In either case, though, the experimentation with processes of fielding foreground a specific politics of affect, shifting the distribution of the sensible through field modulations and thus yielding an alter politics of potentiating affects. As proposed earlier, this turns the notion of fields of experience into a heuristic device for speculative and pragmatic experimentation.

Case #1: Etcetera and Escraches

From the mid 1990s onwards and in the aftermath of the Argentinian dictatorship (1976-1983) the human rights group HIJOS (short for " Hijos por la Identidad y la Justicia contra el Olvido y el Silencio", *Sons and Daughters for Identity and Justice Against the Forgotten and Silence*) staged a series of so-called *escraches*. *Escraches* are a type of direct action demonstrations targeting former military functionaries who never underwent any legal consequences for their crimes during the dictatorship and continue to live unchallenged in their neighborhoods. The *escraches* consist in a publicly announced and widely mediatized disclosure of the address of the targeted functionary and a time and date for the public intervention to take place. On the day of the event, a group of activists and protesters shows up and stages different formats, some more speech like others more performative and theatrical, to publicly denounce the functionary in his everyday milieu. A prior press release by the organizing group ensures the presence of presence of mainstream media. Their immediate live-coverage of the event plays a crucial role in order to yield the desired attention and to raise consciousness for the injustice of the political regime. The trigger for the first *escraches* at the end of the 1990s were the actions of Carlos Menem, the former president of Argentina, who officially pardoned the military functionaries and left them unprosecuted.

The artists group *etcetera* from Buenos Aires, mostly known for their surrealist and political art interventions, decided to join the *escraches* of the late 1990s through a specific contribution in form of theatrical figures. In their performances, they disguised as the military persons targeted by the overall intervention. Rather than just staging an atrocious figure, the group chose to take on a humorous and grotesque styling, resulting almost in a sensation of empathy and pity for the actual violator. In an interview Loreto Garín and Federico Zuckerfeld from the *etcetera* collective state that their main audience in mind was not necessarily the people directly present at the intervention but rather the TV audience witnessing the event at a distance. [28] They wanted to raise empathy for the intervention and its concern for social justice at a moment when the state fails to provide such a platform. Being aware of the controversies such interventions raise, the artists knew that the polarization of the audience into those people in support and those being against such acts disabled any actual process of critical reflection on behalf of the latter group. By creating the grotesque figures and triggering a humorous aspect, they hoped to effectuate a shift in the perception of the event. However, and this is crucial for the fielding of experience which occurred with the invention of these figures, the artists point out the specific time-frame of live-news media coverage. Hinting at the very short time span in which the imagery and footage from the actual events circulate on TV-news, they sought to find ways of inserting a moment of irritation through laughter and empathy, a comic explosion in an utterly politicized and violent atmosphere.

In attending to the timing of TV-news and inventing the figures in their ambivalent triggering of humor, the time of immediate judgment (either support or disavowal) was suspended. Such a minor intervention into the rather gridded and prestructured time-regimes of TV-news, with their specific modulation of audio-visual material, emphasizes an experimental treatment of the field of experience in the immediate present of the event's unfolding. This immediating relay banks on technical milieus and their set conditions while activating its potential for triggering a different fielding process and thus shifting the modes of participating - an overall change in the politics of perception. *Etcetera's* conception of the event is based on a field logic of experience to begin with. It takes into consideration the field of the present, which is experience, and invents ways of inserting alternative time-forms through laughter and the grotesque. It is humor which provides the field of an alternative encounter

with the event immersed in a highly complex history of violence and disappearance (a theme that continues to this day as one crucial focus of social movements in Argentina and beyond). One might even speak of a continuous doubling of two series of fielding, of which one pertains to the present of the (televised) live-experience and the other to the potential resonances of other temporalities occurring through the moment of quasi-humoristic irritation.

Case #2: BERMUDA

BERMUDA was developed as part of the SSHRC *Immediations: Ar, Media, Event* research project (2012-20) by digital artists Mogens Jacobsen and a range of collaborative partners.[2] *BERMUDA* is an interactive installation consisting of a piece of fabric suspended in four wires hanging from the ceiling, each wire controlled by a servo motor and divided into two triangular patterns of movement. The four motors are controlled by four independent data streams connected via an IoT (Internet of Things) protocol. In its current version, the motors are controlled through a real-time analysis of the sound in the Affective Interactions & Relations (AIR) Lab at the IT University of Copenhagen, where the installation is currently based. Each motor is linked to a specific frequency band that either raises or lowers the fabric based on the sound value in the room; high-pitched, high-volume sounds tend to make the fabric go up, but it is constantly shifting its form, and highly responsive to the sonic atmosphere in the room. It is possible to learn how to "interact" with the fabric, but the interaction is ever-changing and never 100% foreseeable – however, it is not totally random either. Through its real-time sound analysis, *BERMUDA* partially captures the atmospheric intensity in the room, and tries to add creatively to it. Partial capture is a key word here since *BERMUDA* does not attempt to perform a precise analysis of all the contributing factors to the atmosphere. It does, however, attempt to enter into a re-fielding of the different experiential vectors expressed through sound in the room, providing a soft modulatory potentiation of the space. Rather than working with mediation, which posits already known and clearly demarcated thresholds between individual parts, *BERMUDA* 'immediates' and becomes and expression where "cultural, technical, aesthetic objects, subjects, and events can no longer be abstracted from the ways in which they contribute to and are changed by broader ecologies." [29]

BERMUDA was originally conceived as a physical expressive resonator of live data-streams from an online and experimental platform developed as part of the Immediations project. Throughout the development phase, *BERMUDA* has been developed as an instance of what we have tentatively conceptualized as an "Affect-o-meter". The idea behind the Affect-o-meter is to visualize oscillations of the intensity of the affective engagement related to an interactive environment. The premise is that this visualization would have to be non-binary, operating on a continuum. Rather than a visualization or extreme points of reaction, it was instead meant to provide a live sense of how the collective affective investment was fluctuating through the spatio-temporal engagement. This registering of the collective appetite arising in the engagement with the installation would then feedback into discussions, modulating the turns things take, and perhaps give a general sense of when the discussion is reaching a critical point, or going nowhere, thus functioning as an indirect decision-making aid.

Figure 1: *BERMUDA* at the Minor Movement workshop, where it was an integrated part of a whole-day of events in and around the AIR Lab. © Authors

Figure 2: *BERMUDA* at the Culture Night, where families explored different movement patterns around the installation. © Authors

We have explored *BERMUDA* in action in a number of occasions, in particular in a workshop series as part of the *Immediatons*-project entitled "Minor Movements;

[2] Credits for BERMUDA: Mogens Jacobsen, Halfdan Hauch-Jensen and Jonas Fritsch.

Infrastructures of un/recommoning" [Figure 1], at an open event at a Culture Night in Copenhagen [Figure 2], where the lab was open to visitors from the outside, and more than 300 people interacted with it, and in the daily activities in the AIR Lab. At the Minor Movements workshop, BERMUDA functioned as an integral aspect of the fielding of the event, creating a shared expression of the mood and collective appetite of the group. During the one-day workshop, the quality of the fabric also made the expression change based on different contextual factors such as lighting, wind blowing through the space etc. Importantly, this added complexity to the expression, which was perceived as a good thing, since nobody was interested in another form of "information visualization". At the Culture Night, it was interesting to observe and talk to a number of people, who all saw different things in the installation: some wanted to use it as a way to create better acoustic in schools, or to teach children how to be quiet to appease the cloth. At some point, we saw a family of three going into the room, gathering under the fabric, getting down on their knees and waiting for the fabric to lower. They then started chanting while slowly rising, wanting to make the fabric go up with them. Again, this points to a multitude of potential use scenarios, with more or less direct forms of interaction, but always qualitatively relaying felt relations.

In its current format, *BERMUDA* only partially activates the full potential of an Affect-o-meter relaying between on/offline actions, atmospheres and encounters. The current use of the data streams to capture real-time sonic changes in the physical space could be further explored into a combination of situated and distributed data-streams, offering a different complexity to the infrastructural setup. What we can see from our current experience of working and living with *BERMUDA* is that it has a sculptural quality that draws people in and actively colors the experiential field of the environment in which it is situated. Future work would engage with the different parameters for intensifying the relays and exchanges between space, people and data over time.

Shifting Immediations and Politics of Affect

The two cases explored differ vastly in terms of their setting, concern and modes of engagement with media technologies. While *etcetera's* interventions are part of a larger context of human rights activism in the face of state violence and suppression, *BERMUDA* is an experimental interactive installation developed as part of a well-funded research project. While their contexts and concerns are very specific and need to be addressed in their situated geopolitical differences, both cases expose different aspects of the fielding of experience and the operational logic of fields of experience. In either case, the focus on a subtle shifting of specific media-technologically infused environments, allow us to further investigate the fielding processes underway in the overall engagements with media technologies. Shifting immediations means to attend to the minor modulations of sentience through different time-forms and their insertion into embodied perception. The question we wish to further unfold through the concept of fields of experience addresses the complex entanglements between such time-forms and their interplay across different modes of existence. Rather than conceiving of technology and the human subject, or the subject and the media environments, experience as a continuum of activity foregrounds an awareness for the power of activation in experience. Such powers can become counterpowers against preemptive modes of harnessing sentience into confined captures of resentment-based identification (the main refrain of right-wing politics) and offer an alter-politics of affect. [30] Such alter-politics of affect are attentive to the fielding that occurs across domains and disciplines, bodies and atmospheres. They experiment with the aim to allow for the occurrence of more complex and thus more open and joyous modes of experience. If we draw on specific aesthetic modalities, it is because we conceive of such aesthetics as a veritable extension of sensuous experience towards felt difference that eschews clear and contained perception while shifting how we perceive – rendering it more complex and thus less susceptible to mischievous appropriation. Such perceptions of perception give an account of sentience in the making and thus renew its modes of making sense adaptive to each shift in the situation. To relay these variations of sense generates a veritable affective politics capable of relaying such vast differences as *etcetera* and *BERMUDA* through the continuum of fields of experience.

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RISONANZE DI VINO: Tuning Wine with Sound through the Senses and Culture

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Abstract

Risonanze di Vino was a creative research project conducted with winegrowers in Campania, Southern Italy that sought to explore resonances between the senses, nature and culture. The non-visual senses were used as the main instruments of inquiry, to unearth the sentient interactions that often lie just beneath the surface of consciousness; in the intuitive ways the winegrowers worked with their changing environments, and through the crossmodal correspondences harnessed in the final multisensory artworks. This paper situates *Risonanze di Vino* within the framework of the artist's concept of *sensory terroir*, an interlaced sensuous-aesthetic system, which in this project blends sensory anthropology, wine studies and crossmodal psychology into a multisensory arts practice. It documents the creation of the artworks, which used the winegrowers' senses to orient field recordings made in their vineyards and wineries that were shaped into soundscapes that worked in harmony or conversation with their wines. These crossmodal *sensescapes* were designed to both transmit the winegrowers' sensory experience, and forge further sensory connections through harnessing crossmodal correspondences discovered between the wines and sounds.

Keywords

sensory terroir, crossmodal art, sound art, wine, sensory anthropology, multisensory aesthetics, sensescapes, soundscapes

Terroir, I think, is the notion that attempts to capture, in a sense, to bottle, this interaction between nature and culture for those involved in wine. Amy Trubek [1]

There is nothing in the senses which does not lead to culture. Michel Serres [2]

Introduction

"It's important for us to remember that the sound and the smells of the countryside we were used to when we were young were lost. When we started working with the vineyards here around 2000, these no longer existed," explains Cantina Giardino's Daniela De Gruttola. However, since starting the winery as a cultural project to preserve old vines and winegrowing traditions under threat from modern agricultural practices, biodiversity has increased and the sensescape has changed. "Now we have recovered these sounds and smells of the past," she states.

De Gruttola's sensitivity to sonic and olfactory shifts in the agricultural soundscape, was one of the sensory insights revealed in the research that grounded the creative *Risonanze di Vino* project. Conducted during an *Interferenze* artist residency in Southern Italy during the 2018 vintage, the project used largely non-visual sensory experience as a medium and a method to explore the sensory, cultural, and affective connections of six local winegrowers [1] with their wines and land. The inquiry involved interviewing and attending to winegrowers in their environments, and tasting their wines. I then used the winegrowers' sensory cues to orient my senses in the field recordings I made in their vineyards and wineries, and the multisensory *sensescapes* [2] I ultimately created. In these works created from each winegrower encounter, a soundscape was designed to interact with a wine from the winegrower to transmit the *sensory terroir* through the salient personal, cultural and perceptual connections I had discovered. The sensescapes were sensorially deepened using crossmodal correspondences, the universal tendency of a sensory feature in one modality to be matched with one from another sensory modality. [4]

Traversing the Sensory Terroir

Risonanze di Vino involved a practical application of my concept of *sensory terroir;* an interlaced sensuous system that draws on the connections between the senses, environments, people, and the multisensory imagination. Using a metaphor harvested from the French concept of

[1] I use the all-encompassing term *winegrower*, which relates to those who both grow the grapes and make them into wine (as is the case with many small wineries where the roles of winemaker and viticulturalist are often undertaken by the same person or people).

[2] The term *sensescape* is borrowed from sensory anthropology, defined by David Howes as: "the experience of the environment, and of the other persons and things which inhabit that environment […] produced by the particular mode of distinguishing, valuing and combining the senses in the culture under study". [3]

terroir – the symbiotic environmental factors that combine to create the overall character of the wine from a specific place – *sensory terroir* resonates with the idea of the senses as a similarly complex synergistic system that together form a unified perceptual experience. In terroir, interactions between soil, topography, climate, organisms, and human culture combine to form a unique character consistently reflected in the sensory experience of the wines from that site. In the sensory terroir of *Risonanze di Vino*, the interplay between the winegrowers' cultural, personal, and sensory experience of their wines and land, and my sensory perception of these, is transmitted through the experience of the distinctive multisensory works of this project. In the site-focused *Risonanze di Vino* project, the intersection of a person's intimate multisensory bodily perception with a specific place, can be viewed as similar to Paul Rodaway's notion of *sensuous geographies,* which use "*the senses both as a relationship to a world and the senses as in themselves a kind of structuring space and definition of place*". [5] The sensory terroir is also a place created through the sensory imagination.

While sensory terroir is not limited to wine-related connections, and can relate to all sensorial networks, actual wine terroir is fertile ground for its application. There is already a web of connections to tap into as a starting point for my investigation, including expanded notions of terroir that regard winegrowers as much a part of it as vines, the view that I hold and is important in this study's culturally engaged encounters with the winegrowing landscape. Conventional definitions of terroir, such as that provided in the Oxford Companion to Wine, focus on the interactions between soil, topography, and climates, rather than the human component. [6] In an Italian context, on his treatise on *Slow Food*, Carlo Petrini uses the Italian term "territorio" (territory) to express a similar concept. [7] One eloquent communicator on terroir, the wine writer Matt Kramer, evokes the potential for terroir as a metaphor to engender a sensitive exchange with nature, as "a way of being alert [and] of both acknowledging and accepting that the Earth – not just the soil – can speak". [8] This Earth is in dialogue with culture in Amy Trubek's anthropological interpretation of terroir, "in the form of a group's identity, traditions, and heritage in relation to a place". [1]

I had already started to explore the sensory terroir of Campania through an earlier project, *Oenosthesia,* made during an earlier *Interferenze* artist residency also in Campania in 2012. [9] This focused almost entirely on creating correspondences using pure sensorial experience. However, in the intervening years, I had become increasingly aware of how our sensory responses are shaped by our experience and cultures. Therefore, on my return to the region, I looked to expand on the scope of my earlier work to create something that actively engaged with and potentially even translated elements of the personal and cultural experience behind the region's wines.

This approach was informed by ideas from sensory anthropology, which highlights how sensory hierarchies can differ between cultures. [10] From numerous previous trips across Italy, and evidenced in its deeply rooted regional food and wine culture, [11] the sense of taste in particular appeared more highly privileged than in my own Anglo-Celtic culture. In a country that spawned the Slow Food Movement, taste appears deeply entwined in its culture, and is evoked by Petrini as a social sense, in being "a pact of fellowship and a program of cultural integration". [7]

I was unable to find any formal studies that compared actual sensory engagement between these two cultures. However, as the use of the senses in language can indicate the 'sensory model' of a culture [12] and highlight different hierarchies, [13] I turned to a study using linguistic and cultural analysis of sensory descriptions of British and Italian tourism websites. [14] This found that the Italian descriptions regularly employed sensory imagery, with numerous references to aromas and flavours, the latter often linked to tradition. In contrast, the British prose was more factual, with the term 'taste' largely used in the sense of personal preference. However, the British descriptions did reference sounds more often, suggesting the possibility of a higher level of engagement with hearing.[3]

Fieldwork in Campania Wine Country

Most of the producers I worked with in *Risonanze di Vino* were located in the Sannio district of Campania in Southern Italy. Here, from the slopes of Mount Taburno down to the Titerno River in the inner part of the Campania region, wine has been made since Roman times and remains an important part of the area's cultural, social, and economic identity. However, it is not one of Italy's most highly-regarded wine regions as it strives to overcome past associations of producing quantity over quality. [15] A number of winegrowers I spoke to mentioned challenges with working on the land, which had seen younger generations leave rural Campania since World War II and increasingly in recent years, to find physically easier and more lucrative work in the cities.

As I was keen to explore the multiple connections within the sensory terroir encountered in the projects, the wineries I worked with were smaller, largely organic operations, or at least following a more natural path in their grape growing and winemaking. Use of synthetic

3 While I was not struck by particularly heightened sonic engagement in most of the winegrowers I met, I did however come across the Campanian term, "pippiare", which fuses both sound and taste in describing the sound of the simmering of the local slow-cooked ragù at the point when the taste becomes just right.

chemicals can be regarded as working against nature rather than with it, breaking bonds within wine's ecosystems, and distancing humans from the land. Those who choose to work organically are forced to have a stronger relationship with their vineyards, to sense their needs and deliver the more involved care these require. In the winery too, minimal human manipulation allows wine to make its own connections – with elements such as the local yeasts – rather than being directed and reshaped by chemical additions. This hands-on connection with wines and land encourages greater sensory-emotional bonds [16] which I suspected would produce deeper resonances for me to tune into.

As these winegrowers were actively involved in making a product that is tasted (and smelled), I acknowledged that these senses might well be ranked more highly in the sensory models of these individuals than in the general population. However, as people working so closely with taste in a culture where this sense is so highly appreciated, I hoped this potentially ultra-heightened sensory engagement would offer a powerful orientation in my relatively short time with each winery. These orientations towards important personal and cultural sensory experiences, I would also seek to convey through the *oenosonic* sound and wine works I would go on to create. I had less idea of their relationships with sound, given questions over the ranking of hearing within Italian culture and as a more peripheral sense in winemaking.

Cultural and Crossmodal Tuning

Each winery visit began with an interview with the winegrower.[4] Using the framework of the definition of wine terroir as including humans, I firstly sought to understand how the winegrower's interaction with nature shaped the character of the final wine and how this might be driven by personal, cultural, and historical factors. My investigations then moved into sensory terroir to discover how each winegrower's senses of smell, taste, and hearing connected them to their general work in winemaking and specifically to their land. I also tasted their wines, noting the way they described their sensory characters, as well as my own perceptions. These sensory observations, of varying depth and detail, helped guide the audio recordings I made in their vineyards and wineries, and the selection of the wine from each used in the final works.[5]

Using each winegrower's sensory feedback as a framework, I created six individual sensory terroir-specific *sensescapes*. These consisted of one of their wines, tasted as part of the work, and a soundscape using recordings from their site. I also sought to deepen the sensorial dimension of the works through harnessing perceptual resonances between the sounds and wines. For this I employed the *oenosonic* mapping system I have developed to help identify crossmodal correspondences between salient characters of wines and sounds. This used a blend of my own senses and research, [9][17] as well as findings from contemporary scientific studies of perception that have confirmed the existence of crossmodal correspondences specifically between sounds and tastes.[6] The crossmodal tuning of the wine and the sounds of the sensescape sought to heighten the perception of these elements, expanding sentience through drawing attention to sensory interactions that often remain just beneath the level of consciousness.

Talking to the winegrowers revealed often deep sensory connections between them and their environments, from the logical and pragmatic to the intuitive and affective. These ranged from the audible reassurance provided by the regular whirr of winemaking machinery, to the powerful embodied sensorial impulsion that had drawn some of the winegrowers to wine and the land away from their original career paths. Questions relating to perceptions of sound initially appeared somewhat perplexing to some of the winegrowers, and in one case I even alerted a winery owner through my own listening to the fact that his wine had started fermenting. However, most were able to articulate to some extent how they engaged with sound in their work, besides the more obvious modalities of taste and smell associated with winemaking. As I had imagined, the winegrowers who were most directly involved with the physical *embodied* winegrowing process appeared more attuned to their senses; of touch, smell, and taste in particular. From charting this sensory terroir, it emerged that the greater the sensory engagement of the winegrower, the lighter their touch on the natural environment with which they worked. In response to this more sensitive handling, these environments appeared more sensorially vibrant, teeming with life and the more complex sounds, smells and tastes this produced.

Presenting the Sensescapes

The six works created in the *Risonanze di Vino* project were first presented at an event at the Cristina Park Hotel, Montesarchio, 7th October 2018.

4 Given that I speak little Italian, and as a number of the winegrowers I interviewed spoke little English, I am indebted to my interpreters, Nicola Carfora and Leandro Pisano for their assistance in interpreting for me in these instances.

5 The recordings were made and the final sound works were mixed digitally.

6 In a review of crossmodal correspondences between sounds and tastes, Klemens Knöferle and Charles Spence confirm that "neurologically normal individuals map tastes (and other aspects of flavor/oral-somatosensation) and both musical and nonmusical sounds in a nonrandom manner". [18]

Resolje
Work details: Masseria Parisi Resolje Moscato Spumante NV and Soundscape 5:29
Winegrower: Antonio Parisi of Masseria Parisi, Baselice
Responses interpreted from the Italian by Nicola Carfora

Despite his parents warning against becoming involved in the unprofitable business of wine, Antonio Parisi abandoned university to return to run his small family wine company, Masseria Parisi with his cousin Paulo Parisi. His parents had already revived the old and now rare tradition of making *passito* from Moscato grapes grown on the cooler higher altitude slopes of Baselice; a wine style dating to pre-Roman times where grapes are dried to concentrate their sugar. Since taking over three years earlier, Antonio Parisi has built on his parents' legacy by further improving the quality of the winery's Zingarella Passito, and started to make a sweet sparkling *spumante* wine from his Moscato. He has also converted the vineyards to organic, a practice closer to that of his great grandfather who started the family vinegrowing tradition through making wines for the local Barons.

Parisi takes me first to Masseria Parisi's vineyards. On high ground near the Campania-Puglia border, winds sough up the steep hillsides rustling the vine leaves and dense organic growth beneath. He speaks of the peace and meditative nature of winegrowing, which was one of the aspects that attracted him back to work his family's land. We then go to a quiet, well-ventilated shed where newly harvested Moscato are just starting their process of drying to become passito. The area's dry winds are essential to this process, and today the muted sound of a gentle breeze drifts through the racks of grapes.

With its crisp, pure, and light character, Masseria Parisi's Moscato spumante was best suited to the higher pitch and timbre of the recordings I made in the estate's elevated windy vineyards. From these I created a sympathetic soundscape for this sparkling wine that cycles between and merges with the wind through the vineyards and the effervescence of Parisi's newest wine fermenting. I sought to capture the sense of peace that was so important to Parisi, but also a dynamic excitement propelled by the currents of fresh air.

Montagna Mia
Work details: Masseria Frattasi SVG920 2017 and Soundscape 3:31
Winegrower: Pasquale Clemente, Masseria Frattasi, Montesarchio

"I love the mountain. I love making mountain wines," Masseria Frattasi's Pasquale Clemente enthuses. We're almost 1000 metres up Mount Taburno with a storm approaching. Before it breaks Clemente wants me to literally feel the excitement he experiences in the mountain's rocks. In a fast-paced tour of his high-altitude sites, Clemente picks up pieces of the limestone that cover these vineyards. Showing me the ancient marine life fossilised within the rock, he gets me to feel their rough crumbly surface.

This situated sensory experience of the vineyards is obviously crucial to him and the way he relates to his land and wines. He reveals that he told one potential overseas distributor that he would only sell them his wines if they first came to visit his vineyards. As well as interacting with his own plantings, he also takes me to experience some rough-barked 200-year-old vines, saved by their isolation from the phylloxera vine pest that destroyed much of Europe's vines from the late 1800s. He has taken cuttings from these from which he plans to establish a new vineyard and preserve the old vine heritage.

Both the wine I used and the soundscape I created hail from over 800 metres up Mount Taburno. The vineyards were dramatic, made even more so as rolling thunder increased in volume and rain began to crash down. The sound of the rain, captured close, battering the leaves on the vines, seemed well suited to the high acidity of Masseria Frattasi's high elevation SVG920 Sauvignon Blanc. The rocks also form part of the soundscape. I endeavoured to translate their texture through the slightly rough timbre and high pitch created when I hit or scraped them together, which works in synergy with the minerality of the wine.

33/33/33
Work details: Vallisassoli 33/33/33 2013 and Soundscape 3:40
Winegrower: Paulo Clemente, Vallisassoli, San Martino Valle Caudina
Responses interpreted from the Italian by Leandro Pisano

At Vallisassoli Paulo Clemente is another of a new generation of winegrowers returning to the land. His interest in wine, which saw him spend time as a sommelier, led him back via his palate to his family's one-hectare vineyard. He has converted this to organic production and made it into a commercial venture. Given his background, taste is central to his experience and wine production. As he has only spent a couple of years involved with making wine, he tells me the other sense he relies on most is vision. He describes sight as the 'most stable sense' that currently gives him the confidence to check whether winemaking processes are going well. He feels intuition may play a larger part as his experience grows.

As well as walking me through his vineyard, Clemente takes me to Castello Pignatelli della Leonessa, where ancient maps of the area are stored, including the one he uses on his wine label. High up in the castle's walled garden overlooking the town of San Martino Valle Caudina, he shows me vines that could well be as much as

300 years old. Clemente wants to make wine from them, if he can persuade the Duke who resides in the castle.

Church bells recorded from within the 300-year old vineyard ringing up from San Martino bookend the soundscape. Perceptually they have a bright tone, purity, and richness to their sound that correspond with the flavours of Vallisassoli's sole wine, 33/33/33: an equal blend of Greco, Coda di Volpe and Fiano grapes. In between the chiming, crickets and insects sing in the living, organic Vallisassoli vineyard, their chorus complementing the freshness of the wine, as does the high pitch of the fermenting wine that's also part of this work. The bells both symbolise the old winegrowing tradition and herald the new, repeated in patterns that echo the numbers in the wine's name.

Changing Flows
Work details: Fontanavecchia Libero Taburno Falaghina 2007 and Soundscape 2:33
Winegrower: Libero Rillo, Fontanavecchia, Torrecuso
Responses interpreted from the Italian by Leandro Pisano

"My wine has flesh and bones, which are perfumed with my memories, the taste which covers one's tongue, and wakes up all of your senses, my wine is the blood of these fields and everything that I have in me," is the poetic quote attributed to Libero Rillo to convey his embodied connection with his family's 150-year old wine estate, Fontanavecchia. [19] For him wine won over the army, and beat more obvious paths leading from his masters in economics, lured as he was by the land and the "amazing" people of the wine industry.

It is people that are now a major focus of Rillo's role as the manager of Fontanavecchia. As the largest winery I visited, it employs numerous staff to carry out specialised roles. These include expert consultants that help him deal with the challenges of climate change, which he considers part of a natural pattern. When I ask Rillo about the sensory engagement involved in his managerial role, he acknowledges the importance of engaging with all the senses. However, he admits that he does not use his hearing much, although he does use his smell to check barrels of wine. His main concern appears more with the winery's big picture rather than the smaller sensory details. This includes strong regional links that manifest in his strong commitment to local grape varieties. He shows me a rare example of an aged Falanghina made by Fontanavecchia, which I select as the wine I work with in my sensescape.

The perceptual characters of the wines and of the winemaking itself largely guided the Fontanavecchia sensescape. I was intrigued by the particularly resonant sounds of the bubbles of the fermentation heard through my hydrophone, which were like nothing I'd recorded before. I shaped these into a more rhythmic structure to reflect the fresh line of acidity in the white Falanghina wine, while its fullness and concentration is reinforced by the drone made from the winery's pumps.

In Giardino
Work details: Cantina Giardino Bianco 2017 and Soundscape 4:18
Winegrower: Daniela di Gruttola, Cantina Giardino, Irpinia

Cantina Giardino was the one winery included in the *Risonanze di Vino* project located outside the Sannio area. I visited it on request as I was intrigued by their wines, which I had tried before, and their extremely natural approach to winegrowing and winemaking. Cantina Giardino manage their vineyards organically. This minimal intervention extends to the winery where their wines are made without temperature control and matured in large vats made of local wood, or amphorae, some of which they made themselves with clay from their own vineyards. Cantina Giardino have been buying vineyards containing old vines abandoned by those considering them unprofitable. "In this earthquake region, where we don't have old buildings, we think these old vines are our historic centre," observes De Gruttola, who trained in sociology before focusing on wine.

As well as noting the changes in the rural soundscape over the decades due to shifts in agricultural practices, De Gruttola tells me how you can hear the sound of creatures in the soil when you don't use chemicals in the vineyards. Many of these benefit the vines, and even those that don't – as illustrated by the whine of mosquitoes she has noted in this wet season – she won't kill them as she considers them all part of the vineyard ecosystem. She takes me through her Chianziano vineyard in Paternopoli, burying her nose deep into the bunches of grapes to check for ripeness, with the smell of the vineyard guiding her instincts in how the wine is to be made in each vintage. She tastes the grapes as she passes through the vines, noting that the Coda di Volpe variety is ready when the seeds crunch.

I endeavoured to capture sounds of life in the soil, but just as Cantina Giardino stress the importance of time in the making of their wines, this required longer than my short period with them allowed. Above ground, mechanical sound drift from outside the vineyard seemed in sharp contrast to Cantina Giardino's lo-fi viticultural approach. At the time I chose to largely edit these from the final work, which used Cantina Giardino's richly textured Bianco, made in the old "ramato" style – using white grapes fermented with their skins – and matured in an amphora. I mirrored its rich layers sonically using deep notes from the heavy clay soil, and textures from the vine leaves and plant growth under the vine to complement its gentle pithy character. The fizzing ferment was used to underpin the wine's fresh grapefruit and balsamic-like acidity.

Postscript: In hindsight, I now consider that I should have been less judgmental about the mechanical sounds. Including these in the final work would have been truer to my experience of the site. The soundscape might have been more challenging, but would have presented a valid dialogue between the realities of differing rural practices, while better reflecting De Gruttola's low intervention winegrowing philosophy.

Spartiviento
Work details: Cantine Tora "Spartiviento" Aglianico del Taburno Riserva DOCG 2011 and Soundscape 2:51
Winegrower: Giampiero Rillo, Cantine Tora, Torrecuso
Responses interpreted from the Italian by Nicola Carfora

Cantine Tora's Giampiero Rillo tells me of the passion for wine that's been passed down through generations of his family. His aim is to make wines that demonstrate the typical expression of the local grapes using an "environmentally friendly" approach where chemical intervention is kept to a minimum.

He regards his sense of hearing as important for indicating how the mechanical equipment he uses is functioning. His ears also tell him what the wine fermenting in the vats is doing. If he hears that it has become too vigorous, he is prompted to slow it. Conversely, if it sounds too weak, he intervenes to make it more active. In the vineyard too, the natural sounds provide signs that can guide his decisions. If he hears the buzz of bees he is happy, as this means the grapes are ripe and ready to be picked.

As I visited on a day when it was raining heavily, which made recording outside a challenge, all the audio for the soundscape I created was captured from inside the winery. The sounds of the fermenting wine that Rillo is so attentive to were some of the most active I'd heard in the region, which worked with the powerful acidity of the local Aglianico grape of Cantine Tora's flagship wine. The rich and supple character of this red was also echoed in the rich smooth melodic quality of the drones of the winery's coolant systems, and its full-body by the lower pitch.

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Author Biography

Jo Burzynska has a two-decade practice in sonic art that spans experimental music performance and recording, to public and gallery installations and sound art curation. Also a widely published wine writer, her work in both areas has increasingly converged in the production of multisensory works that combine the sound and chemical senses. This crossmodal art practice is often in dialogue with contemporary psychological research into crossmodal correspondences; the systematic association of sensory features from different sensory modalities. She established the world's first "oenosthetic" wine and sound bar at The Auricle Sonic Arts Gallery in New Zealand and has just finished a PhD investigating sensory and aesthetic interactions between sound and wine.

Dance and Code with Empathy: A Reading of Joana Chicau and Merce Cunningham

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Abstract

This paper argues that the specifics of dance as a language, as being beyond writing at the same time as being a form of writing itself, can be used as a tool to evidence an aesthetic of code that includes a direct empathy with a formal, machinic feeling and not a metaphor of this feeling. The paper focuses on two specific cases: the live-coding performance *The Theatre of Re_Sources* by programmer and dancer Joana Chicau, which concretely provides connections between dance and code through its exploration of distances, and the Cunningham Technique developed by choreographer Merce Cunningham, which rids movement of any affect to later free the body through movement, illustrating a relationship between the formal and the feeling. The juxtaposition of these two works not only proposes an aesthetic of code that transverses the problems of its formal language, but it also illustrates a possible methodology for a reading of this aesthetic that goes beyond the instrumental and the expert.

Keywords

Dance, Code, Aesthetics, Poetics, Perception, Merce Cunningham, Joana Chicau, Formal Language, Dance-Writing, Feeling

Introduction

The aesthetic of code is a paradox: it comes from its formal, discrete nature. M. Beatrice Fazi illustrates the idea in her Incomputable Aesthetics, highlighting that the inherent openness of code comes from its formal nature and that its aesthetics is thus not based on a structure presented to the viewer but rather a relation between factuality and formality. [1] However, if this is the case, there is a risk of only being able to discuss its aesthetic metaphorically. In her essay on algorithmic points of view, Mitra Azar illustrates the problem: if Henri Bergson's idea that there cannot be perception without affection is used, then an algorithmic perception can only be thought metaphorically as it leaves out the perception of the human, the intuition. [2] Aesthetics is left to grapple with the uncanny valley of the human placed on top of the code like an interface. Indeed, what is needed is an aesthetic that also takes into account the *relationship* between the formal feeling and the feeling, between the algorithm and the human.

With this in mind, this paper proposes that dance as a language, as a tension between being beyond all writing and being writing itself, is a tool for understanding an aesthetic of code as it brings about an idea of empathy within a formal functioning. Mark Franko illustrates the importance of thinking dance as a language of writing:

> "If we think of choreography as writing, it may be because the very concept of dance depends in some measure on the notion of a *trace* in which the body, language as sign and the gesture of drawing coincide as the very definition of what dancing means." [3]

Dance is thus not a mere choreography, as in notation, but rather a complex language that is not required to communicate: instead, it *does*. Although dance is often defined through the perspective of one form of writing or the other, as beyond writing or writing itself, this paper argues that it is through the possibility of both forms of writing—at the same time—that an empathy is created between two forms of feeling, one human and one other.

The first type of writing, dance as being beyond language, is exemplified by Laurence Louppe's idea that writing dance is impossible because it is a "re-presentation" in itself, a trajectory between the real and the sign. [4] Franko explains the problem at hand:

> "In Louppe's discussion of the impossibility of the danced sign to deposit itself on record as such, we come across an unqualified rejection of dance as writing—which suggests that what needs to be recovered is not choreography per se but *états de corps* (as they are called in French dance theory [phenomenologically-based methodology]) and the reception of these states of the body by the eyes, ears and mind." [5]

To overcome the problem Louppe proposes that thinking of dance as poetic creates an empathy between the expert knowledge of the dancing body and the spectator, allowing it to be read through its mode of operating:

> "In this sense, the essence of dance poetics certainly has to do not so much with an aesthetic approach, which is ours, as with the knowledge about the movement and with the modes of analysis that observe it, with its functions and purposes" [6].

Dance is thus a poetics through its expert-knowledge.

In the second type of writing, dance as writing itself, what is commonly called Dance-Writing, dance ethnographer

Sally Ann Ness explains, through something akin to semeiotics, that dance is—literally—an inscription. She proposes to read dance through an *inward* semeiotic perspective where the movement is not inscribed in, but rather *into* the body. [7] Dance-writing thus illustrates a questioning of the notion of the gesture that allows for a reading of the body not as a storage for an idea, but instead as a tool for bringing into consciousness knowledge and thought processes.

These two sides of dance as a language draw out a question, raised by Franko, how can the body be separated from the dancing subject? [8] Which could also be read here, how can a feeling be separated from the executing code? To begin to answer this question, this paper argues that dance as language, as both Dance-Writing and beyond all writing, allows for a reading of an empathy within a function, the feeling within the formal. Read in this way, dance thus approaches its language with an awareness of its ephemeral nature, but also with an anchor in its functioning as an empathy. Dance is indifferent to its public. It does not have to communicate, and yet it still manages to produce empathy. What can code, in terms of aesthetics, learn from this? Can empathy be explored through dance that arrives at a feeling of code?

Dance, unlike other arts, does not have a canonic image nor is it based on aesthetic values and instead defines itself through the constant questioning of the possible. [9] But dance as writing, in both of its forms, provides a concreteness: its impossibility is also situated in the traces of signs. A code, thanks to its executing nature, is also defined as both a mode of operating in the world as well as a concept that it is iterated [10]. How then can dance as writing encourage a reading of the feeling in code—concretely, beyond the metaphor?

To draw out an answer to this question this paper proposes an exploration of Choreographer Merce Cunningham's work and technique alongside the live-coding work of dancer, programmer and designer Joana Chicau. The Cunningham Technique looks to restrict movement to its absolute essential, ridding it of all affection, to later free the body into creation in movement. He explains the aim of his technique:

> "The daily discipline, the continued keeping of the elasticity of the muscles, the continued control of the mind over the body's actions, the constant hoped-for flow of the spirit into physical movement, both new and renewed, is not a natural way. It is unnatural in its demands on all the sources of energy. But the final synthesis can be a natural result, natural in the sense that the mind, body and spirit function as one. The technical aim is not to do a few or many things spectacularly, but to do whatever is done well, whether a smaller or greater amount of actual physical skill is required, and approaching as a goal, the flawless." [11]

What appears throughout this technique, often based in counting and the mechanical, is thus a unique relationship to language that takes into account two different possibilities of feeling, the natural and the unnatural, as they arise from the same action.

Exploring the live-coding performance *The Theatre of Re_sources* by Joana Chicau is one possible path to resolve the issues at hand. The browser-based performance explores notions of dance directly within the writing of code. The work focuses on the programming concept Edit Distance, which is the number of changes needed to change one word into another. It consists of a Main Stage and a Backstage. The Main Stage is a world made of Google-Earth moons and circular browser inspector windows. The Backstage is a landscape mixed with hourglasses floating freely in space, twisted grids with codes also floating and a voice of a robotic woman reciting this code-poem. [figure 1] The work explores the distances between words and their meanings, space and text, technique and imagination and, in its path, draws out some interesting tensions that are read, as this paper explores, by a concreteness of the poetic.

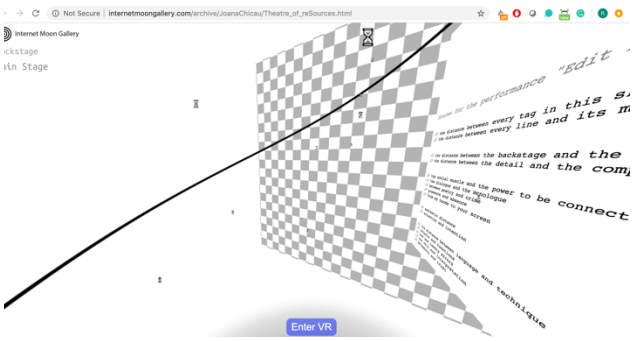

Figure 1. Screenshot of the Backstage of *The Theatre of Re_sources* by Joana Chicau. Courtesy Joana Chicau. Accessed December 15, 2019, http://www.internetmoongallery.com/archive/JoanaChicau/Theatre_of_reSources.html

This paper proposes a reading of these two works, one that is paying attention to the feelings that arise and how they interplay with the formal feeling of the machine. As Cristian Ulrik Andersen and Geoff Cox say in the introduction to the volume they edited on Machine Feeling:

> "Styles, expressions and sentiments are always in flux, yet [Raymond] Williams, and others after him, have with this term argued that they are grounded in cultural history and specific everyday situations. In developing a critical and analytic understanding we should therefore turn our attention to changes in language, style, aesthetics and those social forms which are active in the present, but not yet fully formed or captured by a conceptual or scientific knowledge framework." [12]

And that is in and of itself the power of dance: to do and listen at the same time in the present. [13] The aim of this paper is not to provide a full study of dance language and code, but rather to propose a starting point for a new reading

of a reciprocal relation between dance and code. It does not wish to communicate meaning, nor to produce technical knowledge, but to feel—empathetically—the dancing glimpses of a code that also feels.

Between Dance and Code: A Reading

These first lines of code set the tone of a *Theatre of Re_Sources* by Joana Chicau:

```
// the distance between every tag in this skeleton
// the distance between every line and its meaning
// the distance between the backstage and the front stage
// the distance between the detail and the complete settings
// the social muscle and the power to be connected now
// the dialogue and the monologue
// between poetry and crime
// presence and absence
// from my hands to your screen
// aesthetic distance
// attention and intention
// the distance between language and technique
// objects and functions
// one and twenty errors
// the skin and interpretation
// metaphors and trust
// the most distant or a faraway part of the visible scene
// the space and the text
//language and imagination
// one way: 384,402 km
```

They introduce thematic elements—"between poetry and crime," "metaphors and trust"—however, they are in actuality "commented out," a call to the human eye and not read by the machine. However, when considering dance's relationship to the body as sign, which emerged in its rupture with Classic Dance and in which Cunningham was a key instigator, the lines of code start to take on a different role. Louppe explains that the body was no longer understood in terms of its semantics, as in Classic Dance, and instead was only constructed through its bodily perception with that of other bodies, with the traces it leaves and incorporates in space and time. It is an individual exploration of movement. Dance as beyond all writing takes the stage, and Louppe highlights the need for a concept of intentionality to be read in dance's doing, in its poetic nature. [14] As this undoes the notion of choreography, which becomes the traces of bodies beyond writing and not signs, can codes also be understood as the corporal markings of their feelings, beyond the formal commands?

It is hard not to see that the intention is written in Chicau's exploration of movement and code, but how does it have empathy when the code executes? To explore this further, it is necessary to question a function in the code with what is visible on the screen, in other words, the feeling of the code in juxtaposition with the intention of Chicau. This will be done through a questioning of time as beyond writing and space as Dance-Writing as well as Cunningham's focus on the random which illustrates a relationship between both forms of writing at the same time held together by an empathy.

Cunningham has a unique take on space and time in relation to his technique, his stylistic language. For Stamatia Portanova, thinking specifically of his work using software but that can also be extended to his work created before using software, Cunningham's use of time is paradoxical: although the movement is cut into bits, pixels, points, what is visible is not cuts, but rather a continuity of movement. [15] The Cunningham technique uses formal processes to achieve a continuous, beyond-all-writing aesthetic. In the words of Cunningham himself:

> "In dance, it is the simple fact of a jump being a jump, and the further fact of what shape the jump takes. This attention given the jump eliminates the necessity to feel that the meaning of dancing lies in everything but the dancing, and further eliminates cause-and-effect worry as to what movement should follow what movement, frees one's feelings about continuity, and makes it clear that each act of life can be its own history: past, present and future, and can be so regarded, which helps to break the chains that too often follow dancers' feet around..." [16]

The mechanical nature of the language of the Cunningham Technique thus does not portray its meaning, but rather its pure possibility that is impossible to predict in advance. What only time will tell is not told through the mechanical nature that brings it about in the first place, but rather through the continuous possibilities that emerge in the moment and are thus beyond all writing.

In the choreography *Walkaround Time* (1968), in which the set is based on Marcel Duchamp's *The Large Glass* and the costumes are designed by artist Jasper Johns, perception is explored as the large class cubes on the stage make it so the viewer not only looks at an object but through it. Cunningham relates this to a question of time—and not to go unnoticed here—the computer: "You feed the computer information, then you have to wait while it digests. There's some argument as to whether the computer is walking around or those who are waiting." [17] Throughout the classic Cunningham style movements of kinetic impulses "traveling unimpeded from the torso to other parts of the body" and disjunct head, arms, legs, and torso [18], the mechanized cuts transform into an empathy: it is not about the information that arises, but rather the feeling of the time spent processing them. One of the main dancers of the piece, Valda Setterfield, acknowledges this "When I was flying high on the fact that the rhythm was so divine, I was doing things that I wouldn't believe I could do, if somebody had detailed them in a technical sense." [19] It is the feeling of the possible that remains, and not the formality of the function that made it possible in the first place.

With this in mind, after looking at the following function of code in Chicau's work, a question emerges: can a similar feeling be seen to emerge from the code's rhythm?

```
function vicious_circle () {
        var centro = document.querySelector("body"),
        deg = 10;
        des_centro = setInterval(function() {
```

```
centro.style.transform = "rotateY(" + deg + "deg)";
deg = (deg + 10) % 360
}, 80);
}
vicious_circle ();
```

What appears on the screen is disorientating—literally—and it is not the formal function of code that is read but rather this *feeling*. [figure 2] Much like the idea of the perception found in *Walkaround Time*, the code is looked at as well as through—appearing directly on the screen. The code is *doing*, and although the formality of it is seen, its poetics is felt—dizzingly.

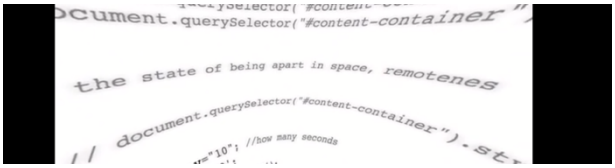

Figure 2. Screenshot from a video of the performance of *The Theatre of Re_Sources* by Joana Chicau. Courtesy Joana Chicau. Accessed December 15, 2019, https://vimeo.com/259568829

Cunningham says:

> "More freeing into space than the theme and manipulation 'holdup' would be a formal structure based on time. Now time can be an awful lot of bother with the ordinary pinch-penny counting that has to go on with it, but if one can think of the structure as a space of time in which anything can happen in any sequence of movement event, and any length of stillness can take place, then the counting is an aid toward freedom, rather than a discipline towards mechanization." [20]

The chain of the formal limits of coded language is freed through its executed rotateY. What is found here is the concreteness of a function, showing itself in both what it does and how it perceives through time, how it *feels*. The formal shows its inherent possibility of calculation (rotate a number of degrees), but on the screen, it is something else: an energy magnified in its continuity, a poetics of the function it executes. Like the divine rhythm of *Walkaround Time* that cannot be written technically, it is not a metaphor of rotating that emerges in the function rotateY, instead it is the poetics of the rotation itself that is felt.

In terms of discrete space, the idea that the feeling of the work is not a metaphor is also shown, but this time through the idea of Dance-Writing. Portanova uses the philosophy of Alfred North Whitehead to explore Cunningham's notion of space. She specifically takes Whitehead's critique of relational gravity, in that the spatialization of time does not account for the case of light, to say that "subtracting [dance's] logic from a purely aesthetic perspective, or even better, reassociating aesthetics to the field of a possible knowledge: every aesthetic perception is accompanied by a knowledge, in the sense that it starts from an integration of indiscernible sensations and ends up with the capacity to discern an image." [21] Knowledge becomes a structuring element. Portanova applies this idea to the choreography of Cunningham, showing that his choreographies do not illustrate a sensory relation, but rather a connection at a distance. [22] She goes on to say that this is numerical, and with that:

> "To reposition ideas in a field of numbers is to acknowledge the importance of an external, neutral intervention into the realm of art: it is for this reason that Cage, and his collaborator Cunningham, are often considered among the precursors of software-based composition in art. And we can find in Whitehead's philosophy the abstract principle coinciding with this external entity (which we will define here as software) of creative composition: it is the notion of 'relation,' which he defines as an 'abstraction from contrast.'" [23]

If Ness's exploration of an inward semeiotics is used to understand this abstraction from contrast, or a connection at a distance, the trace of the body as writing can start to be seen in the numerical aspects of Cunningham's exploration of space. Ness illustrates that dance is governed by sign production in which the outwardly icon and index are supported by the inwardly symbols as these symbols allow the possibility to transform movements into a stylistically coherent form that creates relationships between them and not just concepts of them. [24] Dance-Writing thus constructs space through knowledge. In this way, the recognizable multi-directional body movements of Cunningham are symbols of a repeated knowledge iterated in space, "a structure of permutation that could vary its own quantitative arrangements in . . . different presentational constellations." [25]

This can be seen in the choreography of *Beach Birds for Camera* (1993), which was created using software. Each dancer is an individual dancing freely in the space, resembling a fidgeting flock of birds, connected but at a distance. The seemingly random space between each dancer is structured by repeated movements in the style of Cunningham—flickering torso movements that focus on balance, the body moving in simultaneous directions at once, the human glimpsed from the movement of other—that seem to jump from one body to the other. What emerges is more than the freedom of each dancer: it is a calculated whole held together by abstracted, inward symbols *a la Cunningham*.

This connection at a distance is explored not only thematically in the work of Chicau and the focus on the idea of Edit Distance, but also in the way that it produces the feeling of an unachievable distance as its structuring knowledge, an inward look at its formal signs as the limitations of the possible interactions of scrolling. The infinite scrolling and lack of orientation in the space of the work are held together by a counting of distance:

```
function Distances(){
```

```
document.querySelector('#scale').innerHTML=Texts[co
unt];
count++;
if(count==Texts.length){count='0';}
setTimeout("Distances()",delay*1000);
document.querySelector("#scale").style.fontSize="50pt"
;
}
Distances()
```

What is felt when viewing the work is thus an impossible infinite scroll, a feeling of never arriving, a delay between each new count. [figure 3] But this disorientation is rooted in the feeling of its counting, its formal symbol. The viewer is not left with the muscle-memory scroll of a normal webpage, but rather an inward look at the knowledge of code as structuring. As Portanova says: "By counting, the numbered dancers literally manage to stand." [26] And like in *Beach Birds for Camera*, the structure is created through a relation between each element that resembles the other, a coherent and calculated whole that is symbolic of an inward, formal limitation of number.

Figure 3. Screenshot from a video of the performance of *The Theatre of Re_Sources* by Joana Chicau. Courtesy Joana Chicau. Accessed December 15, 2019, https://vimeo.com/259568829

This idea is slowly coming full circle, creating a path back to the first lines of code and the intention that started this section. What is left is to read both forms of writing together. When time as beyond writing and space as Writing-Dance are taken together, a unique feeling arises that can be seen as an empathy between the formal and the feeling, between the algorithm and the human. Cunningham's focus on chance, created often through the use of *I Ching*, represents this. Both the dancers and the audience are left to the surprise of the event: the chance is what suggests to the dancer to do what they do. Portanova shows the importance of this: "This complexity is the result of a neat separation between the autonomous working of the software (a machine of chance procedures) and the physical consideration of the dancers' anatomy. The software, in other words, is not humanized by Cunningham; to the contrary, it is the body of the dancer that becomes softwareized." [27] It is not that the human is placed on top like an uncanny valley, it is that the formal becomes a feeling to be danced and processed. And that is exactly the empathy *a la dance as language*: it creates new experiences that become supports to lean on—literally. [28]

What emerges is thus a structuring of the possible that achieves the divine. The feeling of the impossible in *Walkaround Time* is anchored by the structured external feeling of code, as empathy between the incomputable aesthetic of its formal being. In *Beach Birds for Camera,* the structured individuality in space becomes the freedom of the human to feel the beat of their own number, a sort of bodily to bodily empathy. And what is found in the work of Chicau, if the first lines of code as illustrated in the beginning of this section are reread, is no longer a one-sided conversation between Chicau and the spectator. Her intention becomes a type of empathy with the numerical, with the function, with the counting. And this resembles what Louppe has shown in her idea of the poetic and dance: the possibility of an event to emerge in the present. However, it also shows a Dance-Writing, that this event is woven in the technique, the symbol of the code as formal. Chicau's work represents a formality of code that feels within an infinite and dizzying scroll of the possible. What this idea of aesthetics reveals is the reality of the thing itself, not its symbolic form or its ephemeral event to come, but rather a feeling of what it is. Cunningham himself defines the it-is-what-it-is, the non-metaphorical, feeling:

> "This method might lead one to suspect the result as being possibly geometric and 'abstract,' unreal and non-human. On the contrary, it is no more geometric than the lines of a mountain are, seen from an airplane; it is no more abstract than any human being is, and as for reality, it is just that, it is not abstracted from something else, but is the thing itself, and moreover allows each dancer to be just as human as he is." [29]

Just as space is hard to separate from time, code is hard to separate from its formal function and its execution beyond the grasp of the human. But it does leave its traces, the problem is, like dance, that these are left to be read by the experts. But in reality, all that is needed is a new type of paying attention to a feeling in the formality of language, one that arises from a tension between its sign and its beyond all signs. It does not communicate, it does not metaphorically mean something, it just feels within the possibility and impossibility of it all.

Conclusion: Further Reading

This paper did not start out to produce meaning, nor an astute scientific study, but rather a new way of feeling needed in our code-based world. Some may say that when dealing with code, it must be considered technically, in its scientific prowess and its instrumental possibilities. But this is exactly the problem: the rest is then left to the metaphor—there is no room for the human there, and even if there was, the level of expert knowledge needed is already too high, it is already too late. But that is, in its own way, a more superficial look as it leaves code to its iterations and ignores the profoundness of its formal nature as a language beyond to be felt. The relationship between code and humans—as

aesthetics—has yet to be developed fully although code is ever-more present in how the world is perceived. Perhaps Cunningham shows it best: "But the pleasure of dance does not lie in its analysis, though one might sometimes be led to think otherwise. Dancing is a lively human activity which by its very nature is part of all of us, spectators and performers alike. It's not the discussion, it's the doing and seeing—of whatever kind." [30] And the enjoying of code is still very far from the surface—of whatever kind. In a world where expert knowledge becomes even more important in the face of advancing artificial intelligence, the dance has had years of experience dealing with the problem of the expert. After all, it is only the dancer who can truly speak for the dance, as illustrated by a lack of consensus and the borrowed nature of dance philosophy. [31] Dance must always face itself as its representational form, as a language. And perhaps that is what is needed in code too: it should be shown as *doing*, and from there, empathy can be felt.

Like all processes and techniques, however, what is necessary is to develop this methodology further, to read more, to read beyond the thematically-aligned works of Cunningham and Chicau, and to invert the argument, to read it from the side of code as language, as the formal and mathematical juxtaposed with the ephemeral and continuous nature of dance. What happens then? The answer—or at least its starting point—is in the feeling.

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PlantConnect and Microbial Sonorities: Exploring the Intersection of Plant, Microbial and Machine Agencies

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Abstract

This paper discusses the intersection of human, non-human and machine agencies via the analysis and description of two artworks that feature novel interfaces between humans, plants, bacteria and computational intelligence. Two projects are discussed: *Microbial Sonorities*, a real-time generative artwork that explores the use of sound and machine learning to investigate the bioelectric and behavioral patterns of microorganisms and *PlantConnect*, which explores human-plant interaction via the human act of breathing, the bioelectrical and photosynthetic activity of plants and computational intelligence to bring the two together.

Keywords

Electronic Art, Interactive Art, Plants, Microbial Fuel Cells, Clustering, Machine Learning, Sound, Light, Breath, Computer Vision, Bacteria, Photosynthesis, CO2.

Introduction

In his influential 1970 paper "The Aesthetics of Intelligent Systems" [1], art theorist Jack Burnham provides vital insight on the impact of intelligent systems on the arts when he notes that the emerging expansion of the art experience brought upon by the then nascent field of "cybernetic" art "encourages the recognition of man [sic] as an integral part of his environment" [2]. Burnham stated his belief that "the 'aesthetics of intelligent systems' could be considered a dialogue where two systems gather and exchange information so as to *change constantly the state of the other*" [3]. This idea of an artwork establishing a dynamic, emergent interplay with human participants is not only common today but is often the central concern of many contemporary interactive artists. The crucial element here is the recognition that each participant in this cybernetic exchange (human and machine) has *agency*, an ability to take action in the world in its own way. Might this performance of agency between human and machine be extended to our relations with living organisms and the natural environment? How might we utilize intelligent computational technologies to create systems that interface with the non-human world in such a way as to create novel aesthetic experiences?

The projects discussed in this paper represent an attempt to create such systems. These projects feature plants, bacteria and microbial fuel cell technology (MFC), technologies and materials that are becoming of increasing interest to new media artists. Two projects are discussed. The first is *Microbial Sonorities*, a real-time generative sound artwork based on bacterial voltages and machine learning. The second is *PlantConnect*, a real-time multimedia artwork that explores human-plant interaction via the human act of breathing, the bioelectrical and photosynthetic activity of plants and computational intelligence to bring the two together. The artistic motivations behind these projects center upon speculative investigations into alternative models for the creation of shared experiences and understanding with the natural world (in this case plants and bacteria). These works seek to establish a dialogue with those who have interests not only in sustainable futures but in reimagining the nature of our relationship to the environment and the nonhuman world more broadly. Might we be able to construct experiences using computational intelligence and living organisms that feature what Andrew Pickering calls a "performative ontology" that does not separate people and things? [4] Can we create an ontological model of the world as one consisting of open-ended interactions and reciprocal interplay between all of the life and matter in it? One that accounts for the agency of matter and all the living things on Earth, in addition to humans and intelligent machines?[5]

Background and Related Work

In what may be called an "ecological turn", contemporary new media art has increasingly demonstrated an increased interest in the relations between humans, nonhumans and the natural environment. The integration of biological systems has had an almost visceral appeal to artists, as systems may not only exhibit unexpected or unconceived patterns of behavior that purely digital or mechanical systems may not, but many artists are also attracted to the thematic blurring of boundaries between digital and biological worlds, as ways of experiencing the enigmatic "otherness" of non-human species [6]. Whether referred to as bio-art, environmental art or any myriad of other names, the focus on human-nonhuman-environmental interactions resonates across these practices. Through various types of

processes-driven practices that feature combinations of living matter and emerging technologies, artists are not only exploring how these systems can serve as vectors of novelty and unexpected variety, they are also forging a new aesthetics and systems of ideas focused on showcasing alternative possibilities of human-non-human relations in the age of climate change and environmental degradation. As these works suggest, a myriad of alternative visions are possible.

The design of intelligent computational systems by artists has been well-documented and analyzed. [7] Using a variety of techniques such as machine learning and evolutionary computation, the field has often produced systems that strive for aesthetically pleasing or "interesting" sonic and/or visual complexity as well as ecosystem simulations that invite the public to interact and play with virtual creatures [8, 9] or listen to (and influence) emergent sonic ecosystems. [10] Meanwhile, the development of arts-based systems that directly engage in interaction and communication between living organisms and computational systems (and sometimes humans) has been an area of increasing interest for both artists and academics. These practices tend to explore the agency of real non-human organisms and often involve material explorations of biomimesis, emergence and self-organization. Through various types of processes-driven explorations that link living organisms with technology, artists are exploring partnerships between these organisms and more traditional computational tools. In doing so, they raise questions related to how living organisms may adapt to technological intelligence and vice versa. Often working within theoretical frameworks that draw from cybernetics, [11] Deleuzian philosophy [12] and ecological sustainability, [13] most of these works feature technically sophisticated and novel sets of interfaces between living and technological systems, such as electronically integrating the human nervous system with mycelium cultures via heartbeat signals as in *MyConnect* by Saša Spačal and her collaborators, [14] creating interactive projection environments based upon the distributed intelligence of the slime mold *Physarum polycephalum* as in *Bodymetries* by Teresa Schubert and her collaborators [15] and the use of computer vision and contact microphones to track the movement and stridulation patterns of leaf cutter ants and using that information to control the "scratching" of turntables as in Kuai Shen Auson's piece *0h!m1gas*. [16]

Many artists have also been exploring bacterial agency and microbial fuel cell technology (MFC), a technology that has seen that increasing interest from new media artists. Some of the more ambitious work in this area has been done by the artist collective Interspecifics. Their work has featured interactive performances with bacteria and AI-powered microscopes, MFC technology and the translation of plant electrophysiological responses to sound to name just a few. [17] Latvian artists and researchers Rasa Smite and Raitis Smits [18] have also worked a great deal with plants and MFCs, making "pond batteries", "swamp radios" and systems where you can speak to plants remotely over the Internet. [19]

More than just using digital technologies to bridge the living world with the computational world, what these works show us that whether it is integrating human heartbeats with mycelia, "speaking" to plants or "listening" to bacteria, computational, biological and environmental technologies all have cultural and aesthetic dimensions that call for further artistic and critical exploration. Indeed, the convergence or intermingling of computational, nonhuman and human agencies may be a template for aesthetic experiences that highlight this performative ontology, showing us the unpredictability and dynamic potency that living organisms can exhibit while showcasing possibilities for new ways of human understanding of these organisms and the environment as a whole.

An Introduction to Microbial Fuel Cell Technology

As the two projects discussed here feature microbial fuel cells, a brief overview of this technology is warranted. Microbial fuel cells (MFCs) are an emerging bioenergy technology for generating electricity from biomass using microorganisms found in diverse environments such as wastewater, soil and lakes. [20] Essentially MFCs are batteries. They convert chemical energy to electrical energy via the action of anaerobic bacteria that metabolize organic matter. Generally, MFCs are used under the conditions of an aerobic cathode with air or oxygenated water and an anaerobic anode in wastewater or other organic matter (see Figure 1). The organic matter is metabolized by the bacteria, generating electrons and protons. The electrons attach to the MFC's anode while at the cathode, oxygen together with electrons and protons are reduced to water. Positive hydrogen ions are also released and are directed through the membrane to the cathode side. In dual chamber designs, a proton exchange membrane is used as a separator between the cathode and anode, while single-chamber designs relay on the organic material (e.g. soil) as a natural separator, where the bottom is under anaerobic conditions and the top is aerobic (the cathode is exposed to air or oxygenated water). In addition to power generation, MFCs can also be used as part of or in conjunction with waste processing systems and remediation of contaminated lakes and rivers. For example, a floating MFC was used to treat contaminated water where the bottom of the anode compartment was left open to the aquatic environment and the cathode was left floating on the surface of the water. [21] Constructed wetland MFCs have been used to treat agricultural [22] and domestic [23] wastewater. In the Netherlands, Plant-MFCs have been used for power generation in "green roof" designs [24]. Overall, MFCs offer a very different approach to power generation and wastewater treatment as the treatment process can become a method of capturing energy in the form of electricity or hydrogen gas, rather than a drain on electrical energy.

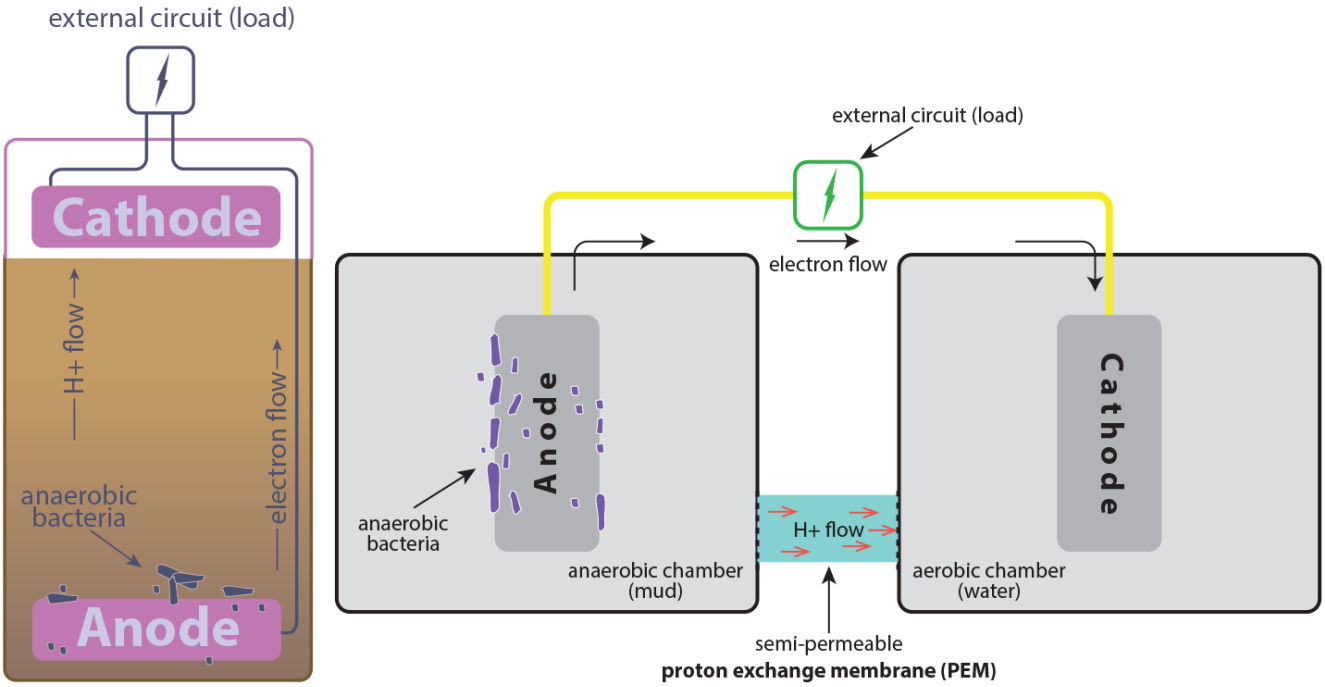

Figure 1. Single-chamber (left) and dual chamber MFC designs.

While *Microbial Sonorities* uses dual-chamber MFCs with compost as biomatter, *PlantConnect* uses an array of 16 plant microbial fuel cells (P-MFCs) as the core element of the system. P-MFCs use naturally occurring and known processes around the roots of plants (typically aquatic plants) to produce electricity. [25] The plant produces organic matter via photosynthesis under the influence of sunlight. Most of this organic matter ends up in the soil as root material or exudates where it is metabolized by anaerobic bacteria, resulting in the release of electrons as described above.

Microbial Sonorities: Bioelectric Generative Sound

Microbial Sonorities explores the use of sound to investigate the bioelectric and behavioral patterns of microorganisms (Figure 2). Based upon inquiries into emerging bioenergy technologies and ecological practices as artifacts of cultural exploration, the piece features a hybrid biological-electronic system wherein variations in electrical potential from an array of microbial fuel cells are translated into rhythmic, amplitude and frequency modulations in modular electronic and software-based sound synthesizers. The research focuses on three primary areas: (1) Microbial Fuel Cells (MFCs), (2) Modular hardware and software synthesizers: The bioelectrical fluctuations of the MFCs are used as modulation and trigger sources for a Eurorack-based modular synthesizer and/or a custom-designed software synthesizer built in the Max/MSP/Jitter visual programming environment (http://cycling.com, hereafter referred to as "Max"). This entails building electronic circuits to amplify the electrical signals generated by the bacteria and software to translate the signals into control voltage (CV) sources appropriate for the synthesizer. (3) Machine Learning: Machine-learning algorithms are used as a way of interpreting the shifting electrical patterns generated by the bacteria. Pattern recognition/classification is used to trigger synthesizer presets and CV gate signals while statistical regression is used to predict variations in electrical potential. If a comprehensive understanding of the bioelectrical patterns can be attained, it will be used to inform the development of a sonic compositional system that is dictated by these patterns. In essence, allowing the bacteria to "express" themselves sonically. *Microbial Sonorities* was exhibited at Centro Cultural Universitario Rogelio Salmona, Colombia as Part of the International Symposium on Electronic Art (ISEA 2017), and numerous venues in the United States.

System Overview

The current system set-up typically consists of four MFCs, a Eurorack modular synthesizer system, an Arduino microcontroller (arduino.cc) and the Max/MSP/Jitter visual programming environment (cycling74.com, hereafter referred to as "Max"). The biomatter used for the MFCs is usually fresh compost or if possible, benthic mud from a local lake or other aquatic body. Voltage from each MFC is amplified and connected to an analog input on the Arduino. In some cases, it may also be plugged directly into the control voltage input on one of the Eurorack modules.

The piece operates on two temporal scales. The first which I call "immediate" consists of a simple linear mapping of voltage to pitch for each MFC. Transient voltage

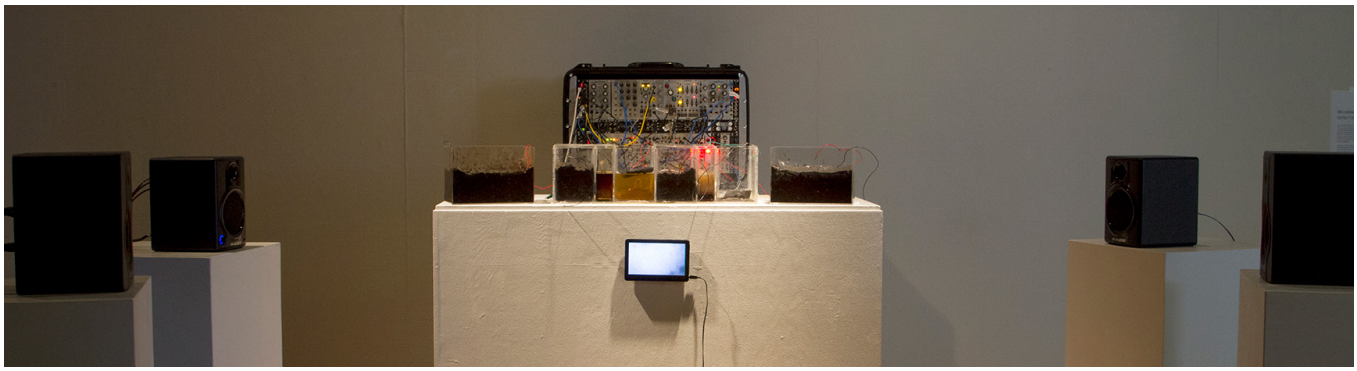

Figure 2. *Microbial Sonorities* installed at Washington State University, Pullman, Washington, USA in 2016. The modular synthesizers are shown in the center behind four microbial fuel cells.

spikes are also detected and mapped to sound. The second time scale, "longitudinal" is a longer-term (from 48 hours or greater) mixing of Eurorack synth patches. Each MFC is assigned a synthesizer patch according to its current "life stage". A life stage is simply a point in the overall voltage curve over which a typical MFC travels over the course of anywhere from 48 hours to several weeks before it "dies". Four life stages have been identified and assigned a synthesizer patch. A regression curve, using a neural network, was then created to mix/transition between the four different sounds/patches. Training data for the network was created simply by drawing a curve in Max's **itable** object that matches a typical MFC voltage curve. The x coordinates of the **itable** represent discreet time steps (0-50 hours), while the y coordinates represent voltages (0-1000 millivolts). While the piece is running, a running average of the voltage is kept for each MFC and sent out to the neural network application once every 30 minutes. In essence then, the MFCs and the software together function as a sort of hybrid "smart mixer".

The regression curve used for the mixing of synthesizer patches was created using a simple, three-layer neural network. It consisted of an input layer with two inputs for voltage and time, one hidden layer (with 3 nodes) and an output layer with two outputs representing the x/y coordinates of the quad mix (of the four modular synthesizer patches). This model was copied four times (one for each MFC).

PlantConnect: A Speculative Human-Plant Interface

An extension of *Microbial Sonorities*, *PlantConnect* (Figure 3) measures the photosynthetic and bioelectrical activity from an array of P-MFCs and translates them into light and sound patterns using machine learning in real-time. In *PlantConnect*, bioelectricity, light, sound, CO2, photosynthesis and computational intelligence form a circuit that enhances informational linkages between human, plant, bacteria and the physical environment, enabling a mode of interaction that is experienced not just as a technologically-enabled act of translation, but as an embodied flow of information. *PlantConnect* was exhibited in 2019 at the Asia Culture Center in Gwangju, Korea as part of the Arts & Creative Technology (ACT) Festival and the Interna-

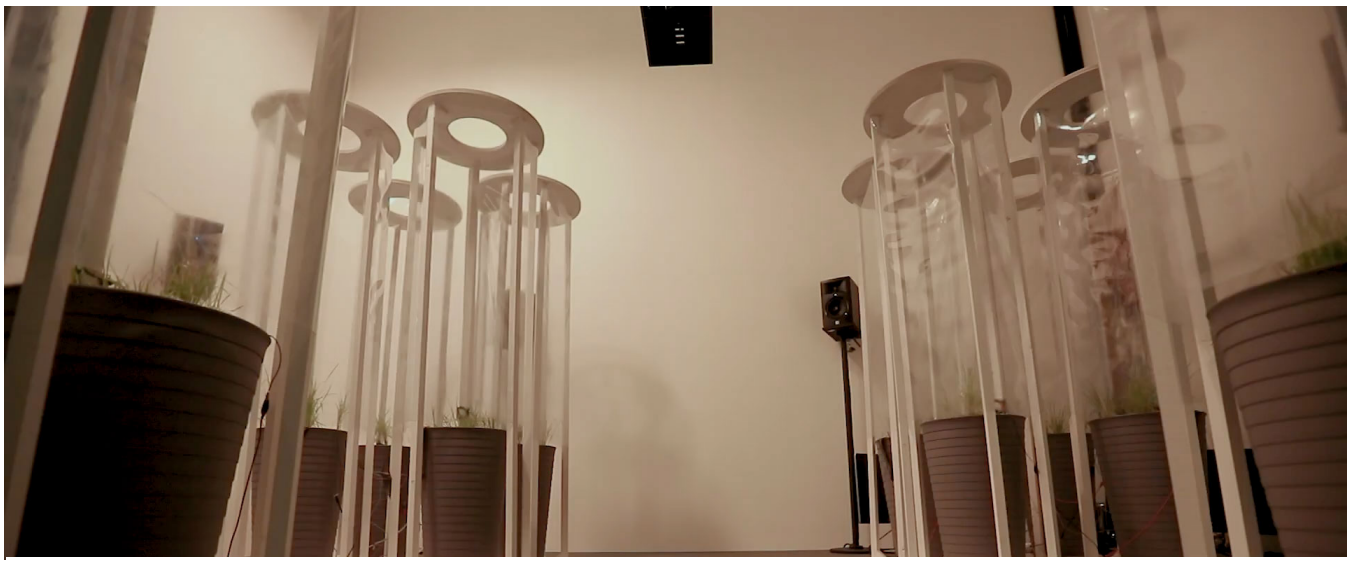

Figure 3. The *PlantConnect* installation.

tional Symposium on Electronic Art (ISEA 2019).

System Overview

As seen in the system diagram in Figure 4, when a participant blows, whistles or otherwise exhales into a CO2 sensor located within the array of plants, it causes the CO2 levels to surpass a baseline threshold. This in turn triggers an array of 16 grow lights and a set of software sound instruments. Participants thus receive an immediate visual and sonic response. The lights are directed at the plants (from 2m above) and thus contribute to their photosynthesis. There is one light for each plant. The photosynthesis levels are obtained from housings containing a plant and a CO2 sensor placed near it (discussed below). When the light above the plant turns on, it causes the CO2 levels near the plant to decrease. These levels are translated into interpolation parameters for the software sound instruments and spatialization module of the system. Meanwhile the voltage signals from the P-MFCs are read by a standard microcontroller and analyzed to find the minimum & maximum voltage values. These thresholds determine the on/off patterns of the lights when they are triggered by human breath/CO2. Once the CO2 levels on the breath sensor fall below the baseline threshold, the lights turn off. This can take anywhere from 1 to 10 seconds.

Using two digital video cameras and a simple blob detection algorithm, the system then detects the on/off state of the lights in the light array, relative to the background. This data is then sent to a clustering algorithm that performs rudimentary pattern recognition. This data is then sent to the sound instruments and spatialization module to create the generative sound environment. In this way, the machine learning algorithm — and by extension the plants — select instruments and alter their amplitude, duration, pitch, and other parameters. This is all discussed further in the succeeding sections below.

As mentioned above, when a participant blows or whistles into the CO2 sensor located in the center of the space, it triggers each grow light to turn on but only if the voltage of its associated P-MFC is above the requisite threshold. The result is an unpredictable and varied pattern of lights and sound that are experienced as a reaction by the plants to human breath and light. The entire sound, computer vision and machine learning portion of the system was built using Max (version 8.0.5). The project runs on two Apple Macintosh computers. One computer (the "CV/ML" computer) handles the computer vision and machine learning tasks, while the other (the "sound" computer) handles generative sound and communication with the microcontroller. Data is sent from the CV/ML computer as UDP messages from Max over a standard Ethernet connection to the sound computer that is also running Max, with the sound instruments loaded. The sensor readings, P-MFC voltage readings and light control system were built on the Arduino microcontroller platform. The following subsections detail each of the aforementioned elements of the system.

Plants and Plant Housings The plants used in this project are Oryza Sativa, commonly referred to as Asian rice. Asian rice has been deployed in several P-MFC designs. [26] The plants are housed in enclosures made of wood and clear vinyl. Though they also serve an aesthetic purpose in the piece, these housings are necessary for properly measuring changes in CO2 absorption from the plants themselves, irrespective of changes in the surrounding CO2 levels in the space. They also provide sufficient ventilation to allow for adequate air flow (and thus not risking the CO2 continually rising inside the housing). [27]

Biosignals and Light Control All signal acquisition and light control is handled by a single Arduino Mega 2560 microcontroller. Acquiring voltages from the P-MFCs is a simple matter of connecting each cathode (which in this case is the positive lead) to an analog input of the Arduino. However, the voltages are not acquired from each individual P-MFC. Instead, groups of 4 P-MFCs are wired together in series to make a single voltage source that is then connected to an Arduino analog input. As there are 16 P-MFCs, this amounts to 4 groups of 4 P-MFCs (hereafter referred to as "P-MFC groups") and thus a total of 4 voltage sources. The P-MFC groups are arranged in a reverse C arrangement.

While the system is running, the voltage signals in each MFC group are analyzed to continuously find the minimum & maximum values. These values are used to generate a set of dynamic thresholds. A total of four thresholds are generated, one for each light and P-MFC in the group. These thresholds determine which lights activate and thus determine the on/off patterns of the light array. The thresholds are spaced apart evenly from each other. For example, if the minimum voltage value of a given P-MFC group is currently 10mV and the maximum value is currently 100, then the two middle values will be 40 and 70. Each of these values will set each light in the group to an active state successively in a clockwise manner when it is surpassed. For example, light 1 is set to active when the voltage surpasses 10mV, light 2 is set to active when the voltage surpasses 40mV, light 6 set to active when 70mV is surpassed and light 5 is set when 100 mV is surpassed. When a participant blows on the CO2 breath sensor (and the sensor value goes above the predetermined threshold) it will trigger the active lights to actually turn on. The lights themselves are 20 watt led grow lights (obtained from ackegrowlight.com) that emit a warm white color. They are connected through two 8-channel relays, which are controlled by the Arduino. When plants are actively photosynthesizing, they absorb greater amounts of CO2 than when they are not photosynthesizing (e.g. at night). In our project, the P-MFCs' levels of photosynthesis are obtained by measuring CO2 near the plants. The sensor (a SenseAir K-30FR obtained from CO2Meter.com) returns the CO2 levels in parts per million and sends the data via a standard serial/RS232 connection to the Arduino. The breath CO2 sensor is also connected via serial/RS-232 to the Arduino. Here, we keep a running median of the nine most recent CO2 levels. This helps to establish a baseline level with

respect to the surrounding environment. Thus the threshold for triggering lights and sound is a predetermined level above this baseline (20ppm by default). Readings are taken at a rate of two per second.

Computer Vision A simple blob detection algorithm is used to differentiate the lights from the background. This is a relatively simple task as the piece is installed in a rather dark space. In order to achieve blob detection easily and reliably within the Max environment, a third party library, **cv.jit** (https://jmpelletier.com/cvjit/) was used. The **cv.jit.blobs.centroids** object returns a list of blob centroid coordinates. Two USB digital video cameras (Mobius Maxi, www.mobius-actioncam.com) were mounted between the plants and the grow lights (just over 2m from the floor) to provide the video feeds. They were pointed directly at the lights and connected to the CV/ML computer running Max. The two video feeds were combined and together produced a streaming image that captured all the lights in the space. The video feed was then virtually cut up into 4 rows and 8 columns, for a total 32 cells. In our default configuration, the video image is 640 x 360 pixels. Thus each grid is 80 x 90 pixels. This grid is the reason for using blob detection (as opposed to simply reading the on/off states from the microcontroller). The size of the lights and the fact that each light panel takes up to 500 milliseconds to reach full brightness means that a single light may actually register as more than one blob as it may spill over to another row or column. Both of these factors serve to add an element of variety and aleatoric behavior to the system (for example the system may very quickly switch between several different cluster assignments for the same light pattern, resulting in an erratic "glitchy" sound).

Blobs are analyzed and the x/y coordinate of each blob's centroid (center of mass) is returned. A list of 32 binary numbers corresponding to the location of each centroid within the grid of 32 cells is then output, with 0 being "off" and 1 being "on"). This list determines which "voice" of the sound instrument (which essentially corresponds to pitch) gets played. For example, if the first light is turned on and the blob centroid is located at pixel location (40, 55), index 0 (the first item in the list) will be set to 1 and thus will trigger the sound instrument to play its lowest pitch. Depending on how the system is configured, the duration of each triggered voice is set to a fixed amount at runtime or is determined by whether the blob detection algorithm recognizes the light (essentially as long as the light is on, its corresponding voice stays on). Pitches (or which voice gets played) are arranged left-to-right and top-to-bottom in the 4 x 8 grid. Thus the first voice 1 would be the top left and voice 32, the bottom right of the grid.

Clustering/Pattern Recognition The same list of 32 binary numbers that is sent to the sound instruments is also sent

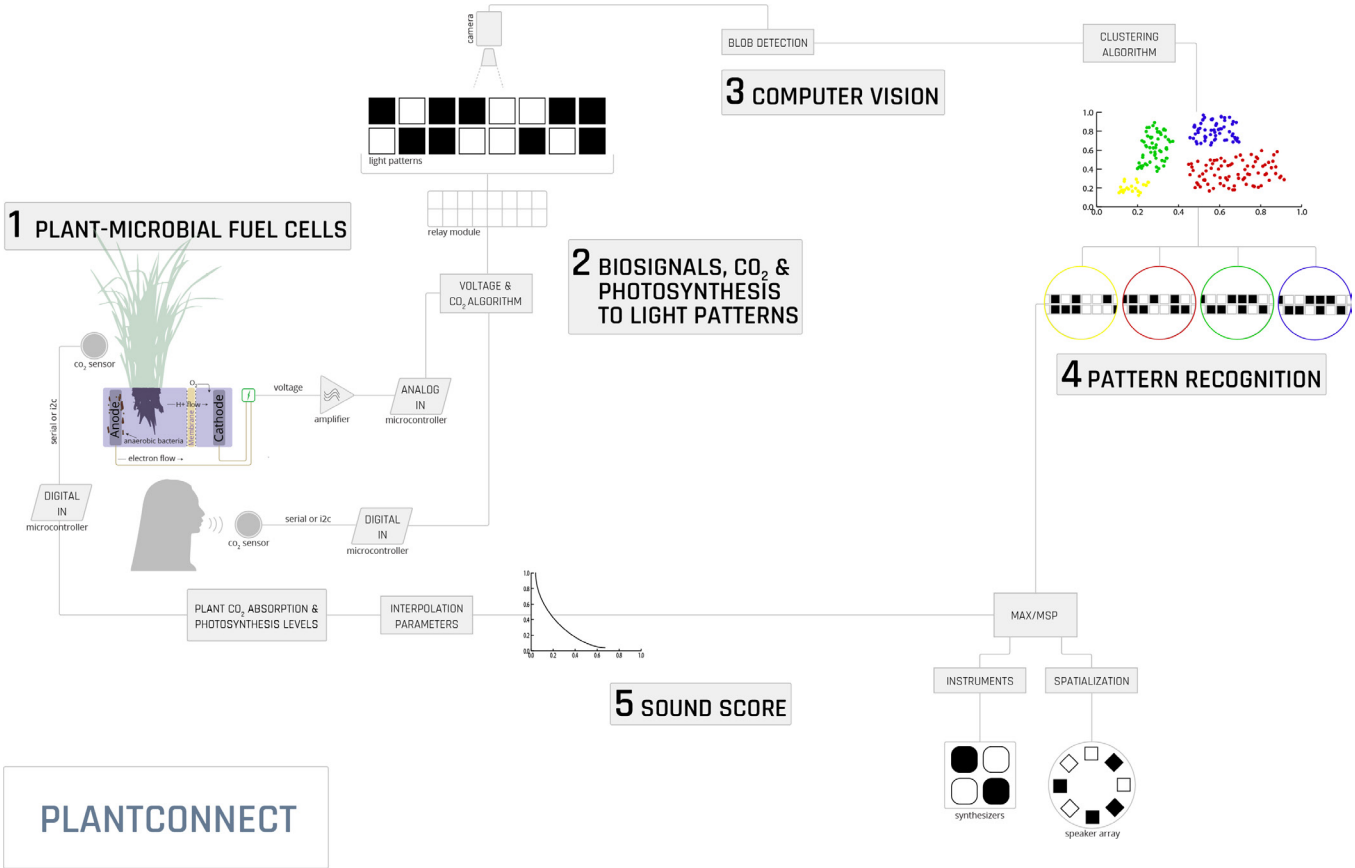

Figure 4. *PlantConnect* system diagram.

to the machine learning module. In this project we apply a fuzzy c-means clustering algorithm to the data. Fuzzy c-means clustering (FCM) [10] is a method of clustering (a type of unsupervised machine learning) that allows a given data point to belong to more than one cluster. A membership grade (in our case a floating-point number between 0.0 and 1.0) is calculated for each data point which indicates the degree to which that point belongs to each cluster. Frequently used in pattern recognition tasks, FCM assigns membership in a cluster by calculating the distance between the cluster centroid and the data point. The closer the data point is to the cluster centroid the higher its membership grade for that cluster (i.e. the closer it is to 1.0)

In our project, we use the **ml.fcm** object from the **ml.*** package for Max [11]. We first initialize the object by assigning it a fuzz coefficient of 1.05, selecting the number of clusters to calculate (in our case four) and a termination threshold of 0.01 (the default). The fuzz factor effects how "crisp" or "fuzzy" the cluster memberships are (higher numbers return fuzzier membership grades), while the termination threshold effects the speed and accuracy of the cluster calculation (higher values produce quicker, more approximate clusters). We then generate one thousand random data points as a sort of training set. Each data point has 32 dimensions (corresponding to the possible location of each centroid within the grid of 32 cells) and consists of ones and zeros. Once this is done and the live video feed is turned on, the system is ready to perform real-time clustering of incoming light patterns. When the system is running and new data on the light on/off patterns is received, a query is made to the **ml.fcm** object which then outputs a list of 4 membership grades (one for each cluster). These numbers are used to set the volume of each sound instrument (0.0 = minimum volume, 1.0 = maximum volume). In essence, the FCM algorithm is used as a sort of mixer for the sound instruments, generating a variety of sounds that would be unlikely or even impossible for a human-controlled mixer to achieve.

Generative Sound The real-time data representing the shifting light patterns along with the output of the FCM algorithm are translated into a series of UDP messages that control the sound instruments and a spatialization module within the Max environment. These messages essentially function as note on/off messages to "play" the instruments. Five sound instruments have been constructed, each with its own distinct timbre. Four of these instruments correspond to the four cluster memberships generated by the FCM algorithm (and will henceforth be referred to as the "cluster instruments"). These instruments require human interaction (via breath/CO2) to be activated. A fifth instrument is the default instrument. It plays continuously, requiring no human action to be heard.

The default sound instrument simply maps the voltage levels from each P-MFC group to pitch (the higher the voltage, the higher the pitch). In addition, any transient spikes in the CO2 levels from any of the P-MFCs are also sonified by the default instrument (and are heard as transient spikes in the pitch). The cluster instruments receive CO2 levels as well. However, in this case we add up the CO2 level of each plant of each P-MFC group and get an average of those readings. Then we take the five most recent averages and obtain the median value. These values are then used as interpolation parameters for the spatialization module (discussed below).

Finally, the CO2 readings are also collected and used to construct an envelope function (using the Max **function** object, essentially a breakpoint function editor) that is used as a modulation source for the cluster instruments. Each instrument uses this modulation data differently. For example, one instrument uses it to crossfade between different wavetables, while another uses it to alter the depth factor (the amount of deviation around a center frequency) of modulation oscillator and to crossfade between two control signals.

PlantConnect also features 8-speaker sound spatialization using circular panning. By default, sounds related to readings taken from each P-MFC group are sent to the two adjacent speakers closest to that group. In addition, whenever a light is triggered above a particular P-MFC in a group, the sound instrument will be heard on the two adjacent speakers closest to that group, in a manner similar to L-R panning. The idea being that the sound instrument is heard near the P-MFC whose lights are currently on (and thus triggering sound). Finally, CO2 levels of each P-MFC influence the amount spatialization spread between all the speakers. The median value of the five most recent averaged CO2 readings of each P-MFC group is used to determine the amount that the triggered sound instrument spreads from its "home" location (the two adjacent speakers closest to it) to the other speakers. When triggered, the sound spreads in both a clockwise and counter clockwise direction from this home location.

Evaluation

While to date, no formal user studies have been performed or data collected on the works discussed here, informal participant observation have been performed that may infer as to the participant experience. In *Microbial Sonorities* for example, two days of viewer observation revealed a consistent pattern of behavior. Almost everyone who observed the piece would bend down and lean in very closely to observe the MFCs from just inches away. In *PlantConnect* (also after two days of observation), after the initial surprise of the triggering of lights and sound, participants would again observe closely (in this case by often walking around and looking up as well as down and close to the plants). In all, most viewers stayed with the works considerably longer than is typical for most artworks [17], and did so in a manner (looking around, perhaps confused but curious or even delighted) that is suggests that they appreciated (if only partially "getting") what was going on the works (one observer referred to *Microbial Sonorities* as "swamp music", which is perhaps as good a description as any the artist could give). Though the evaluations presented here are preliminary and provisional, it suggests that

these works — after the initial novelty and surprise — evoke a curiousness about the systems and perhaps an awareness that there are process and possibilities being revealed that were perhaps previously unknown or not considered.

Conclusions

The projects presented here all share a desire to explore zones of negotiation and reciprocity between the human and non-human worlds by incorporating nonhuman organisms and elements of the natural environment with intelligent computational systems in an attempt at showcasing a performative ontology — a vision of the world as full of co-emergent, co-evolving systems that exist in a perpetual state of becoming, characterized and brought forth via emergent relations of complexity. Matter, the environment and non-human life are seen not as passive and inert but rather as lively and dynamic. This convergence of agencies may serve to further disrupt dualist ontologies that are at the heart of our often dysfunctional and destructive relationship with the natural world.

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Carlos Castellanos is an interdisciplinary artist and researcher with a wide array of interests such as cybernetics, ecology, embodiment, phenomenology, artificial intelligence and transdisciplinary collaboration. His artworks have been exhibited at local, national and international events such the International Symposium of Electronic Art (ISEA), SIGGRAPH & ZERO1 San Jose. Castellanos is Assistant Professor at the School of Interactive Games & Media (IGM), Rochester Institute of Technology.

Archive or Alive:

The Experimental VR Digital Collection of Shou-You LIU's *Shapde 5.5*

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Abstract

Archive or Alive: Digital Archiving Development of a Solo Dance by Shou-Yuo Liu was a project dedicated to applying contemporary digital technology to the methodological construction and R&D of non-material archiving technique concerning performers' body movement. Breaking away from previous practice of single-perspective recording, this project provided a sweep panorama of the performer's whole body, insofar as to give the spectators a 3D stereo view of the performer's body movement. This paper assumes that, apart from collecting existing objects, this archiving technique can be applied to comprehensively and objectively preserving works from different periods and the body languages that have not been systematically handled by the other archiving techniques yet, so that we can channel unprecedentedly vigorous energy of art into our archival display with new technologies of data restoration and presentation. Premised on the aforementioned assumption, this paper seeks to investigate the digital technology R&D and technological culture analysis accomplished in "Liu's Solo Dance," thereby explicating how this new performing arts genre transformed ephemeral art into a virtually archived work affording timeless admiration.

Keywords

Shou-Yuo Liu, *Shapde5.5*, digital archive, virtual reality

Introduction

Since the 1980s, performing arts has extensively incorporated media and evolved a sui generis genre known diversely as multimedia performance, cross-media performance, cyborg theater, digital performance, virtual theater, new media drama, and so forth. This nascent, changing field still lacks a proper scheme of taxonomy as a research tool and method to disentangle its own portmanteau contents. [1] The somatic stimulation, liberated participatory space, and script flip-flop characteristic of this media technology not only offer spectators unique experiences, but also alter their interactive relations to theater pieces. Today's digital technology further makes performing arts something more than their earlier incarnations that could only evoke ephemeral feelings of presence. Virtual archive has empowered spectators to determine their preferred duration, perspective, and scene of the work they're viewing. Virtual technology has also gradually transformed the admiration of works that had been performed into participatory somatic experiences. Immersing themselves in a world detached from realities, spectators comprehend theater pieces not so much by conscious perception as through a world constructed from image-actor, stage installation, and immersive technology. Spectators employ body-mind fusion again to set out on a fantastic journey across the virtual universe, indulging themselves in the world of image-body interaction.

Archive or Alive: Digital Archiving Development of a Solo Dance by Shou-Yuo Liu (hereafter referred to as *Liu's Solo Dance*) was a project dedicated to applying contemporary digital technology to the methodological construction and R&D of non-material archiving technique concerning performers' body movement. Breaking away from previous practice of single-perspective recording, this project provided a sweep panorama of the performer's whole body, insofar as to give the spectators a 3D stereo view of the performer's body movement. This paper assumes that, apart from collecting existing objects, this archiving technique can be applied to comprehensively and objectively preserving works from different periods and the body languages that have not been systematically handled by the other archiving techniques yet, so that we can channel unprecedentedly vigorous energy of art into our archival display with new technologies of data restoration and presentation. Premised on the aforementioned assumption, this paper seeks to investigate the digital technology R&D and technological culture analysis accomplished in "Liu's Solo Dance," thereby explicating how this new performing arts genre transformed ephemeral art into a virtually archived work affording timeless admiration.

Shou-Yuo Liu's Shapde 5.5

As a practice of performing arts, Shou-Yuo Liu's *Shapde 5.5* (2014) drew out meaningful and thought-provoking implications from a simple narrative structure. By means of bodily performance, soliloquy, vocal expres-

sion, and image overlapping, *Shapde 5.5* was replete with the intertextual imagery distinct from the performance and horizons of conventional theater, embodying the life cycle from born in light and shadow, via the feminine identity developed during coming of age, the autopoiesis of masculine attributes, and the resistance and struggle against aging, to the eventual demise. As a cultural narrative, Liu's body graced the stage. Amidst the four layers of white stretch fabric, his body not only exuded an aura of performativity, but also served as a vehicle for fragmented image narratives. In this work, he invoked the metaphors of a long scarlet dance skirt and suit and tie to represent female and male bodies respectively, so as to evoke the imagery of gender convergence. Besides, the four layers of white stretch fabric on the stage not only constituted the spatial context of this work, but also performed the tasks of capturing and presenting multiple images. Furthermore, the layers of stretch fabric were objects carrying symbolic meanings. Seemingly fragmented, the performer's body images were projected onto these layers of screen-like stretch fabric, as if they were flowing amidst these membranes, echoing one another, and permeating every corner of the stage. [2]

Archive or Alive: Digital Archiving Development of a Solo Dance by Shou-Yuo LIU

How can a performance create an experience we will remember, even if we didn't view it on site? How can people understand this specific piece of history with their absence? No matter how vivid the images and narrations are, it's fairly difficult for people to have a feeling of empathy and to immerse themselves in the venue conveying a strong sense of rhythm; hence the question as to how we can preserve a performance venue (e.g. its space, music, lighting, and performer) in a way of capturing its essence. Through concessive projects under the theme of "Archive or Alive," the idea ET@T proposed is that "the purpose of archive serves not only to conserve objects, but also to keep alive the artistic energy residing within itself in contemporary times.

During the six-month implementation, this experimental research project revolved around *Shapde 5.5*, the chef-d'oeuvre of senior theater practitioner Shou-Yuo Liu, and developed the non-material archiving technique, based on which an archiving platform for body language was established. This platform will be helpful for archiving works of multiple performers as well as extending technological applicability and discursive scope. The project's presentation included dancer motion capture and restoration technology application. It also featured in the "Concept Museum of Art" (2019) at the Digital Art Center Taiwan that optimized performing arts archiving technique by integrating display technology with viewer experience. Therefore, the non-material archiving technique developed in this project not only focused on the audio-visual level—i.e. how the work is represented in high definition and verisimilitude—but also considered the spectators' viewing experiences in specific temporal and spatial conditions, rendering the work epochal in representation and contemporary for the spectators.

To archive and present *Liu's Solo Dance*, the project team first of all asked the dancer to re-enact *Shapde 5.5*, so that they could record his body movement in the form of a sweep panorama. Then the team discussed with the dancer on the ideal way to represent the archive according to the data output: inviting the spectators to wear VR glasses that allowed them to admire the work from different perspectives at will. The reason this project took *Shapde 5.5* as its case study was to offer professionals (e.g. dancers, researchers, and critics) and amateurs (e.g. spectators with no background in dance) a digital archive that affords repetitive, panoramic reading of the dancer's body language, from which we expected to see pluralistic applications such as the disassembly and analysis of fundamental movement, the movement learning and training, and the presentation of restored images with VR display devices. This project restored the dancer's body language with digital technology, which created inimitable digital narrative experiences for the spectators.

Both the analysis of *Shapde 5.5* and its applications in performance design and artistic creation would be impossible without the 3D stereo view of the dancer's body movement recorded with the sweep panorama technology. Given the existing logic of art exhibition and the current schedule of technological R&D, this project not only integrated the "archived body language" with the "archive-generated personal digital narratives," but also involved techniques of archive display, aiming to experiment with the technique and discursive design regarding how a performance is "exhibited."

Technological Experiments

Scene Reconstruction

According to Liu, the reason he treated the three parts of his solo dance in *Shapde 5.5* as the target of his experiment was because this work represented the results of his exploration and accumulation on bodily performance over the past three decades, unveiling not only his innermost consciousness inside out, but also the relations between the human body and objects (material and non-material): body vs. motion, body vs. nakedness, body vs. costume, body vs. objects (stage props), body vs. sound, body vs. consciousness, and body vs. space-time. Apart from Liu's bodily performance in *Shapde 5.5*, his "improvisation"—his choreographic originality—was archived as well.

With the assistance from the "Body Phase Studio" [3] in 2018, ET@T and Liu spent nearly 6 months reconstructing *Shapde 5.5*, including the stage, lighting, projection, and

music of its three parts, as well as the rehearsal, recording, panoramic view editing, and VR interface making. [4]

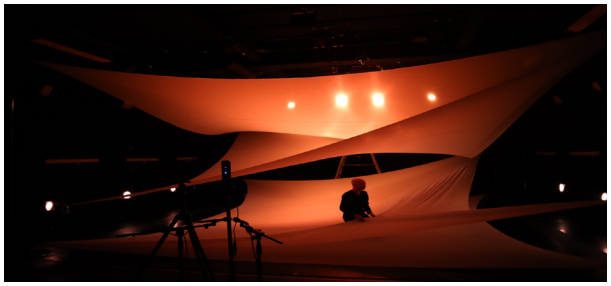

Figure 1. Re-setting the stage in the studio for video recording in panoramic view ©ET@T

The Multi-angle Recording of the Dancer and the Stage Setting

ET@T recorded Liu's solo dance from five different angles with a total of eight cameras, including an 8K 360° camera above the stage, four 4K 360° cameras (downstage left and right, upstage left and right), and three 4K 2D cameras (on the ceiling and downstage left and right). The dancer shuttled amidst the four layers of stretch fabric on the stage as they were fluctuating with the music and plot. Having mass and quality, the stage was rheological and present from beginning to end. The dancer sometimes stepped on the layers of fabric, and sometimes hid behind them. The spectators would have different experiences if they admire the performance downstage or from the sides of the stage. Therefore, the multi-angle recording ingeniously and appropriately afforded a panoramic stage and a bird's eye view that would be impossible with a conventional proscenium stage.

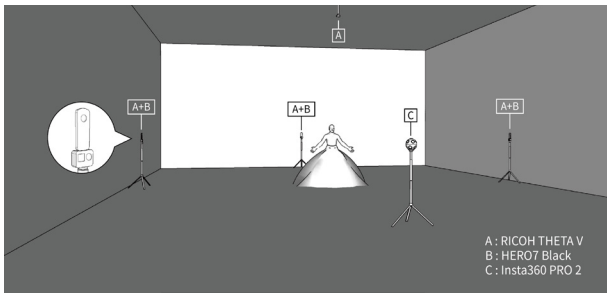

Figure 2. The demonstration of the multi-angle recording setting. © ET@T

Video Production

Given the limited time for recording and the impossibility of simultaneously monitoring the eight cameras, ET@T and Liu recorded the bodily performance and improvisation in *Shapde 5.5* for four times, from which they selected the finest one. Dancing to nobody's tune, such an unmonitored performance brilliantly echoed Liu's philosophy underpinning the creation and rehearsal of this work in 2014.

The VR Interactive Experience—Seat + Handheld Sensor

The exhibition invited the spectators to take seat while selecting and viewing their preferred parts of virtual image.

Figure 3. The spectators to take seat when selecting and viewing their preferred parts ©ET@T

The Overall Result of the "Concept Museum of Art"

Be it Liu's introspective bodily performance or the correspondences between the body and objects on the stage, *Liu's Solo Dance* was imbued with emotions and heterogeneity. The physical movement in the novel, structural audio-visual formats and vehicles such as panoramic digital images and VR viewing experiences undoubtedly revealed the independence and permanence of images. *Liu's Solo Dance* altered our previous perception of 2D images, giving rise to deeper understanding and discourse of the human body, which concerned not only image and our knowledge of the performer's body, but also our ways to remember them.

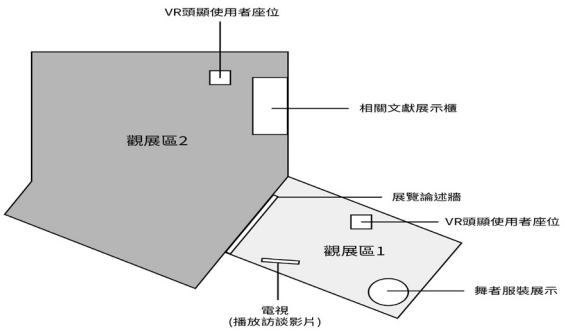

Figure 4. The floor plan for exhibiting the work in Concept Museum of Art ©ET@T

Figure 5. The exhibition took place in Concept Museum of Art ©ET@T

Technological Cultural Analysis

As a project in "Archive or Alive," *Liu's Solo Dance* exhibited multi-perspective horizons in virtual archiving. Firstly, different from traditional moving image, *Liu's Solo Dance* not only gave prominence to imagery elements, but also opened up new possibilities for multiple screens and plural images with the assistance of digital technology. Besides, dissimilar to the conventional function of cinematographic machines, this experimental work allowed the spectators to discuss its charm from multiple perspectives and indulge themselves in the immersive sound field. Finally, distinct from the common agenda shared by works of video art, this project granted the spectators preference-based option. It is clear that digital technology has directly impacted the analysis of theater and performance, particularly in terms of presence, documentation, and spectatorship. Digital technologies such as high-resolution imaging, motion capture, and data analysis have not only refreshed the spectatorship and scholarly interpretation of contemporary media and performance, but also influenced art collection methods as well as the plans and roles of art museums.

In addition, *Liu's Solo Dance* enabled the spectators to admire its "liveness" virtually in different space-time, and invited them to consciously get involved in this "event" with their bodies and senses. There was no such thing as a "perfect" angle of admiring this work when the spectators entered the realm of this machine-image performance and roamed the venue. To put it another way, the spectators experienced this work in a reality constructed in an abstract and symbolic fashion. They gave feedback, making movement and space meaningful components of their experiences.

The synaesthetic experience thus found expression in the abovementioned process. Somatic reactions dominated sematic interpretations in this immersive performance that involved all human senses. Employing the strategy of virtual immersive spectatorship, *Liu's Solo Dance* allowed the spectators to associate their memories of viewing with their present admiration, hence the continuation of the somatic-sematic relation, a distinguishing attribute of virtual archiving. [5] To resolve the internal contradiction between the synaesthetic immersion and the heaviness of technological installation that haunts general VR works, this project invited the spectators to take seat and admire the remade version of *Shapde 5.5*, a piece of performance by Shou-Yuo Liu that had been delivered at the Guling Street Avant-Garde Theatre in 2014, from multiple perspectives.

Conclusions

Liu's Solo Dance highlighted the characteristic of database-based performance that transforms "performance" into "archive," so that people no longer miss any piece they want to see. According to Tara McPherson' talk "Post-archive: Scholarship in the Digital Era," we are in the midst of the "post-archive moment," in which an archive metamorphosed from a collection of objects into a database of them. [6] *Liu's Solo Dance* was exactly situated in the dialectical relation that databases dominate, overwhelm, and replace the text of liveness." This viewpoint coincided with Lev Manovich's notion of database—a database is "a cultural form of its own." As a cultural form of the contemporary digital generation, *Liu's Solo Dance* represented the world as an inventory and refused to order the items in it. This project simply demonstrated an aggregate of materials, and left the rest to the spectators' participatory autonomy. In this project, technological media produced the illusion of presence (liveness). It didn't really present the body on-site, but vividly showed the human body, objects, and scenes in a way as if they were "present" at that very moment.

Acknowledgements

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[1] Sarah Bay-Cheng, Jennifer Parker-Starbuck, and David Z. Saltz, *Performance and Media: Taxonomies for A Changing Field* (Ann Arbor: University of Michigan Press, 2015), p. 2.

[2] Chih-Yung Aaron Chiu, "The Bodily Narratives in the Field of Technological Image: A Brief Review of Liu's *Shapde 5.5,*" TaiShin Artalks website, accessed October 2, 2019, https://talks.taishinart.org.tw/juries/ccy/2014092906.

[3] The Body Phase Studio was founded by Mo-Lin Wang in 1991. In 2005, the Guling Street Avant-Garde Theatre Executive Committee was founded by the Body Phase Studio to operate the Guling Street Avant-Garde Theatre. *Shapde 5.5* was staged at the Guling Street Avant-Garde Theatre in 2014, organized and executed by the Body Phase Studio. (Quoted from the Special Issue of GLT Magazine on the 2014 Performance)

[4] On 14 August 2018, the C-LAB announced the grant-winner of the first CREATORS. ET@T's proposal "Archive or Alive: The Digital Archiving Development of a Solo Dance by Shou-Yuo Liu" won the grant of NT$ 1,000,000. It took them five and a half months to complete this project until 31 January 2019.

[5] Bay-Cheng, Parker-Starbuck, and Saltz, *Performance and Media*, p. 6.

[6] Josephine Machon, "(Syn)aesthetics and Immersive Theatre: Embodied Beholding in Lundahl & Seitl's *Rotating in a Room of Images*," in *Affective Performance and Cognitive Science: Body, Brain and Being*, ed. Nicola Shaughnessy (London: Bloomsbury, 2013), pp. 204-207.

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Hsing-Jou YEH is now the Chief Coordinator in ET@T and Interim Secretary-general in Digital Art Foundation (DAF). She graduated from Graduate Institute of Arts Administration and Management, Taipei National University of the Arts in 2013. She joined ET@T and DAF in 2014, served as project manager in ET@T and coordinator of international affairs in DAF. ET@T has been dedicated to on-line archive project since 2015, focusing on cultural events in the late 1990s in northern Taiwan, which are mostly filmed by ET@T after it was founded in 1995. ET@T produced "Archive or Alive: Digital Archiving Development of a Solo Dance by Shou-Yuo Liu" project and participated Concept Museum of Arts organized by DAF in 2019.

The Mattering of Algorithms: Reading the Media Performance of Erica Scourti through Originary Technicity

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Abstract

Against the anthropocentric binaries such as human/machine, subject/object, mind/body, this paper will offer a counter argument through the theory of originary technicty, which advances the perspective that humans have always been mediated, and as such, the privileged position of the human and its exclusive claim on agency and consciousness needs to be questioned. This perspective will be followed by an examination of the media-facilitated performance of artist Erica Scourti. Through a comparative reading with the work of playwright Samuel Beckett, the paper argues that Scourti's performance asserts the entanglement of the human and algorithmic/linguistic and questions the boundary between the two.

Keywords

originary technicity, algorithms, language, materiality, digital media, performance, Erica Scourti

Introduction

According to a variety of recent scholarship from diverse disciplines, such as the writings of Karen Barad, Bernard Stiegler, Peter Paul Verbeek, Baruch Gottlieb, and Tim Ingold, the privileged position of the rational human mind needs to be undercut by the elevation of objects of the world into similar considerations of agency and consciousness. Following from this, the anthropocentric view that contributes the binaries of human/machine, subject/object, mind/body, human/nature need to be seriously questioned. As Gottlieb writes from a materialist perspective, "technology is not separate from or invented by humanity but already emergent in the relation between ourselves and the world." [1]

The notion that technology is independent from the human and other non-human elements of the world cannot be supported, if one follows the theoretical perspectives of originary technicity, which negates the separation of the human subject and the technological object, mind and body, human and non-human, episteme and techne. By asserting that we have always been mediated, and that the 'digital' must be embedded within the material, within Nature, this paper emphasizes that digital media technologies are not external to us. Rather, if a materialist perspective is followed, then what matters is that the world and the phenomena within (including thoughts, consciousness, language, pixels, bits) all consist of matter. The digital is material, and the digital medium is part of the materiality that is the world, and as such, not external to the human and is simply another matter that intra-acts with the material that is human. The paper will then explore the negation of this separation of human and machine with the smart phone-facilitated media performance of Erica Scourti, *think you know me*.

Originary Technicity

Philosopher Arthur Bradley writes that Western metaphysics is marked by a binary of transcendence versus immanence, the soul/mind versus the body, the immaterial versus the material, and episteme versus techné. In this binary, techné is that which is suppressed and considered less important than the dominant mind and knowledge of episteme. Such binary places emphasis on the immaterial, on thought, on theory, rather than the material, the practice, the non-human (technical) medium, which is positioned as a mere means, a mere supplement to the primacy of the mind. Bradley argues that Bernard Stiegler's concept of originary technicity is precisely a negation of binary between episteme and techné, an insistence on the entanglement of the two, where the porous agent of the human bleeds into (and has always bled into) the exteriority that is the non-human. Seen in this light, this bears resemblance to the weight placed on matter, body, and situatedness in the world, framed as doing/making and know-how, against the abstracting and rational subject of anthropocentricism. The concept of originary technicity emphasizes a need to re-examine the place of the medium

by undercutting the privileged position of the human subject, but more importantly, it asserts that the human is always already, and always has been, technologized.

Stiegler achieves this, drawing partly from Derrida's deconstruction and Heidegger's refusal of any "residual Cartesian dualism between subject and object, consciousness and world," but also from philosopher Gilbert Simondon's theory of technogenesis that reverses the idea of the subject asserting 'form' onto 'matter' through direct causality, but rather through a heterogeneous set of elements that interact together, a process that precedes the individual human agent. [2] In addition, he draws from anthropologist Andre Leroi-Gourhan's radical scholarship on human evolution that reverses the traditional conception of the human subject being tool-wielding due to their intelligence. In Leroi-Gourhan's re-write, it was only when the Australopithecus became upright and object-wielding did it free the mouth (which was used to wield objects), leading to the development of language, communication, and intelligence. In other words, the human subject is not tool-wielding because they possess significant cranial capacity, but rather they have significantly-developed brains because they are tool-wielding. For Stiegler, at the very least the two co-developed, with "the human inventing the technical, the technical inventing the human." [3] As such, "defining human qualities such as consciousness, intelligence and the capacity for symbolic thought are not the cause of tool-use but an effect," and any consideration of the 'human' is inextricable with such extension, with technology. [4] Thought of in this way, technology cannot be conceived as a mere prosthesis that has been added to the human or extends from the human, but has always been part of the human. This concept goes beyond McLuhan's definition above where media/tech is defined as any extension of the human, and digs deep into the inextricability of the two. "The human is always bound up with its non-human supplements." [5] Or as Stiegler writes more forcefully, "the human is the technical." [6]

In his seminal text on originary technicity, *Technics and Time I: the Fault of Epimetheus*, Stiegler elaborates his thought in opposition to Rousseau's desire to return to an unmediated Nature, a point in which humanity had no 'prostheses' yet. Instead, he proposes that the "human is immediately and irremediably linked to an absence … to a process of supplementation, of prosthetization … where everything is found mediated and … technicized." [7] Everything we do, all extensions, are technological, such that to distinguish between the human and technics is futile. While McLuhan expands the notion of media and technology to include any extension of ourselves and reframes them as 'environments,' such as language, Stiegler goes even further and boldly asserts, "the prosthesis is not a mere extension of the human body; it is the constitution of this body qua human … it is not a means for the human but its end." [8]

The language of the 'lack' draws from Derrida's concept of supplementarity elaborated in *Of Grammatology*, which foregrounds the importance of the supplement in constituting the human subject, previously thought of as whole and self-sufficient. The fact that language and writing is needed to supplement human memories (and form an integral part of civilization), points to the indispensability and 'originary' nature of such supplements, which attenuates the boundaries of the human. In other words, the lack presented by the human demonstrates the indistinguishable nature between the human and the supplement/technics (in this case, language). Stiegler continues this project by complicating the exterior/interior binary of the human subject, destabilizing the place of the subject and its mind, which by the traditional metaphysics and philosophy of technology has been considered as the seat of control, free will, and intention, pre-existing and asserting agency over objects, such as technology. By doing so, however, "we are putting the human cart before the technological horse: any interiority has actually been constituted retroactively by the process of technological exteriorization." [9]

The subjects' lack and its co-emergence with technics/material/objects is part of its constitution. Such complication of the interior versus the exterior is reminiscent of Ingold's and Barad's arguments of the porosity and contingency of boundaries. It is inaccurate to speak of stable and given boundaries if we consider the world through an ontological model of matter intra-acting and animating one another, refuting the centrality of the anthropocentric subject and the idea that it is separate, prior to, and superior to the objects and phenomena around it. In language reminiscent of Barad and Ingold, Stiegler writes that technical object is in a sense 'organized matter,' the combination of a multitude of forces which forms various affordance and limits. And rather than asserting intention onto matter in a simple causal relationship, "the human has no longer the inventive role but that of an operator … listening to cues from the object itself, reading from the text of matter." [10] From such perspective, the human is embedded in and indistinguishable from its material surroundings, including media/technology.

Language as Technology

If one is always already mediated and technologized, then perhaps language is precisely one such form of technology, an originary lens through which one comes to know the world. In *What is an apparatus*, philosopher Giorgio Agamben defines the apparatus as anything that captures, determines, orients, and controls. In a long list of examples that follows, which includes computers and cellphones, Agamben ends with language, and notes that it is perhaps the most ancient apparatus. Neil Postman, likewise, refers to language as our most fundamental technology. Hidden from view, language arguably is an instrument that consists of "a set of assumptions of which we are barely conscious but which nonetheless direct our efforts to give shape and coherence to the world," he writes. [11] "The world we live in today is a world in-formed by the abstraction technology of language," echoes Gottlieb, a technology that began the elevation of the rational mind over embedded materials. [12]

This section will lean on the work of renowned post-war playwright Beckett to provide insight on a piece by Erica Scourti titled *Think You Know Me*. Questioning the centrality of language and simultaneously acknowledging the impossibility of doing away with it appears to be a main theme in Beckett's work. If language is framed as a technology, this bears similarity to the concept of originary technicity and Scourti's work, who often highlights the mutual-constitution of the human and non-human (ie. algorithmic operations) from a critical perspective, while conceding the inextricable relationship between the two. Much of Beckett's work depicts "the compulsion to talk … forever compelled to fill the void with words." [13] Yet this desire to get away from language, from consciousness, from thought, is impossible, for one is always already mediated, immersed in the linguistic register. "Language in Beckett's plays serve to express the breakdown, the disintegration of language," writes Esslin, "if Beckett's plays are concerned with expressing the difficulty of finding meaning in a world subject to incessant change, his use of language probes the limitation of language both as a means of communication and as vehicle for the expression of valid statements, an instrument of thought." [14] Entangled with language, the characters in Beckett's work are forever split, incessantly communicating and attempting to locate meaning, to no avail.

The paradox of wanting to cease communicating through language but being impossibly tied to it can be seen in Scourti's work too, which in a way updates the idea for the information society. Performed at Transmediale in 2015, *Think You Know Me* entailed Scourti linking her smart phone keyboard's predictive auto-finish function to her various online accounts and footprints, such as Gmail, Facebook, Twitter, Evernote, and her own website. Through doing so, a database has been created for the predictive algorithm, supposedly giving it access to Scourti's personal information, what constitutes her as an (online) individual, and allowing it to learn, adapt, and better predict. Literally, equipping it with information that supposedly could allow the algorithm to finish her sentences. The performance itself consisted of Scourti typing into her smartphone and reading out a long monologue as suggested by her personalized predictive algorithm. The mechanism resulted in some of the following utterances: "Hello my name is live in the UK for a while to reply to your account after the war in the morning of my favorite colour is not the absence of fear in gone to the right to the right place at St. Andrews Street parking restrictions on my work and of the blue sky blue sky is the most of the day before the end of this and I am unable to find the right place for you can see the latest version and then we will try dm and then the Yeah I think the only way we do you want these days and will not …," reminiscent of Lucky's monologue from one of Beckett's most well-known plays, *Waiting for Godot*.

The Mattering of Tech/Language and its Imbrication with the Human

Think You Know Me performs the mediated self and unfolds in real time, as the utterances show the entanglement of Scourti and the algorithm in situ. The algorithm speaks through Scourti, and vice versa, entwined to such an extent that one cannot make clear distinctions, for the boundaries between the human and non-human are decidedly porous. The technology of language deployed through natural language processing algorithms, like any other material, displays something akin to agency and consciousness, as its role in the constitution of the self is highlighted. As is the case with numerous Beckettian characters, and the contemporary user of ICT, Scourti cannot *not* communicate, even if the result is nonsensical and the meaning is always deferred. Scourti is caught likewise in the technological mediation of language, but in this case, the language is itself the output of other technologies: algorithmic operations informed by a whole slew of software.

The work also undergoes two instances of estrangement. On the one hand, the self is certainly estranged, Scourti functions as a cyborg whose boundary with the algorithmic language is indistinct. On the other, the predictive algorithm

is also estranged; pushed beyond its limits, the promises of machine learning through data-mining the personal archives fall short, revealing its inadequacy and the logic underpinning its claims. Both of these instances of estrangement are executed through a breakdown of language and the communicative promises of language and ICT. As noted above, Beckett often utilizes the tactic of disintegrating language, which, as Esslin theorizes, has the potential of heightening awareness that is often deadened by habit. Referring to *Waiting for Godot*, Esslin writes that "the routine of waiting for Godot stands for habit, which prevents us from reaching the painful but fruitful awareness of the full reality of being," for that habit paralyzes our attention. [15] Through rupturing the speech act, the paradox that often occurs in Beckett's work resurfaces in Scourti's performance: while the technology of language dominates the self, who wish to cease its relationship with it, the self simply cannot end this relationship for the self is split and porous, entwined with this medium.

Jodi Dean's theorization of what she terms 'communicative capitalism' seems to be an approach concept to accompany both Beckett and Scourti's work: a state in which one is compelled to communicate, and where such communicative norm is the platform on which domination is exercised and surplus is extracted. The dominance through language, specifically the communicative act of texting tweeting blogging reviewing profiling commenting sharing, is in a sense a magnified Beckettian scenario: one is subjugated through the technology of language, but one cannot cease to participate in its call. In the case of *Think You Know Me*, the cyborg is already the norm, and the average user is entangled with the machine to such an extent that it is difficult to tell whether the user is using the device or the device is using the user. The work does not celebrate such ambiguity, but rather, through estranging both the speaking self and the predictive algorithms, it unsettles this mundane operation, oscillating between meaning and incoherence, and questions this mediation by focusing on the medium itself (which is of course entangled with everything else). The question of the user's way of knowing becomes ever more pressing when predictive algorithms prescribe frameworks for knowledge-production, significantly influencing the statements and thoughts of an individual, all of which hinge on the claim that machine learning algorithms are capable of capturing, representing, and forecasting the individual users.

Conclusion

As a concept that undercuts anthropocentrism and the hierarchy of human over nature and objects, originary technicity focuses on the entanglement between human and media/technology, in a way that emphasizes the non-human and the know-how of material practices – things considered secondary to the subject – and undermines the transcendental floating human mind. The key is to insist on entanglement, recognizing the human is always already mediated, and insist on the dissolution of the binaries between the human and non-human/machine, subject and object, mind and body.

Scourti's work highlights such decentering of the rational subject by emphasizing its inextricability with other materials in its constitution, in this case the technological prosthesis that is language, along with the data-mining algorithms housed within a smartphone. What this piece foregrounds is the agency of such prosthesis, the force it exerts on the human, and the crucial point that it is not a passive object awaiting the causal influence of the human. Through such blurring of boundaries, the project asserts the inevitable presence of the techne/object/medium, be it the mediation of language or algorithms, highlighting its role in the co-constitution of the human and its claims of consciousness, selfhood, and agency.

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Cyborg Encounters: The Abilizing Capabilities of Embodying Disabling Avatars

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Abstract

In her text, "The Virtual Body in Cyberspace," media arts scholar, Anna Balsamo, coins the term "cultural autism" to refer to the new intersubjective experiences which arise from inhabiting the information environments of VR. Balsamo uses this term to characterize the virtual body as being a "disabled foil to the presumed able-bodied 'real' communicator" [1]. In recognizing that this term is drawn from a reductive understanding that people with autism are removed from "authentic" bodily experiences, "Cyborg Encounters" draws from Art Historian, Anne Pasek's text, "Errant Bodies: Relational Aesthetics, Digital Communications, and the Autistic Analogy," by considering how the term cultural autism can be used to positively reflect alternate lived experiences through digital media. Combining Pasek's notion with Judith Halberstam's low theory and haptics, this paper explores the opportunities granted through limited game mechanics as well as different gaming communities in order to investigate how players corporeal act of embodying an avatar creates a celebratory experience for differently abled bodies.

Keywords

Critical disability studies, videogames, haptics, low theory, interactivity.

Introduction

With the prevalence of the so-called autism epidemic emerging at the same time as the rise of Internet in the 1990s, autism provided a fertile ground for "suspicions and anxieties about the new" to emerge [2]. During this time of skepticism towards emerging technologies, art and technology writer, Anne Balsamo coined the term *cultural autism* to refer to the new intersubjective experiences that arose from inhabiting the information environments of VR technology [3]. Through this term, the presumed experiences of autism are translated into the practice of one's virtual body serving "as the impaired and disabled foil to the presumed abled-bodied 'real' communicator" [4]. This notion is drawn from the reductive understanding that people with autism are removed from 'authentic' bodily experiences and intersubjective contact, as they lead withdrawn lives in affective remoteness [5]. The notion of cultural autism contains negative associations, as it is used to express the physically and socially disjointed experiences created by technology [6] and reinforces autism as a cultural trope through its diminutive associations. While avatars have been historically used across a variety of media systems, within videogames they offer an unprecedented amount of interactivity from the player, allowing them to enact gestures within virtual environments, as the virtual bodies they control exist as proxies to that of their own. Within such digital worlds, the player's gestures become restricted to a set amount of movements that they can enact within such spaces; therefore, within videogames, the presumed able-bodied player materially represses their physical body through the mediated experience of embodying a digital avatar [7], and it is through the limited set of actions placed upon them which allows players to inhabit a body that functions outside of societal norms. However, rather than considering one's avatar as functioning as a 'disabled foil,' the player's corporeal embodiment of their avatar instead creates a celebratory experience for differently-abled bodies through their creation and use of avatars within cyberspace.

Through the act of embodying differently-abled avatars, players are then encouraged to navigate environments through alternate means from which they are accustomed. Rather than viewing the limitations imposed onto player's through game mechanics, this paper instead considers how such restrictions, alternatively, provide the opportunity to understand different ways of navigating through space. By examining practices within various gaming communities, such as superplayers, speedrunners, and The Super Smash Bros. Community, one can observe how attitudes that embrace the restrictive nature of videogames occur through their focus on game mechanics and glitches.

Anne Pasek, a media and environmental humanities scholar, claims the term 'cultural autism' can be used to reflect the alternate lived experiences created through digital media [8]. Rather than interpreting the interactions of disabled people as being restrictive and socially inappropriate, she suggests that their "capacity can be understood as having limbs, organs, neurodevelopment, and technological tools that facilitate the performance of specific tasks" [9]. Within the built digital environments of videogames, these socially considered restrictive actions that are aligned with autism are instead supported and encouraged within gameplay, rather than excluded and viewed as impairments. Drawing from Pasek's ethos of disability studies, this paper will analyze how the restrictive, fragmentary movements, created through game mechanics, glitches, and avatars within videogames functions to create alternate sensory encounters for players, considering these experiences as creative opportunities rather than errors [10].

Avatar Embodiment

In the virtual environments of videogames, vision tends to be prioritized over ulterior sensory outputs; however, as navigation plays an important role within these digital spaces, proprioception functions as an equally important sensory modality [11]. Part of a wider array of somatic senses which function alongside one's sense of touch, and that are composed under the umbrella term 'haptics,' proprioception:

> "refers to the sensory processes responsible for the conscious appreciation of posture and movement, and also to the many sensory inputs involved in unconscious, reflex adjustments of balance, posture, and locomotion" [12].

Through this notion, haptic interactions can be understood as an embodying practice, where our sense of touch functions as more that a singular modality, as it processes "subsystems of pain, pleasure, and temperature information," in turn translating and enabling our direct bodily experiences with the materials with which we interact [13]. As a result of the necessity of manual inputs within gaming interfaces, such as keyboards and controllers, proprioceptive engagements play a key role within gaming systems, enabling movement within these virtual spaces.

Videogames create alternate proprioceptive experiences to that of reality, and it is through their differing interactive qualities that they have become labeled as being akin to autism [14]. These so-called autistic qualities are considered to be present in videogames through the player's embodiment of their avatars, through which they encounter a suspension of proprioceptive abilities and bodily language cues [15]. Within such games, these disjointed sensations are considered to arise in instances of deferrals of presence and altered affective intensities within one's avatar [16]. A result of the player's mediated engagement through material interfaces they are then able to enact gestures within their avatars through a series of keystrokes rather than within their own bodies. Disabled bodies are considered not to be "materially or willfully repressed, but […] rather sensorially unpredictable and 'noisy'" [17]. It is through such disjointed experiences within videogames, where one's body is materially displaced into a digital sphere, that these unpredictable and 'noisy' experiences are said to occur, as one does not move their avatar in the same manner to that of their own body. In turn, it is through relations such as these that players encounter events of altered proprioceptive experiences and social interactions through unnatural three-point perspective views, abnormal manoeuvring within space, and glitchy behaviour, all of which derived from game design and the corporeal mediation of the player and their avatar. It is this alternate embodiment of space, characterized by the act of inhabiting a body that interacts differently within its environment than one's own, that characterizes Balsamo's notion of cultural autism, which is created through the player's mediated aesthetic interaction within the virtual environment.

The Language of Videogame Embodiment

Through the player's embodiment of their avatar, the player and their character come to form a hybrid being through the joining of the human body with the circuitry of videogame systems. Functioning as a singular unit, the avatar therefore translates and mediates the actions of the player within the digital sphere [18]. For the player, their avatar's virtual form functions "as a medium for information and of encryption, [as] the structural integrity of the material body [exists] as a bound physical object" within the space it inhabits [19]. Through this notion, the player's embodiment of their avatar employs the logic of Cartesian dualism, as the player plays "the role of the disembodied *cognito* [by] using the game character to act upon the digital *res extensa* of the game world" [20]. This cumulated divergence of mind and (virtual) body develops a cybernetic understanding of videogame play, as the joining of different bodies results in the formation of a cyborg form through which the player experiences the game [21]. This hybridity of the cyborg identity within videogames forms the player into a posthuman figure through its more-than-human construction [22]. The fluidity between bodies and identities is necessary to interact within virtual spaces, as players "are not imperiled by the splice, but depend on it" in order to inhabit the digital landscape [23]. Thus, it is through these corporeal embodiments that players become

capable of experiencing the alternate reality of virtual environments, in turn enabling them to develop a new bodily language in order to navigate such spaces.

The hybridity of technologically mediated bodies is not formed through the player's "direct, preconscious engagement with [a] virtual body" [24], but is instead created through the mediation of the console's controller. The physical interfaces of gaming consoles enable players to function as acting agents within the game world through a series of system commands [25]. In this sense, the avatar is the player's proxy to the videogame world, functioning as a point of articulation to a simulated space with which they are unable to directly interact with [26]. The mediated act of controlling one's virtual body through inputting "a series of complex and often counter-intuitive button or keystroke combinations stands in for a range of widely varied real-world skills," that "limit [the player's] physical and gestural expression, and reduce complex embodied responses to a simpler and more easily managed relationship between vision and touch" [27]. Through these gestures, arbitrary control inputs become associated with a limited set of movements that the player can enact within the game, where toggling the controller's stick can enable walking and head movement, and pressing a variety of buttons can causes avatars to jump, run, crouch, or attack. In this sense, the movement mechanics of gaming consoles develops a new kinaesthetic language which one uses to navigate virtual space, physically interacting with virtual objects through digital bodies.

The act of inputting one's actions into a controller in order to interact with the environment creates alternate proprioceptive experiences through virtual spaces, as the players corporeal schema is joined into a "circuit of organic, technological, and representational actors and materialities," with which the virtual body of the player becomes reorganized across [28]. As a result, the cybernetic body created through the circuitry of the player and the game characterizes a focus on proprioceptive and kinaesthetic senses which are dependant on sensory inputs and outputs [29]. Videogame critic, Brendan Keogh states that this coupling of bodies allows the player to experience the suspended sensations of their avatar, as in driving games, a car can feel 'heavy' through the joining of the way the vehicle behaves onscreen, the audio it emits through the speakers, and the resistance of the controllers thumbstick—all of which recreating how the player believes a car should act [30]. Elaborating on this concept, Keogh claims that in videogames, the avatar carries the position of a vehicle or equipment for the player [31], breaching the distance between player and fictional space through the console's physical interface. This physical relation between the player and their console therefore suggests a sort of embodied knowledge that arises through the development of a kinaesthetic language within videogames, as the repetition of control inputs within the controller functions in ingraining gestures within the body.

Mechanic Limitations in Videogames

Where conventional videogame controllers provide a method for players to experience alternate proprioceptive encounters while interacting with virtual worlds, writer of *Video games, emotion and the six senses* (2008), Eugénie Shinkle states that such interfaces "have little to offer when it comes to the physical and gestural aspects of play, restricting, rather than supporting" players' individual expressive responses [32]. Through this notion, she argues that, for the most part, videogame interfaces, consisting of keyboards and button-operated controllers, normalize player response, as they limit individual expressions through their removal of total agency within gameplay [33]. Keogh draws similar ideas through his exploration of *Tomb Raider*'s (Eidos, 1996) avatar, Lara Croft, as players only have the option to walk, run, or jump throughout the entirety of the game; however, he diverges from Shinkle's call for the need of total agency within gameplay, as he states that these limitations function as audiovisual characterization [34]. Through this notion, Keogh claims that the restrictions placed upon the player's virtual body demonstrates how they can interact within the digital environment [35]. Through his argument, in *Tomb Raider*, players understand that they "*should* jump over the bottomless pit rather than fall into or float over it," as a result of the avatar's movement options [36]. In this instance, the restrictions in Croft's actions characterize the ways in which the player can interact with the digital landscape, as these audiovisual limitations within the game, while debilitating, aid the player in comprehending the dangers that exist in the virtual spaces they inhabit [37]. By adjusting to the limitations of such mechanics within gameplay, players then learn how to corporeally inhabit different bodies, since across varying videogame characters differing bodily limitations are found.

Within different videogames, player's avatars contain a diverse array of possibilities and limitations in the ways that they may interact within virtual environments. *The Last of Us* (Sony Computer Entertainment, 2013), although more recent than *Tomb Raider* and containing a larger array of actions for players to input into their controller, only provides the opportunity for players to jump within certain quicktime events. Within gameplay, quicktime events exist in instances of context-sensitive moments, where the player is given a visual prompt on their screen to press certain buttons on their controller. Therefore, in comparison to *Tomb Raider*, *The Last of Us* restricts the player's opportunities to jump, as they cannot perform this action any time they desire to do so. This lim-

itation within *The Last of Us*' avatar's kinaesthetic behaviour forces players to scavenge various landscapes for ladders and planks in order to cross pits and buildings, 'disabling' the avatar in a different way than that of *Tomb Raider*. In this sense, the restrictive actions within videogames affects players' engagements within the virtual environments their avatars inhabit, encouraging experimentation and creativity in the ways they interact within such spaces by using techniques that may differ to that of their realities. *The Last of Us*' restriction of jumping mechanics and limitations in the ways buildings can be scaled causes players to be creative in the methods they use to manoeuvre landscapes since they can additionally only interact with a restricted amount of objects. These different interactions within *The Last of Us* and *Tomb Raider* demonstrate how the limitations within the abilities of avatars can allow for creative interplay within the landscape that differs across videogames, in turn contrasting Shinkle's demand for player agency that steps away from sets of "established protocols and narrative events" [38]. As within such protocols and events, players learn how to engage and succeed in environments and bodies that function under different sets of constraints than that of their own.

Disparate Bodily Capabilities within *The Last of Us*

These restrictions in capabilities within videogames additionally crosses over through the act of embodying different characters within the same game, further providing the opportunity for players to inhabit a variety of differently abled-bodies within the same world. Within *The Last of Us*, players navigate a post-apocalyptic landscape where humans slowly transform into zombie-like creatures called the "infected" if they inhale a mutated fungal strain. Playing a smuggler named Joel, players must escort Ellie, a teenage girl, across the United States, protecting her from the infected and bandits as well as manipulating ladders and boards to help her cross bodies of water since she cannot swim. Through Joel, players collect and produce an arsenal of tools that helps the player survive and eliminate variety of enemies throughout the game. Also incorporating stealth tactics, players can slowly dwindle down a group of enemies through the use of a makeshift shiv. As the game advances, players adjust themselves to navigating the game through Joel's body, as his physical strength makes him an asset. However, approximately halfway into the game, Joel becomes badly injured after encountering a group of bandits. Once he is brought to safety, players are then made to navigate the game through Ellie's body. It is at this moment where players learn the ease they had previously been granted in navigating this landscape, as Ellie is no match for the same type of head on attacks as Joel. Even in terms of stealth manoeuvres, these actions fall short of that which players have been conditioned to expect within this game thus far—Ellie's offensive capabilities are limited to inflicting small injuries that have the negative ramification of causing her enemies to notify their allies of her presence. With a switchblade as the only offensive option of attack, players are then forced to sneak across the landscape with only the added bonus of being able to crawl through small spaces which they would have been unable to access through Joel.

Through these narrative events, *The Last of Us* forces players to acknowledge the inherent differences in inhabiting disparate bodies, through the shift from navigating the world as a middle-aged man versus a teenage woman. Within the game, this variation in avatar abilities forces players to rethink the ways in which they navigate the landscape based off of their character's abilities, as Joel's goal is to kill off enemies to ensure the safe passage of both him and Ellie, whereas Ellies's goal is to simply sneak past and outrun enemies. These divergent interactions are not only reinforced on a physical scale, but a narrative one as as well, as Ellie also encounters the threat of sexual assault in an encounter with cannibals, which arises partly as a result of her limited physical capabilities since she doesn't have the strength the fight back larger enemies, making her susceptible to alternate physical components in the game.

The Last of Us also makes players feel, on a physical level, the inherent difficulties in navigating Ellie's body through button mashing mechanics,[1] as during the final battle with an enemy she is fending off, players are required to urgently tap a button in order to reach for a weapon to help her protect herself. While this mechanic is present through inhabiting Joel's avatar in terms of opening doors and fending off enemies that attack him from behind, in this instance players are subjected to a higher level of urgency, as the negative repercussions of failing this manoeuvre are unknown, with players only being aware that Ellie is typically unable to complete the same attacks as Joel based off of previous interactions. On a material level, the player is engaging in the same physical struggle as Ellie, who does not have the strength to fend off this enemy. Through these diverging functions in game mechanics between Ellie and Joel, *The Last of Us* forces players to encounter the different events that can arise as a result of the types of bodies they inhabits, as scale, strength, and learnt techniques within each character alters the player's gameplay.

[1] Button mashing refers to the act of repetitively pressing a button in a videogame in the hopes of executing an action or attack.

The Embrace of Mechanics and Glitches

While videogames such as *The Last of Us* encourages players to reflect on the physical capabilities of one's avatar in relation to the spaces they inhabit, certain gaming communities have extended this reflection regarding the physical interactions of one's avatars in ways the developers of these games did not intend. Within gaming, *superplay* is a type of gameplay in which players seek to master their performance within the games they play [39]. Through this notion, superplay takes on a Debordian form of détournement, as the goal of this sort of gaming privileges taking the "gameplay beyond the limits of human performance by harnessing technical tools to enact [a] theoretically perfect performance" rather than focusing on the intended narrative of the game created by developers [40]. As a result, a strict focus on the bodily mechanics of the player's avatar occurs, as realizing superplay calls for the exploitation of the limitations and structures within the game's design which are enabled by the player's inputs into their controller and the manipulation of their virtual avatar, which is used to achieve such a perfect performance.

In order to practice superplay, players also seek to harness in-game glitches due to their, at times, predictable nature [41]. Within such communities, glitch hunters focus on "the process of exposing and documenting such programming errors" in order for them to later become exploited and used [42]. Later shared through online discords, such methods of gameplay become widely accepted amongst gaming communities, in turn becoming an integral aspect of the game, as unintended gestures become adapted within competitive scenes. Through the act of seeking out unintended glitches within gaming systems, players demonstrate and embrace non-conventional ways of interacting within a space. This embrace of such interactions of space is derived by altering the normative expectations of bodily interactions within the game, as they seek out breaks within the smoothness of sensory modalities in order to experience the so-called 'noisy' proprioceptive engagements aligned with cultural autism in a celebratory manner.

Superplay and Glitches in the Super Smash Bros. Community

In 2001, *Super Smash Bros. Melee* (Nintendo, 2001) was released by Nintendo. Initially designed as a simple beat em' up party game in which players could casually battle each other with popular characters from the Nintendo franchise, this game was largely transformed into a highly competitive practice through the discovery of movement options which resulted in speedy and technical gameplay. When observing The Super Smash Bros. Community today, one can see how competitive players take part in discourses which consider the minute details of each character's movement options. With each avatar containing differing weight classes, speeds, and attack options, community members explore the limitations of each of these elements, breaking down these movements to their frame rates, hurtbox, and hitbox scales[2], exploring which movements combo best together in order to enact the most effective attacks. Through these interactions, The Super Smash Bros. Community demonstrates an embrace of the restrictions placed upon the characters which they embody, as they set out to explore scenarios in order to unveil how to maximize the potential of their avatar, therefore demonstrating elements of superplay within their gameplay.

Within the The Super Smash Bros. Community, a variety of glitch-based moves have become foundational within competitive play. In order to remotely be able to complete within today's Super Smash Bros. scene, players must be able to perform actions such as a w*avedash*, a movement option that is capable of being used by all characters in the game which drastically accelerates an avatar's movement. The movement option itself is a glitch within the game, caused when a player air dodges diagonally into the ground, making them slide a short distance. In this sense, The Super Smash Bros. Community demonstrates how the seemingly unintentional shortcomings of glitches within videogame systems are savoured, sought out, and have transformed the ways in which gameplay occurs [43]. This appreciation for glitch-based moves, such as wavedashing, within the Super Smash Bros. Community therefore demonstrates how such gestures have become adopted as tools in the player's arsenal in order to "exploit the peculiarities of [*Super Smash Bros. Melee*'s] construction and implementation" [44]. Whilst existing in the game as technical glitches, the discovery of these gestures have been vital to the game's rise to fame, as a variety of such moves are now integral within competitive play.

Through this in-game exploration of manoeuvres within The Super Smash Bros. Community, occurrences such as Ness's Shock Jacket and the Ice Climber's Wobble have also emerged as effective offensive options as a result of the discovery of glitches within the game. Not only dow these bugs draw parallels to critical disability studies through their disruption of 'normative' gameplay, but they are also reminiscent of "the proprioceptive and sensory 'noise' experienced by [people with] so-called low-functioning" autism [45]. The term glitch, or bug, functions as

[2] A hurtbox is the area on a screen where a character is vulnerable to attack, whereas a hitbox refers to the area, where when penetrated, counts as a hit. Both of these elements are invisible in the game itself.

a generic term used to refer to a programming error, and affects gameplay to varying degrees [46]. The term's ties to autism are characterized by noisy boundaries and the overlapping of spatial locations, subjects, and objects [47]. In this sense, the phenomena's aesthetic of distortion is considered to interrupt the smoothness of one's sensory modalities in gameplay [48]. Often discovered after a game's commercial release, glitches exist as unintentional remnants of imperfect quality within the the game's final product [49]. However, where glitches are theoretically considered to be an error within a game, Pasek states that a distinct aesthetic pleasure can also arise from the unpredictable nature of broken media [50], resulting in communities that actively seek them out.

Speedrunning and *The Last of Us*

As another facet of superplay, speedrunning is a practice in which games are reduced to their barest of forms, as players derive pleasure from competing to complete a videogame as quickly as possible as a means of demonstrating mastery over the system [51]. Through this practice, speedrunners record their run-through of a game and share their results within online communities on sites such as speedrun.com, where competitors' results are stacked against one another. Within each game, there exists various categories that players can compete in depending on the sort of game, such as glitchless, any%, all collectibles, or difficulty setting-based runs. Therefore, within speedrunning, glitches can also play an integral role in reshaping the way players corporeally interact with virtual environments, as they can aid the player in completing the game more quickly [52]. Through the act of speedrunning, players willingly disrupt the designed narrative smoothness of a game, as their goals exist outside of that which the programmers intended, voluntarily taking on the 'noisy' proprioceptive engagements aligned with cultural autism, as their method of play aims to break the game's predetermined structure. Within such practices, moments such as cutscenes and fights, which progress the narrative of the game, are avoided at all costs as a means to achieve the quickest run-through possible. The players also test the virtual boundaries of the game, as they explore how to skip sections of their playthrough by walking outside of its playable boundaries by using cheats and bugs as a means to access these typically unplayable areas.

In speedruns of *The Last of Us*, players drastically alter the pacing and narrative smoothness in the ways they navigate the game, as the intended story falls to the background in order to complete it more quickly. Within such speedruns, players skip integral cutscenes through menu options, avoiding interactions such as Joel and Ellie's first meeting, instead having Ellie simply pop into the game to join Joel as he is running through an eroded cityscape. Instances such as these thus demonstrate how the intended experience of the game is altered as the player is no longer focused on Joel's relationship with Ellie as he smuggles her across desolate landscapes. Within any% speedruns of the game, runs in which glitches are allowed within the gameplay, in-game bugs are sought out and shared as a means of further breaking down the game's structure, carrying the ability to remove roughly 20 minutes from a player's run. The designed narrative of the game is further broken down through the implementation of glitches such as the shiv glitch allowed within any% runs, as it allows players to gain additional supplies through the repicking up modded lead pipes within the game. Through the implementation of glitches such as these, the post-apocalyptic world of *The Last of Us* dissolves, as the scarcity of materials within the diegetic space that function to develop the urgency experienced by the in-world characters is removed.

Through such bugs, speedrunners also challenge the digital materiality of virtual environment as they explore and discover paths outside the designed boundaries of the game through the manipulation of their avatar in order to enact cheats and glitches. For example, within *The Last of Us*, players can skip a section of The Downtown in an early segment of the game, allowing them to avoid a group of infected and a fight sequence by walking outside the game's border. In order to walk through this material boundary, players stand on the edge of the building at a specific angle and aim their pistol in a certain direction before walking forward and falling out of bounds. These seemingly arbitrary actions transport the player outside the boundary of the game, allowing them to navigate the blank out of bounds space through a series of planned keystrokes that allow them to roam around invisible walls and structures until they fall through a transparent level in the floor, traversing into a later section of the game. Occasions such as these demonstrate the celebratory attitudes towards the noisy elements of glitches within gameplay, as players manipulate their digital bodies through seemingly awkward movements as a means to enact a sort of time travel by walking through invisible segments of the game. Such actions within gameplay thus aid players within their speedruns, as glitches are embraced and implemented in order to achieve quicker run throughs.

Success within the so-called Failure of Videogame Embodiment

Drawing from queer theorist, Judith Halberstam's low theory, exploring these traditional conceptions of failure within videogames serves to bring forward questions surrounding what constitutes a normal body, and why these alternate interactions, considered to fall outside of what it

means to inhabit a normative body, are viewed as failures. Through the labeling of player embodiment as being a form of failure by scholars such as Balsamo and Shinkle, the opportunity to analyze how new life and meaning can be gleaned from such interactions arises. In this sense, the regulation of such embodying practices as being failures provides the opportunity for them to be employed as modes of resistance. As scholar James C. Scott has stated, failure can be used as a weapon for the weak, in turn translating seemingly negative occurrences into oppositional tools as a means "to recategorize what looks like inaction, passivity, and lack of resistance in terms of the practice of stalling the business of the dominant" [53]. Through the act of utilizing these 'failed' systems, the embodiment of such avatars functions as a method of subversion, as employing failure functions in "refusing to acquiesce to dominant logics of power and discipline as a form of critique" [54]. In this sense, the celebratory experience enabled by the player's embodiment of virtual avatars within the aforementioned communities is an inherently political act in and of itself, as it provides a rejection of the norms surrounding that which is constituted as being able-bodied.

In working with failure as a mode of resistance, a recognition of the inconsistencies within dominant power arises, allowing failure to exploit the unpredictability grounded within its ideologies [55]. The idea of what it means to inhabit a successful normative body is itself a rigid category which leaves many people to the wayside through its othering of individuals that do not align within its strict categories. By privileging ability, such categories separate people based on what they can and cannot do, and are grounded in preexisting ideas of normative tasks without considering the nuances found within individual bodily experiences. Yet, when considering the alternate corporeal experiences found by embodying Joel and Ellie's bodies within *The Last of Us*, one can observe how such demarcations of normative bodies carry little weight, as they demonstrate how one can thrive differently within a desolate post-apocalyptic landscape. This act of reclamation of the concept of 'disabled' is also represented in the discourses within The Super Smash Bros. Community, as each character is treated and discussed as an individual rather that molded into a categorical ideal. Within the structure of many videogames, such as the *Fallout* (Bethesda, 1997-2018) and *Mass Effect* (Microsoft Game Studios & Electronic Arts, 2007-2012) franchises, individuality is treated as a privilege when levelling up, allowing players to have the option of embodying a wide array of bodily modalities, such as close combat, charisma, engineering, tech, or wisdom, among others. In this sense, videogames are understood as having a tendency of being grounded within the idea that a homogenous model of success is flawed in and of itself, as they present and encourage numerous ways to corporeally navigate space in ways that demand creative interaction.

Within today's society, non-normative bodies are demarcated and treated as faults through their inability to integrate within hegemonic societal settings and environments; however, such settings are designed without consideration for disabled people in the first place, making it difficult for such individuals to integrate (as seemingly desired) within such spaces as a result. Therefore, as a result of videogame's failure to enact the practice of so-called ideal embodiment as characterized by scholars, the act of player's embracing such restrictions and noisy experiences instead opens the opportunity to present alternative understandings of corporeal experiences. In this instance, avatar embodiment instead functions in questioning able normative notions within common sense by refusing to cling to the status quo, as such subordinate "modes of common sense lead to the association of failure with nonconformity, anticapitalist practices, non-reproductive life styles, negativity, and critique" [56]. The encouragement of creative, individualized interactions and limitations within videogames is thus subversive towards dominant models of corporeal success.

Conclusion

Through the corporeal embodiment of avatars by players, the joining of both physical and virtual bodies occurs in order to create a cyborg form, which is facilitated through the mediated experience of manipulating one's digital body through a haptic interface. This posthuman form enables able-bodied people to experience different corporeal interactions, through embodying a form that has different capabilities than oneself. Through such hybrid forms, differently-abled bodies are no longer seen as faults, but are accepted amongst players in a celebratory manner, as they create new opportunities for them to interact within virtual spaces in different and creative ways. Where Balsamo applies the term cultural autism to describe the disabling faults of inhabiting virtual realities, consequently viewing these occurrences as errors within the system, expert players demonstrate how such limitations and glitches within a game's mechanics can be used to shape the player's experience of the game through their inhabitation of alternate proprioceptive and kinaesthetic encounters. As within games such as *The Last of Us*, one can observe how the players' embodiment of both Joel and Ellie gives way to new understandings of how corporeal experiences differ across individuals, as a result of the limitations placed upon the game's avatars. Such embodied experiences vary across videogames as well, as game mechanics function in restricting the player's movement options in a variety of different ways. However, drawing from Keogh's claim, for players, such limitations aid in understanding how one thrives within various digital environments and bodies, as kinaesthetic gestures are treated as knowledge systems, in

turn subverting hegemonic values of normative bodies through their implementation. In addition, by looking at gaming communities such as superplayers, speedrunners, and The Super Smash Bros. Community, one can further understand how an embrace of diverse bodily modalities occurs, as the proprioceptively noisy experiences aligned with autism within the limitations of game mechanics (that do not translate to the player's physical capabilities) and in-game glitches cause players to reflect and discuss their bodily interactions within virtual environments.

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[36] Ibid, 7.
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[38] Shinkle, "Video games, emotion and the six senses," 912.
[39] James Newman, "Superplay, sequence breaking and speedrunning," in *Playing with Videogames* (London and New York: Routledge, 2008): 123.
[40] Ibid, 123.
[41] Ibid, 124.
[42] Ibid, 134.
[43] Ibid, 113.
[44] Ibid, 135.
[45] Pasek, "Errant Bodies," 72.
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Author Biography

Serena Desaulniers is an MA student studying Art History at Concordia and University. While her research delves into sensorial and material interactions within craft and digital media, her work frequently touches on themes of cultural production as well as critical disability studies. These notions are evident within her two curatorial projects, one for Concordia’s Centre for Arts in Human Development, in which she co-curated a digital exhibit that showcased the collaboration between adults with developmental disabilities and undergraduate design students as a means of addressing the stigma found surrounding the possibilities of people with disabilities. Her other curatorial project, *Interface*, was produced for Art Matters’ 2019 Festival, consisting of an interactive exhibition that explored the haptic interactions connecting textile production and intermedia.

Water Ways Visualization Computational Reflexivity for Sustainability Action

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Abstract

We discuss Water Ways project that uses a research creation approach to bridge scientific, Indigenous, artistic, and humanistic perspectives within media rich datadriven visualizations. The Water Ways demonstrates how the researchcreation method enables articulation and exploration of the nature of humanwater relationships in the Okanagan Valley, British Columbia. The resulting visualizations employ use of interactive media technologies and software design to form a platform for dialogue across communitybased, poetic and scientific water knowledges. The project synthesizes important water knowledge and research in order to catalyze greater ecological awareness and promote more sustainable water use practices among Okanagan residents. The work explores the multiple meanings that water holds for the many communities, and interest groups in the valley, including Indigenous Okanagan (Syilx) communities, environmentalists, artists, agriculturalists, foresters and tourists. By weaving together multiple community stories, diverse water knowledge, and artistic expressions, the visualizations provide a setting for our complex local understanding of water. Acknowledging the sustainable practices of the Okanagan people on this land, we engage in a design methodology for creating an experiential learning environment that aligns with the holistic approach evident in Indigenous ways of regenerating and developing important communal practices. This methodology tightly integrates many ways of knowing through story, song and creative expression.

Keywords

3D Visualizations, Researchcreation, Western and Indigenous worldviews, humanwater relationships, experiential learning;

Introduction

Expressing sustainability practices through aesthetic experiences allows multiple ways of knowing and understanding of our environment to be represented holistically. Spaces designed to foster creative thinking and meaningful interactions through thoughtful multisensory composition are instruments to evoke participants unique memories and associations place in the given cultural and environmental context. Through experience design, Hassenzahl [22] details how these spaces motivate and expand the cognitive impressions and shared experiences of participants by creating positive, and personally meaningful interactions.

Researchers recognize that it is important to make the complexity of climate change and sustainability practices more accessible by making the concepts locally relevant and concrete, grounded in experiential learning, and situated in interactive media environments (eg. [17, 5, 21, 1]). For instance, climate change communication experts have found that visualizations can convey strong messages quickly, condense complex information, engage people in environmental challenges, and motivate personal action [14]. Audiovisual stimuli can trigger innate reflexes and feelings, while imagery that generates lasting emotional responses can influence information gathering and decision making [23]. In cases where visualizations have been evaluated for their validity or effectiveness, results suggest that place based and cultural realism leads to more emotional and/or more relevant responses, and interactivity can improve cognition [22]. In the field of interaction design, engaging experiences that embed positive aesthetic stimulation, and use narratives as a dramatic structure enable more effective access to the challenging content [5]. Interactivity can also provide a space of connection with other participants in collaborative activities, creating a sense of being part of a larger social structure [4].

Galanter [6] argues that computational media, such as visualizations, is uniquely positioned to open up a shared space across the sciences and arts for successfully integrating multiple ways of knowing. This space for dialogue is an essential resource for addressing sustainability in a cross cultural context. The goal is to empower creative responses to our current challenges and motivate sustainability action globally through locally based solutions. This entails identifying and developing cultural narratives of sustainability that energize and motivate actionnarratives that nurture human energy and promote regenerative activitiesto positively influence environmental and human health. Without new stories and visions of a regenerative relationship among people and with the natural world, we risk failure in achieving sustainable and resilient communities [19]. Interactive visualizations provide an experiential learning environment that facilitates a space for 'ontological reflexivity' [3], which is the process of integrating alternative ways of knowing through multi-sensory experience that activates reflection, lateral thinking, and intuitive grasp of concepts. Interactive visualizations involve the design of spaces for human reflection, where the emotional and sensual aspects of interactions are as important as the intellectual aspects of a given experience [24].

Developing interactive tools for communicating environ-

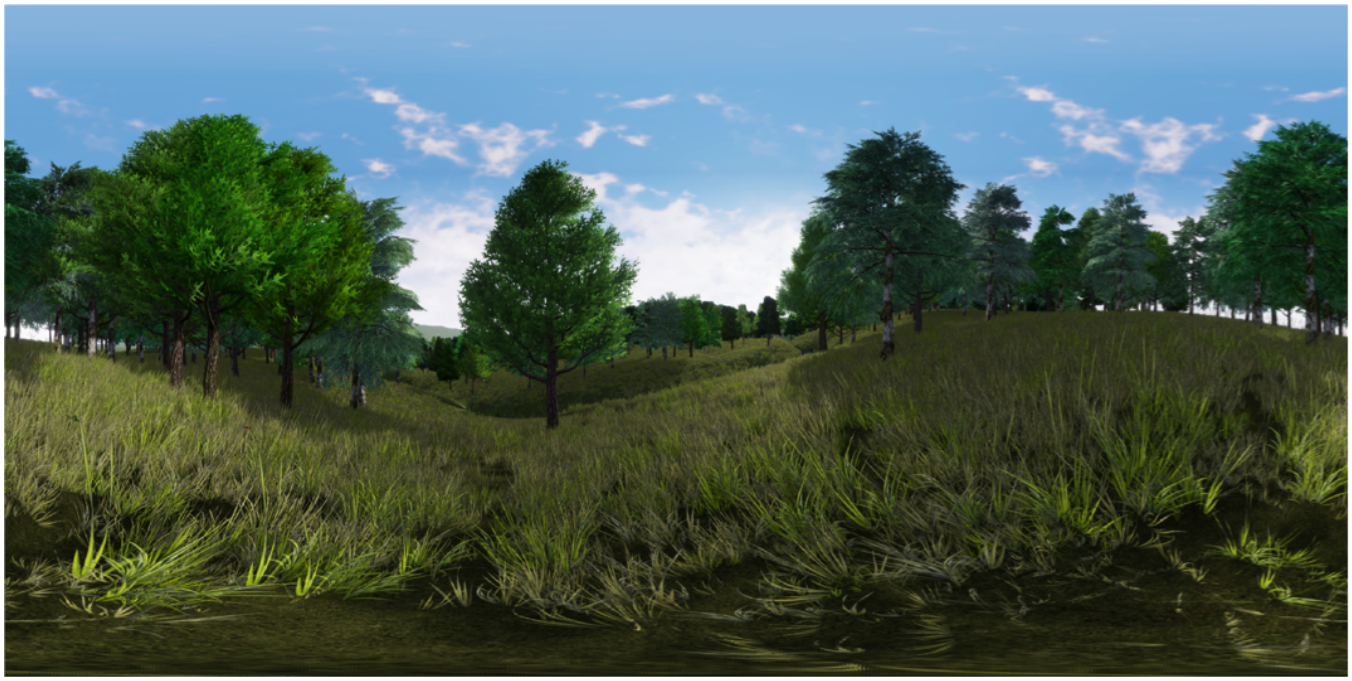

Figure 1: Water ways pre-contact visualization of Mission Creek area in Kelowna. ©Respect Copyright.

mental challenges and its solutions needed to build resilience in our communities requires an integration of scientific and humanist methods. Researchers have been working to develop better methods of decision making using emerging tools such as machine learning, scientific modeling, visualizations, and community engagement, respectively. We are bringing these interdisciplinary streams, including scientific and cultural knowledge, with the design processes to co-create, interactive 3D environments for communicating culturally grounded solutions. The unique aspect of our research creation methodology is bringing different streams of science and design with Indigenous knowledge and philosophy together into 3D visualizations. Through the Water Ways project, we demonstrate how scientific, academic and practice-based communication can delve deeply into the place-based concepts and water sustainability challenges and solutions. As such, there is a framing and reframing of the problem setting, working towards the creation of a reflective space for place-based communal knowledge sharing.

The Water Ways is a community-based research project that engages interactive media to investigates the nature of humanwater relationships in the Okanagan Valley. The focus of this presentation addresses human-water relationships through an exploration of pre-contact 3D visualizations of Mill and Mission creeks and Penticton river. The visualizations are meant to provide a creative platform for dialogue across diverse community-based, poetic, traditional and scientific water knowledges of the past and present to aid envisioning of sustainable water futures in the Okanagan Valley. The aim of this project is a framing and reframing of the problem setting, working towards the creation of a reflective space for place-based communal knowledge sharing.

Background

Climate change and biodiversity loss are the most urgent and far reaching environmental issues ever to have affected our socio-environmental health. There is widespread awareness of the adverse effects of anthropogenic activities on the Earth, yet the gap persists between available social, economic, technological, and policy solutions and the viable pathways for action. We explore ways to close this gap through solution-oriented, locally situated and accessible visualizations that facilitate the experiential understanding of the complexity of locally relevant climate change and sustainability practices. The unique aspect of Water Ways project is the commitment to bridge Western and Indigenous world views to co-create a new understanding of socioecological wellbeing.

The science-policy nexus has been successful at mitigating environmental problems such as ozone depletion. However, wicked problems such as climate change have proven resistant to solutions in these terms. In the context of climate change, the sociologist Kari Norgaard [15], the philosopher Dale Jamieson [9], psychologist Dan Kahan [10], and the climatologist Mike Hulme [8], among others, have indicated that, scientific facts remain politically ineffective when they are not grounded in the cultural, affective, and rhetorical dimensions of diverse societies. The environmental challenges that face our global community are founded on human beliefs, values, and cultural assumptions [[15, 10, 9, 8]. Thus, critical and creative approaches to understanding the past, present, and future of human-environment interactions are essential. Due to the dispersion across different fields of research and creation, engaging with these approaches requires an interdisciplinary inquiry.

The dynamics of engaging Indigenous and Western knowl-

edge systems are increasingly valued in relation to the impacts of climate change on ecosystems [17]. Attempts to protect sensitive ecosystems and biodiversity encounter significant obstacles when they ignore the Traditional Ecological Knowledge (TEK), values, and uses of animals and plants as understood and practiced by local communities. The integration of TEK and Western knowledge perspectives can significantly relieve the disruptions to the land and traditional socioecological relationships as well as develop successful approaches for resilience in the face of environmental change. In the Okanagan context, Syilx knowledge and the practices that conserve ecological knowledge in an oral tradition (referred to as captik [2]) inform the identification of the key relations between humans, animals, plants, and the land. The traditional knowledge systems of the Syilx people are the intellectual property of the Syilx, and we respect the intellectual property rights of all participants. The value of both Indigenous ontologies and Western scholarly traditions are equal. The commitment to creating innovative, reflexive, and respectful ways of integrating these knowledge systems in the practice of research and technology development is one of the foundational values within this work to bring these different ways of knowing together in a codesign situation. The collaborative design paradigm enables the synthesis of innovative knowledge transfer that are embedded in the 3D visualizations of the local environment.

Context

Water is the most precious natural resource in the Okanagan Valley. Water is life it is essential to the health of our ecosystems, the survival of our inhabitants, the beauty of our landscapes and our flourishing economy. Situated in the rain shadow of the Coast and Cascade mountain ranges, the Okanagan basin is classified as semiarid [19] and over 80% of the valleys average annual rainfall (approximately 350mm) is lost to evaporation [16]. Given current water use patterns and projected population growth in the region, the valley will be facing significant and persistent water shortages by mid-century (21). Even though longer, drier summers and more frequent droughts due to climate change are predicted to be the new normal in the Okanagan Basin [16], a pervasive myth of abundance persists among many Okanagan residents, impeding fulsome public understanding of the gravity of the situation. Consequently, more sustainable water use practices are not widely embraced. The reasons are not as simple as a lack of local knowledge or scientific studies, but relate also to the lack of perceived relevance at the local and personal level [7].

Many organizations and individuals in the Okanagan region work on water issues from a variety of perspectives. As a result, there is a vast amount of knowledge that could be mobilized and communicated to the general public. There are the current management practices and water strategies of the Indigenous Okanagan people (Syilx), historical records, scientific data, academic publications, a variety of policy and technical studies generated by government agencies and water management institutions, local knowledge of community members, environmental organizations, museum archives, agricultural association records, and the creative expressions of local artists in poetry, film, photography, paintings and landscape representations. However, much of what we know about water in the Okanagan exists in knowledge silos or cultural sites and contexts that are not widely accessible. The majority of residents have limited ability to digest the technical and scientific studies that document the interconnectivity of natural waterscapes and they also have had little exposure to the Indigenous Syilx community voices that are integral to understanding water sustainability in the Okanagan.

Related Work

In this section, we put forward the related work that investigates rebuilding different landscapes and cultures through visualization technologies. These projects demonstrate the range of approaches researchers have explored to create experiences and simulate places that encourage a reflection of the past and present situated in these environments. Through rebuilding landscapes of the local area in a 3D environment for the project Locus Amoenus: Place of Delight, John Power [18] created a media art installation to facilitate a comfortable, indoor oasis of calm in the heart of the city during midwinter in Melbourne. Power evaluated the experience of patrons frequenting the cafe in the hospital building and demonstrated that people perceived a more pleasant environment and would want to stay longer and return more often to the location. The Manhatta project [20] aims to visualize what the Mannahtan area in New York would have looked like before colonial settlement. The project rebuilds the ecological history of an island, recreating the topology and natural landscape of the hills, valleys, streams, beaches, forests, caves, wetlands, and ponds that existed on Mannahatta. The technique for the Manhatta project was to reference a map of the area created by British mapmakers in 1782 that is illustrated with the locations of natural features, such as salt marshes, streams, hills, and woods. The researchers overlaid this map on a grid of modern Manhattan to match the original landscape to the current city block.

Brett Leavy is the leader of Virtual Songlines [26], a collection of first nations and non-indigenous game developers specializing in the recreation of precolonial Australia. He has been working to reconstruct a digital interpretation of the local landscape from an Indigenous perspective, modelling the fauna, flora, and Indigenous communities to communicate the ecological and cultural perspectives of the people in the landscape. Following Virtual Songlines, Leavey and colleagues designed the Digital Songlines project [26] for developing protocols, methodologies and toolkits to facilitate the collection, education and sharing of indigenous cultural heritage knowledge across Australian communities, cultural institutions and commercial businesses.

The Water Ways project builds on previous work by author 1, Future Delta, an educational media environment designed to communicate climate change challenges and solutions in Delta, BC [5]. The game provides a compelling place-based learning platform for high school environmental curriculum. Future Delta was developed within landscape planning framework and involved an extensive and participatory co-design process with teachers and high school students from the Delta School district and was subsequently tested

in Delta high schools with promising results. Students were excited about playing the game, preferred it to conventional learning formats and learned some key concepts about impacts and possible solutions.

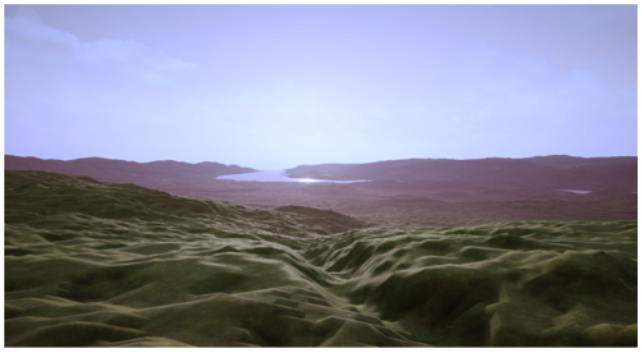

Figure 2: 3D terrain of the Okanagan Valley, that is used as a basis for visualizations. ©Respect Copyright.

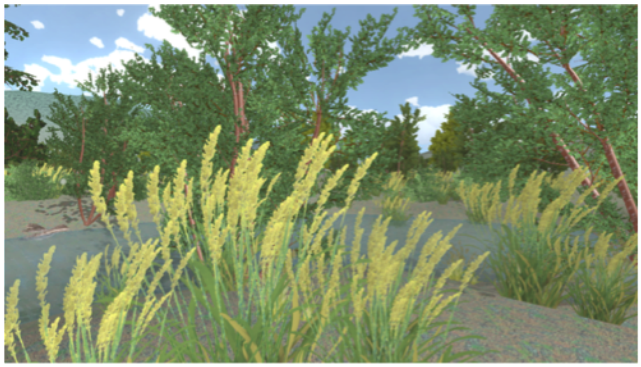

Figure 3: 3D pre-contact visualization of Mill creek area. ©Respect Copyright.

Methodological Approach

Water ways projects acts as a platform for interdisciplinary research, visioning, and visualizations of local sensitive ecosystems across Indigenous and Western perspectives. The project aims to make the complexity of sustainability and ecosystem protection practices more accessible through locally and culturally relevant 3D visualizations of past and present to extend the knowledge about local ecology towards the resilient futures. Social learning and capacity building in the context of Water Ways projects involves the engagement of multiple stakeholders and water knowledge to highlight the possibilities for community action. We investigate the ways that scientific data, community reflections, and traditional knowledge can come together in 3D visualizations to help communities accelerate dialogue toward finding solutions to place-based environmental challenges. Interactivity within 3D visualizations allow active learning and engagement: 1.) They provide accessible and experiential representations of complex systems; 2.) The participants can make

Figure 4: Visualization of Kokanee Salmon current recovery efforts in Mission creek area. ©Respect Copyright.

Figure 5: Visualization of Kokanee Salmon release in Mission creek area. ©Respect Copyright.

decisions, receive feedback, and collaborate; 3.) They provide an opportunity for reflection, discovery, exploration, and challenge; 4.) Moreover, they enable experiential learning through both cognitive and affective engagement with complex ideas.

Water Ways project uses the design as an inquiry to utilize the technique of decision making, analysis, and synthesis-in-action. This approach enables the exploration of multiple and often contradictory experimental spaces for co-development of concepts and representations of numerous present and future solutions to real-world challenges [26]. Contextual knowledge encompasses all the relevant information gathered. While this information includes measurable data and scientific models, it also integrates the less tangible aspects in a culture, such as the knowledge embedded in stories, oral traditions, feelings, and other relevant social actions. Contextual knowledge in design links science with community input, values, and cultural understanding that are then embedded in appropriate spatial and media forms as representations of the community visions, essential for place-based climate change solutions [5, 3]. The pragmatic reflection-in-action approach within the design resonates with Indigenous methodologies that form a holistic research paradigm. It expresses realities as relational and interconnected [11].

Indigenous approaches to research are conducted through

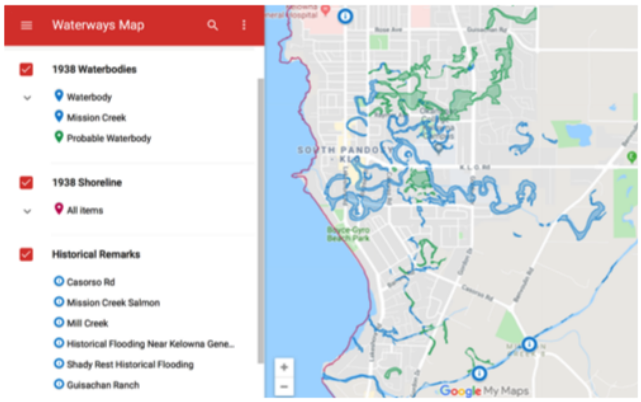

Figure 6: Present Google map overlaid with pre-contact creek system in downtown Kelowna between Mill and Mission creeks showing the historical remarks drawn from the archival research. ©Respect Copyright.

relational accountability, which means that responsibility, relevance, as well as respect for and reciprocal engagement with all living beings is considered [25]. Based on these overarching values and beliefs, the methodologies of conducting research reinforces the understanding of how the researcher is placed within "a circle of relations" [25]. The relevance of the research is reflected in the ways in which communities will benefit from the project and its outcomes [11]. Respect for interrelated participants in the research process is manifest in careful attentiveness to those relationships. Reciprocal engagement requires the researcher to codevelop, exchange, and participate in the local community context, highlighting collaborative processes for constructing knowledge through self reflexive engagement and participatory action. These ideas provide a research context for co-designing and visualizing local sustainability solutions. This context bridges intercultural, and interdisciplinary ways of knowing, to benefit all partners involved in this research. The co-design of interactive visualizations for social and environmental change is situated within local, communal, and traditional knowledge. This research takes a holistic approach to experience design, and builds bridges between scientific knowledge, computational analytics, and cultural resources to develop of media-rich visualizations.

Water Ways Visualizations of the Okanagan basin: past, present, and future

The local 3D visualizations are based in three locales with-in the Okanagan valley: 1) Mission Creek area (Figure 1), which include the visualization of Kokanee Salmon recovery efforts (Figure 5 and 6); 2) Mill Creek area floodplain in the downtown region (Figure 3) and 3) Penticton river visualizations. The locales focus on the historical characteristics of Mission Creek, Mill Creek, Penticton river and their tributary creeks and wetlands in the floodplain area.

The visualizations represent knowledge regarding ecological changes within the flood plain area (Figure 2 and 7) in order to express possibilities for better care for creeks, wetlands and riparian habitat in the Okanagan area in the future. Each visualization has historical, contemporary and future layers that can be explored.

Figure 7: An example of Birch modeled for the project. All local plants and animals used in the visualizations are modeled based on historical and Indigenous records. ©Respect Copyright.

Historical visualizations of the Okanagan landscape are based on diverse records that refer to the Okanagan landscape before settlers developed the valley. We draw from participation form Indigenous (Syilx) communities in order to include and visualize Elder accounts, from naturalist records [13], historical agricultural descriptions [25] as well as the Okanagan Historical Societys publications of local historical writings since 1925. We brought together historical aerial photographs, archival maps of land tenure, irrigation district records, leases and ownership, as well as reconstructed terrestrial ecosystem mapping [12] for 1800 and 1938 with the raw data (Figure 2 and 7).

Contemporary visualizations of the Okanagan landscape are constructed based on publicly accessible geo-spatial data from the BC Data Warehouse and Google map records (Figure 4). This provide information detailing terrestrial ecosystem mapping, vegetation resource inventory, sensitive ecosystems inventory, lakes and streams, wet-lands, public land tenure and leases (e.g., forest tenure, rangeland, utilities, etc.), and community watershed boundaries.

Future visualizations of the Okanagan landscape are based on the user interactions, where the past can be combined with present to create a personal account of possible future.

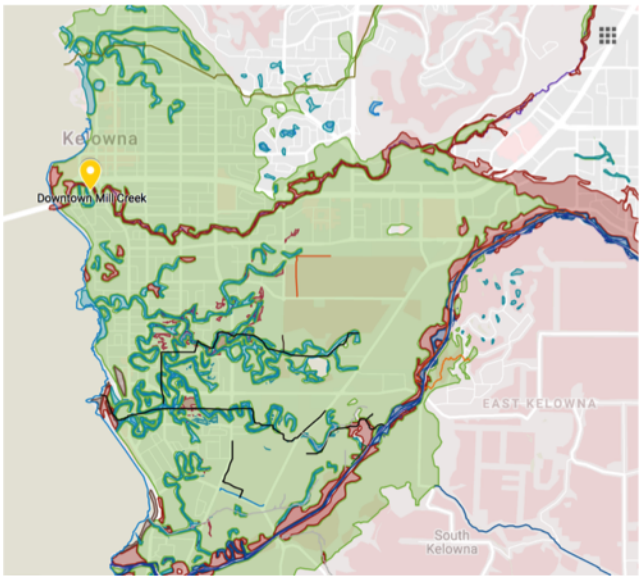

Figure 8: Present Google map overlaid with pre-contact creek system and wetland/riparian ecosystem in Kelowna between Mill and Mission creeks. ©Respect Copyright.

The content is designed to teach people what the areas used to look like and what we have lost with the rapid development. This information is significant for understand-ing how could restore the area, based on the local ecology, plants and animals and what we can work towards. It pro-vides essential understanding of local sensitive ecosystems critical for the restoration initiatives and wildlife connectivity including species corridors, and ways in which we can regenerate local ecosystems.

The visualizations point to communicating urgency in terms of frequent floods accelerated by climate change and rapid development. The visualizations communicate al-ready known and successful solutions within the context of the Okanagan. The content is focused on supporting Indigenous rights and identifies Indigenous leadership in the contexts of many successful restoration initiatives, such as bringing both ocean and land-lock the salmon populations back to the Okanagan creek systems. It points to the ways we can re-wilding the Okanagan city areas, highlighting the ways we can make changes at the neighbourhood areas and mobilize citizen initiatives. Complexity - Flooding and insurance companies; living/building in the floodplain

Discussion and Conclusion

The research-creation methodology presented in this paper builds upon design as an inquiry to utilize the technique of decision-making, analysis, and synthesis-in-action. This approach enables the exploration of multiple and often-contradictory experimental spaces for the co-development of concepts and representations of numerous present and future solutions to real-world challenges. The media-rich data-driven visualizations can create a platform for dialogue across community-based, poetic, and scientific water knowledge, that bridges scientific, Indigenous, artistic, and humanistic perspectives.

An essential aspect of this work is the integration of measurable scientific models with cultural knowledge that form a holistic research paradigm. Indigenous approaches to research are conducted through relational accountability, which means that responsibility, relevance, as well as respect for and reciprocal engagement with all living beings is considered. The overarching values and beliefs, exemplified by the methodologies of conducting research, place the researcher within a circle of relations. These ideas provide a research context for co-designing and visualizing local sustainability solutions.

Using the Water Ways project as an example, we demonstrate using our research-creation approach to explore the nature of human-water relationships in the Okanagan Valley, British Columbia. Water Ways acts as a platform for interdisciplinary research, visioning, and visualizations of local sensitive ecosystems across Indigenous and Western perspectives. The project synthesizes water knowledge and research to catalyze greater ecological awareness and promote more sustainable water use practices among Okanagan residents. The work explores the multiple meanings that water holds for the many communities and interest groups in the valley. The research-creation methodology presented in this paper enables weaving of multiple community stories, scientific modelling, diverse water knowledge, and artistic expressions to create visualizations for our local understanding of water.

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Authors Biographies

leksandra Dulic (Associate Professor, Department of Creative Studies, UBCO) is an artist-scholar with expertise in interactive art, climate change communication, and media for social change. She is the Director of the Centre for Culture and Technology (CCT) and leads an interdisciplinary research team that engages multiple forms of art, media and information technologies as vehicles for the expression of community, culture, and identity. Dulics research is centered on the creation of interactive systems and experiences that bring local, cultural and communal resources to the forefront. One thread of this work is the research in interactive installation with multi-channel audio-visual displays that enable the creation of complex community images. These threads of research intersect in the idea of interactive art as a place for community reflection. She has created a number of large-scale dynamic environments and multimedia project as well as published insights that arise from these research-creation projects.

Miles Thorogood (Assistant Professor, Department of Creative Studies, UBCO) is an artist/engineer with research centered around the practice and theory in media arts for developing interactive experiences. He is head of the Sonic Production, Intelligence, Research, and Applications Lab (SPIRAL) that develops research of computational creativity systems for generative art. His research contributions have produced new knowledge in the fields of soundscape studies, affective computing, and cognitive science focusing on sound design practice. This research seeks to identify formal models of creativity as it is by investigating aspects of human perception and the design process in order to encode creative structures for computer assisted technologies in art making environments. His work has been featured internationally as interactive museum exhibits, installations, and performances.

TwttrGraph: I Wish to Speak with You.

A Telegraphic Sound Installation

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Abstract

The representations that real-time, always-on, data-driven technologies will enhance society like never before promotes an historical inattention that ignores the entangled genealogy of contemporary social media. As we live our lives increasingly in the public realm of social media, we are not only exposed to a human gaze. What happens when we slow down the present through the past? Using a media archaeological research approach, this paper presents Twitter and the telegraph as related forms of social media. Developed by the first author, *TwttrGraph*, an object-based sound installation utilising obsolete media technology, is presented as an audio-visual representation of a genealogy of connections between past media technologies and contemporary social media. *TwttrGraph* can be considered a return to the material representation of media through the physical re-presentation of Twitter messages transported as invisible digital media through the physical materiality of the telegraph key. By enabling the ability to hear the present through the past, *TwttrGraph* reconfigures the existence of the telegraph within a broader history of social media.

Keywords

Sound art, media archaeology, social media, Morse, telegraph, Twitter, obsolescence

Introduction

A quick look at Wikipedia's *Timeline of social media* page shows that today's social media has its origin in the early 1970s. [1] However, the same website's *Social Media* page states, "Social media may have roots in the 1840s introduction of the telegraph." [2] These brief examples highlight some of the debate surrounding the history of, and what is, social media. It is not the authors' intention to argue an origin or exact definition of social media but to use these differing perspectives to help inform a conceptual and aesthetic approach for the appropriation of obsolete media to create sound-based art. Using an approach grounded in media archaeology, the project builds on these differing perspectives to create an interpretative relationship between two forms of media whose origins are approximately 160 years apart.

This paper presents an object-based sound installation that, through a media archaeological approach, connects the telegraph and Twitter as historically related forms of social media. As an object-based sound installation, the work foregrounds the sound producing object, visibly connecting the sound to the sound source. The sound installation replays Twitter messages through a set of telegraph keys. Through their performative presence, we can hear the present through the past and establish a temporal connection between the telegraph as an early form of social media and Twitter, a contemporary social media platform. As such, *TwttrGraph* identifies the presence of the telegraph within a broader history of social media.

The next section contextualises social media between past and present social practices and media technologies within a broader representative paradigm. Following that section, the paper introduces media archaeology as an approach used to inform the first author's sound installation *TwttrGraph*. After a brief literature and repertoire review, the paper introduces *TwttrGraph* as an interpretative object-based sound installation. The paper ends with concluding remarks.

Social Media: Opposing Perspectives

Social media, as it is manifest today, is considered a part of the second media age. In its concept and application in the 21st century, the birth of social media is generally considered to have its origins in the emergence of Web 2.0 technologies. The term, Web 2.0, is often used to characterise the second generation of the World Wide Web supporting "user creativity and collaboration through participatory social media applications." [3] [4] In this context, social media are considered to be a set of web-based and mobile platforms that allow an audience to interact and share content or to participate in social networking. Social networking is the use of those platforms where audiences gather and interact in similarly interested communities. Facilitated by the development of online social networks, user-generated or self-published content allows individuals and groups to communicate and collaborate through a series of virtual communities [5]. However, today's now naturalised expression of sociality

through technologies may be seen as nothing more than a "way of realising what has existed in human nature for millennia." [6].

If social media is considered more than a collection of technologically-mediated platforms that are used to communicate and collaborate, what alternative perspectives exist? Zizi Papacharissi argues that all media are social by definition and that "socially based communication has always utilised platforms, digital or non-digital, which were somehow networked." [7] Tom Standish defines social media as "an environment in which information was passed from one person to another along social connections to create a distributed discussion or community". [8] Grant Bollmer posits that rather than social media being a "shorthand phrase for a specific articulation of technology", it should be used to identify a "specific manifestation of a massively complex social formation." [9] As such, these perspectives question the assertions that social media is a 21st century phenomenon and of defining the social via particular media technologies. By seeing the social in media in this way, lines can be drawn between past social practices and technological invention and today's social media platforms. This suggests a genealogy of social media rather than an origin grounded in the emergence of Web 2.0 technologies. Such a genealogy can be a way of seeing history differently through elements of the past that remain present in society and technology. One way this can be interpreted and contextualised is through media archaeology. Through this method of inquiry, a linear narrative of progress can be re-presented as interwoven temporalities between historical and contemporary media technologies.

Media Archaeology: Through the Looking Glass

Media archaeology, as an approach to the critique of contemporary media culture and history, is considered to formulate counter histories to the dominant narratives of technology and media. One approach to undertaking media archaeology research excavates the agency of the machine, a shift from understanding media history through discourse alone, to consider it through the use and remediation of a material artefact without human intermediaries. [10]

Accordingly, Wolfgang Ernst's media archaeology analyses "media-induced phenomena on the level of their actual appearance as physically real traces of past articulation, sonic signals that differ from the indirect, arbitrary evidence symbolically expressed in literature and musical notation." [11] Ernst argues that by operatively engaging with past media technologies, media archaeology can uncover a "*mémoire involontaire".* By doing so, he sees a way of creating a "sonic heritage" not through symbolic transcription but by listening to the non-musical articulations of the medium. [12]

Media archaeology as an approach to research allows for the exploration of the material possibilities of obsolete media through a practical, operative, and sensual engagement with the object. One way this can be interpreted is through the creative appropriation of the obsolete object for the production of sound-based art. Through this physical engagement with obsolete media in artistic practice, resituating an object in an unfamiliar context can transform the perception of an object's use and, placed in different contexts, can establish new forms of expression outside the object's normal utility. Mandy-Suzanne Wong argues that, unlike historical narratives, sound art is not a "description of the past but a presencing of past conditions in the present". As such, she considers the self-expression of the nonhuman in sound art along with the human as creating a multisensory history. [13]

The next section considers works that use social media and telegraphic representations in sound-based art to establish a relationship for TwttrGraph within the context of the object-based sound installation.

Related Work

Within the context of the object-based sound installation, this section briefly reviews the use of social media and telegraphic technologies as sources for creative sound-based works.

Previous forms of media exhibit characteristics that suggest them to be precursors to contemporary social media through a series of genealogies and prehistories that have made contemporary social media possible. Contextualising Twitter within a general history of communication media, Dhiraj Murthy reveals similarities with, and departures from, the electric telegraph. [14] [15] He argues that both mediums bought an immediacy and brevity to communication, compressed space and time and brought the private into the public. As such, the telegraph provided a significant advance in the global reach and immediacy of communication, an advancement amplified with social media platforms such as Twitter. In a similar manner to criticism of the telegraph that it would bring the downfall of traditional forms of communication, Twitter has been criticised for potentially threatening longer length forms of electronic communication. At the same time Murthy identifies a number of Twitter's characteristics that resemble those in other early social technologies creating a genealogy of affiliations with contemporary social media platforms and practices.

Social media services such as Twitter have been leveraged in the past by artists in a number of forms. Whether as live data or archived messages, social media are sources of material to create sound-based works. Specifically, Twitter data has been used in sonification

works that engage with such themes as surveillance, environmental issues, social sentiment and as a sonic representation of the real time flow of social activity. A cursory reading of the proceedings of the International Conference on Auditory Display (ICAD) shows a number of papers describing various works that sonify Twitter content. Indeed, its 2012 conference theme, *Listening to the World Listening*, ran a sonification contest based on extracted listening data from Twitter.

Aside from data sonification, Twitter has provided content for metaphoric and interpretive sound works. Noriyuki Suzuki's *"Oh my ( )"* (Figure 1) listens to Twitter for the keyword God in 48 languages and then plays "oh my (god, in the tweeted language)". [16] The work creates a metaphoric Tower of Babel as a way to perceive the limitations of human perception when trying to listen to and understand every voice. In another example, An Xiao Mina bridges the past and present by presencing early electric telegraph communication alongside Internet communications in *Morse Code Tweets* to examine the evolution of instant communication as an expansion of time, space and our sense of identity [17].

Similarly, Anna Friz utilises spoken Morse code in her radio artwork, *Radiotelegraph*. By using voice with recorded electronic signals, Friz attempts to blur the roles of the telegraph operator and machine. The work, conceived in Seyðisfjörður, Iceland, was inspired by two historic radio telegraph events. In 1906, the first audio transmission of the human voice by wireless means was achieved in the U.S. and Seyðisfjörður was the site of the first telegraph cable connection between Iceland and Europe. Broadcast at sunset in Seyðisfjörður, Iceland and Chicago, U.S. (Icelandic time), the work, as a beacon, "tells that long nights are coming, but we will not be alone." [18]

The telegraph has been utilised in works that reference historical aspects of communication in relation to current media formations. Silvia Ruzanka's (Figure 2) series of virtual reality works tells stories of online romance and the

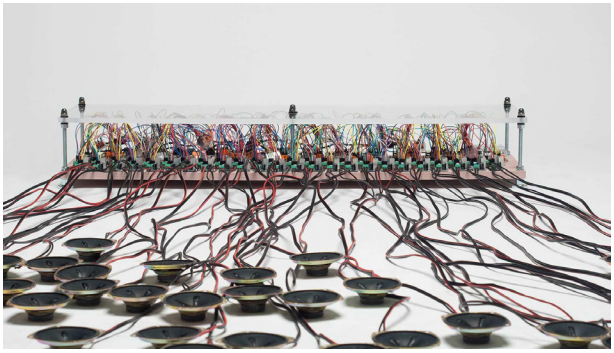

Figure 1. Noriyuki Suzuki's *"Oh my ( )"*

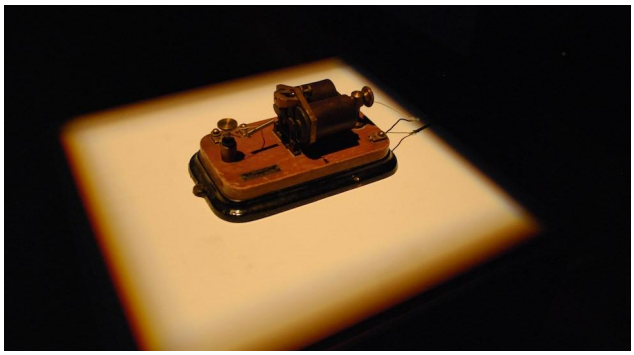

Figure 2. Still from Silvia Ruzanka's VR Telegraph Series

spiritual dimensions of telegraphic technology that prefigure the Internet, avatars, online dating, and the blurring boundaries between real and electronically generated worlds. [19] As such, she positions the telegraph as an early form of cyberspace. Paul DeMarinis uses early telegraph technology similarly in his work, *The Messenger*, to create an historical awareness that many of the Internet's features were anticipated by the cultural formations developed around earlier telecommunication systems. [20]

Discussion

This section has introduced the use of social media as a content source within artistic practice. In sound-based works, Twitter has been used for artistic data sonification, drawing parallels with a range of themes, and, as a scientific method, a way of listening for knowledge. Twitter's content has also been used for metaphoric and interpretive sound-based works. The limited number of these that connect obsolete media with contemporary social media is an opportunity to create a media archaeologically informed sound-based work.

As a research approach, media archaeology can be a way to contextualise and interpret contemporary social media through a past media technology to foreground characteristics of that past media that remain in the present. Material media archaeology, by physically and sensually engaging with the obsolete object, can be one way of understanding history through the object's operative enactment within a contemporary context; a way of representing what has remained of the past in the present through that past media. As such, the obsolete object, visibly and audibly present in the object-based sound installation, brings its sound making qualities to the foreground. In this way we can listen to the apparatus as an expression of itself as a delayed historical presence, listening to the symbolic codes and streaming data of technical media rather than relying solely on cultural texts or notation as a description of history. In this context, the

divergent perspectives of social media provide opportunities to explore traces of past media within contemporary social media that are represented as a sound-based installation.

It is the characteristic similarities between the telegraph and Twitter that has informed the ideation of TwttrGraph. Engaging with the physical, material, and technical properties of the electric telegraph, the following section introduces *TwttrGraph*, an audio-visual representation of the historical connection between the telegraph and contemporary social media.

TwttrGraph

Developed by the first author, *TwttrGraph* (Figure 3) is an object-based sound installation that uses a media archaeological research approach as the core of its conceptualisation and realisation. By physically engaging with the telegraph key, the work aims to explore an obsolete object, utilising its physical properties and historic materiality. As such, placing the telegraph key in a new artistic context – making the familiar strange – alongside Twitter as social media creates an awareness of characteristics manifest in earlier media remain in contemporary media. This approach provides a media archaeological short circuit between historically separated times to provide a new perspective for the listener's engagement with and interpretation of sound by hearing the present through the past.[1]

Appropriating obsolete telegraph keys and foregrounding their sound making qualities, *TwttrGraph* replays Twitter messages as Morse code. Playing the messages in this way re-presents, what some consider, one noisy medium (the socio-communication of social media) through another (acoustic key clicks) to create a presence of telegraphic communication within the contemporary realm of social media. *TwttrGraph* is seen as a return to the material representation of media through the physical re-presentation of Twitter messages transported as invisible digital media through the physical materiality of the telegraph key. As such, by re-engaging the material analogue world in tandem with the digital it can be considered a return to the tactility of pre-digital media. [21]

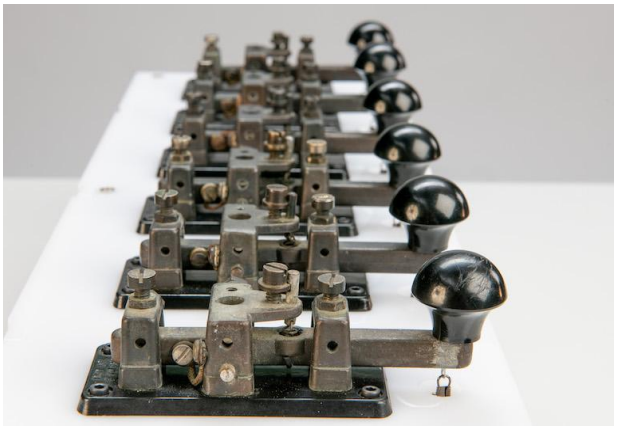

Figure 3. *TwttrGraph*

[1] Short videos for *TwttrGraph* can be seen at https://www.youtube.com/watch?v=YNKPfeF_k0Q and https://www.youtube.com/watch?v=PH3_uX5QmHg

System Overview

As a sound installation, *TwttrGraph* is the audification of Twitter messages replayed as a series of Morse encoded telegraphic messages. As an object-based sound installation, the work presents a line of six obsolete telegraph keys atop a plinth. In its minimal prototypical state, *TwttrGraph* is based on the use of a single telegraph key (Figure 4). Reduced to a basic sounding object in this way foregrounds the key's sonic materiality. This materiality is heard as a double click when the key's contact points engage and disengage. As such, the compositional palette is limited. The raw building block of a single telegraph key is extended to six keys as an iteration of the single unit to create a richer audio-visual experience by exposing the nuances of each key and expanding the compositional palette. The significance of six keys is elaborated in the next section.

Each telegraph key has been electromechanically prepared to operate by actuating a solenoid. Each solenoid is powered and controlled by a custom made circuit board. The circuit board receives input signals from a microcontroller (a Raspberry Pi) to programmatically control each solenoid. The microcontroller runs custom code developed using Processing 3.

Connecting to Twitter via the Internet, messages are extracted, transformed from alphanumeric symbols to Morse elements and translated to digital pulses that trigger the solenoids. A high-level system overview is shown in Figure 5.

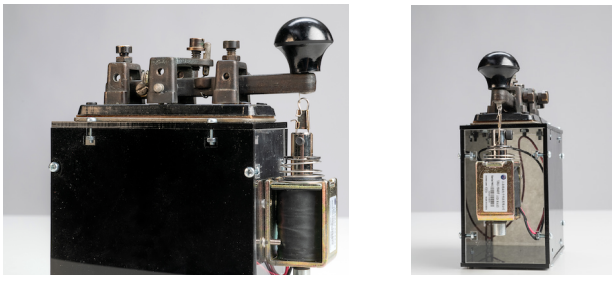

Figure 4. *TwttrGraph* Single Key Prototype

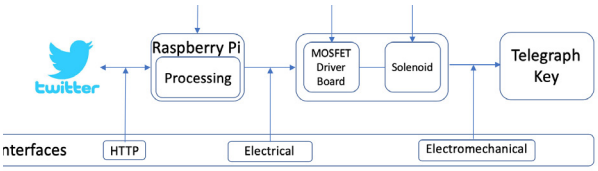

Figure 5. *TwttrGraph* System Overview

TwttrGraph's primary sonic material is provided by each telegraph key. An additional sonic cue is provided by a sine tone that is always on. The use of this sonic cue is expanded in the following sections.

Aesthetic Approach

An important aesthetic element of the object-based sound installation is foregrounding the visibly present sounding object. The telegraph keys' position atop a white plinth draw attention to the primary audio-visual elements of the work. This is shown in Figure 6. Other electromechanical components are contained inside the plinth to reinforce the presence of, and maintain of focus on, the sound making object (Figure 6).

Two additional elements of the work reinforce the audio-visual relationship with the telegraph keys. A sine tone waits for a signal to disrupt its presence. The "always on" of the telegraph circuit waits for an "always on" social media. The use of the sine tone, based around the frequency of wireless telegraphic transmission, provides a further aural connection to the visual movement of the telegraph keys and the inherent rhythm of the replayed message. A visual representation of the replayed message is projected as video.

Based on the technical properties of Morse code, using six keys allows letters, numbers and punctuation to be encoded, creating the ability to play an extended range of alphanumeric symbols. For example, a letter can be one to four Morse elements, numbers are five elements, punctuation symbols are five or six elements. As Morse elements (the dots and dashes) are received, keys tap sequentially from left to right. The inherent rhythms of the

Figure 6. Telegraph Keys as Visibly Present Sounding Objects

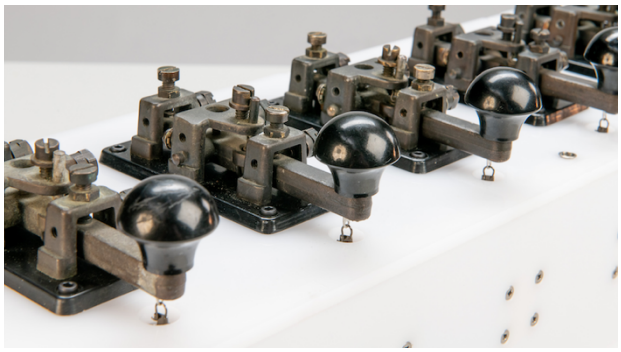

Figure 7. The Material Sound Making Object

digital media stream are revealed through this material transformation. Manufactured to the same specifications, time has eroded each key's mechanism in different ways (Figure 8). While mechanically the same, through this material change in each key we can perceive, at times, small differences in their mechanical operation and to their sound producing qualities. The barely perceptible mechanical differences disrupt an otherwise robotic approach to the work. By iterating the single sounding unit in this way, a variation in the inherent sound making qualities of each key can be heard.

Compositional Strategies

The technical signalling properties of Morse code are used to inform the primary compositional strategy for *TwttrGraph*. Some of these properties are used in the timing of the Morse code and establish the tempo of the work. The timing of the work's Morse sequences are directly related to the timing for Morse code. The tempo for the compositions is based on Morse code's typical word method used to determine a standard transmission speed. The words used are PARIS, reflecting a natural language word rate, and CODEX, reflecting a random letter word rate. As such, these provide quantised time periods of 60ms (PARIS) and 50ms (CODEX) for each mark and space (see Table 1) and have been used to determine the tempo for message playback with *TwttrGraph*. The tempo is fixed by the selection of one of these transmission standards with the length of each mark and space determined by the Morse element. Each Morse element used by *TwttrGraph* is represented by a single key. Within a musical paradigm, each mark and space, as quaver notes and rests, provide tempos of 125bpm (PARIS) and 150bpm (CODEX). The tempo of the work is able to be changed at initialisation by selecting one of the timing standards.

Morse element	Time Unit	PARIS Time (mSec)	CODEX Time (mSec)
. (dot)	1	60	50
- (dash)	3	180	150
Element space	1	60	50
Letter space	3	180	150
Word Space	7	420	350

Table 1: Morse Elements as Compositional Input

Morse code is a text-based communication medium. As such, the rich content able to be included in a tweet cannot be represented by Morse code. Emojis, video and some text characters are not able to be played by *TwttrGraph*. Therefore each message's content is reduced to its base Morse elements by removing symbols that are not represented in the Morse system. As previously stated by Murthy, both Twitter and telegraphic communication received criticism for their brevity threatening longer forms of communication and a general dumbing down of society through the "impoverishment of grammar, vocabulary, spelling and so on." [22] *TwttrGraph*'s need to "dumb down" Twitter's messages can be perceived metaphorically as being situated within the moral decline of communication of which both technologies have been accused.

Exploring different ways to replay messages can be a way of interpreting and unfolding the patterns and rhythms within the encoded message. Where the replay mode allows it, a continuous sine tone plays, only interrupted by a key's actuation. This acknowledges that telegraph systems were always on as a method of knowing whether the communication circuit was live and as a metaphoric connection with an 'always on' social media. Messages of archived tweets, based on the keyword phrase "What hath God wrought?", are stored by the microprocessor. This keyword phrase is used to acknowledge the first Morse coded transmission between distant locations in 1844.

Sequential Message Replay

This replay mode isolates each message character and replays each character's Morse elements sequentially across the keys. Playing the message in this way exposes the characteristic nuances of each key's physical properties and material sound. The sonic property of the object's sound is heard as each key is engaged and disengaged. Replaying messages in this way connects together the audio and visual elements as a way to emphasise the rhythmic patterns inherent in the Morse code.

Polyphonic Message Replay

Using the same information source noted previously, one way these rhythmic patterns can be explored is to replay the messages polyphonically. While still breaking each character into its individual Morse elements, they are replayed in parallel. In this way new patterns, such as syncopated rhythms, may emerge as keys engage and disengage at different times.

Additional Replay Methods

In addition to different modes of replaying the message, other methods of representation can be explored. An interactive installation can be a way of engaging an audience. *TwttrGraph* can listen for a message that includes a keyword, and, when detected, can replay the message. The replay can be sequential or polyphonic. In this way an audience can explore phrases, word or character sequences as a compositional approach to find rhythmic patterns in their messages. By engaging an audience in this way, it may also allow them to reflect on the interwoven temporalities that exist between past and present media technologies.

While utilising either of the previous methods of replaying a message, an approach can be to listen only for new incoming messages. With social media platforms expanding and evolving and the amount of information seen by some as overwhelming, there can be a sense of getting lost in the noise of social media. Rather than endlessly scrolling through inane posts, advertising content and reading expanded conversations, this mode could be seen as a return to earlier pre-electric communications by creating a long wait for a message to arrive.

Conclusion

This paper has introduced *TwttrGraph*, an object-based sound installation. Utilising social media and obsolete objects, *TwttrGraph* uses telegraph keys to replay a series of Twitter messages as Morse code thereby creating a presence of past media alongside contemporary media technologies. A number of compositional strategies have been presented to explore and emphasise the rhythmic patterns embedded in the source material. Blurring the temporal boundaries between the past and the present can be a way to disrupt the linear narrative of progress. As such, *TwttrGraph* is an audio-visual representation of a genealogy of connections between past media technologies and contemporary social media. Using a media archaeological approach to research, the obsolete object, in this case the telegraph key, is able to be contextualised alongside contemporary media technologies thus creating a presence of the past in the present. Considering the object from the material perspective of media archaeology allows one to physically and sensually engage with the technical and operative features of the object and to utilise these in a creative way. Through the operative enactment of the telegraph key an audience is able to see and hear this past media as an expression of itself although its world has been rendered obsolete. Excavating the past in this way, an archaeological dialogue emerges in finding something new

in the old and the relationship between past and present media. By utilising obsolete telegraph keys, *TwttrGraph* also speaks to the historical materialism of objects left behind or 'defeated' in the march of technological progress. Human communication from the written word to contemporary social media has been transformed over the ages by a series of expansions of time and space. By appropriating the telegraph key and creating a new cycle of life as the object-based sound installation, *TwttrGraph* is part of a historical continuum through a genealogical connection between the telegraph and social media.

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Authors Biographies

Paul Dunham is currently a PhD candidate at the New Zealand School of Music (NZSM), Te Kōkī at Victoria University of Wellington (New Zealand). He holds a Bachelor of Music (Composition) with First Class Honours. He has produced a number of sound-based works across different media. His current research is focused on creating a series of sound sculptures that, within the transdisciplinary frame of media archaeology. This research aims to establish a narrative through the convergence of obsolete and current media technologies whilst exploring the sound producing qualities of these media in his work. Previous works have been exhibited and presented at The Dowse, Adam Art Gallery, Victoria University, The Pyramid Club (Wellington) and at the Australian Computer Music Conference (Sydney), International Symposium on Electronic Art (Durban) and xCoAx (Milan).

Mo H. Zareei is an Iranian sound artist and researcher based in New Zealand. Using custom-built software and hardware, his experiments with sound cover a wide range from electronic compositions to kinetic sound-sculptures and audiovisual installations. Regardless of the medium, Zareei's work aims to highlight the beauty in the basics of sound and light production and reductionist audiovisual elements that draw inspiration from physical and architectural principles.

Zareei has presented his work at various international events including International Symposium on Electronic Art (Vancouver/Dubai), New Interfaces for Musical Expression conference (London), International Conference on Auditory Display (New York), International Computer Music Conference (Perth), New Zealand Festival (Wellington), SETxCTM Festival (Tehran) and Tehran Annual Digital Art Exhibition (Tehran). His installation work "Rasping Music" was the recipient of the 1st prize for Sound Art in the last iteration of the Sonic Arts Award in 2015.

Professor Dale Carnegie has a BSc. in theoretical physics and applied mathematics, an MSc (first class honors) in applied physics and electronics and a PhD thesis in computer science. He was a lead developer of the Engineering Programme at Victoria University of Wellington and established the University's first Mechatronics Research Group. He is currently the Dean of Engineering.

Professor Carnegie's current research interests are in the area of mechatronics, autonomous mobile robots, sensors, embedded systems, adaptive control, mechatronics in music applications and engineering education. Specific areas of on-going research include autonomous search and rescue robots and full field image ranging systems. He has published and presented over 200 research papers in various journals, book chapters, conferences and patents and founded the Electronics New Zealand Conference series which is held annually.

Dugal McKinnon is Deputy Director of the New Zealand School of Music – Te Kōkī at Victoria University of Wellington where he teaches sonic art and composition, and directs the Lilburn Studios for Electronic Music. He has been a resident artist at IEM (Graz, Austria) and ZKM (Karlsruhe, Germany), and STEIM (Amsterdam). His artistic research spans instrumental and vocal composition, electronic music, sound and installation art. As a scholar he has a particular interest in the ecological and material dimensions of sound-based art and electronic music.

Expanded Notes on the Exhibitionary Conditions of Virtual Reality

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Abstract

By acknowledging that virtual reality is experienced in real space, this curatorial research posits that the ways in which mediated Virtual Reality (VR) experiences are integrated into their encompassing curatorial and museological contexts describes a distinctive set of exhibitionary conditions. As will be developed here, VR and museums, in their own respective ways, function as multi-dimensional spaces in which aesthetic experiences are situated. By critically reflecting upon field research involving notable VR artworks – including my first-hand exhibition encounter with filmmaker Alejandro Iñárritu's celebrated *Carne y Arena* (2017) being focused upon here – I will argue that critical examination of immersive experience should not be based on an interpretation of the visual and affective qualities of the simulated, virtual image alone; but instead be responded to more expansively by contextualizing its viewing experience as part of a broader, unfolding exhibition encounter that the work's gallery-based installation supports. These supplementary notes extend the line of inquiry initiated in my previous theorization of *Carne y Arena* by drawing Edward Kienholz's environmental tableaux *Five Card Stud* (1969-72) into this constellation of concerns. In doing so, this text will extrapolate how the horizon of VR extends well beyond the cinematic to the cinematographic, and onto the curatorial design of exhibition space itself.

Keywords

Virtual Reality, Curatorial Design, Curatorial Research, Museum Studies, Exhibition Studies.

Describing the Exhibitionary Conditions of Virtual Reality

As the interrogation unfolds, certain members of the group presumed to be "coyotes"[1] are singled out for questioning by the border police. Others, mainly women and children, are corralled together and ordered the get down, stay quiet and remain still. Swept up in this scenario, you (the viewer) are immediately faced with a dilemma: Submit to the narrative by joining your compatriots in following the instructions being forcibly issued by these officers; or make the decision to wilfully break the bounds, the terms of engagement established by the diegetic story-space. The gravitas of this decision, like the tense situation you find yourself swept up in seems to hang in the balance. Time feels suspended; yet the film keeps running, and the story continues to unfold around you.

Making the decision to remove myself from the immediate confines of the confrontation, I quietly step backwards. In principal, nothing is stopping me from turning away to escape the claustrophobic intensity of the scenario playing out in front of my eyes and wandering off into the relative calm of the desert night. Instead, I determine to move slowly and stealthily around behind the group in order to survey this scene from different vantages. Reinforced by the sensation of sand being swept beneath my bare feet, my strides trace an arc around the outer circumference of the arena wherein this dramatic "tableaux vivant" continues to play itself out. Uneasily, I bring myself back to stand immediately alongside one of the police inquisitors. Drawing up as close I can bring myself to, the effect is uncanny; standing close enough to be pummelled by the aggression of the orders shouted from the officer's mouth, yet otherwise evading the intimidating impact of the words being directed towards me. Then just as unnoticeably, I pull away from him to return to the clutches of the huddled group

[1] A colloquial Mexican-Spanish term for the recruiters and transporters involved in people smuggling.

shivering in the cold desert night. Together, framed by a halo of light produced from the convergence of search lights perforating the blackness of the desert, I too drop to my knees and raise my hands in surrender.

A dream or reality composed within a frame

Exhibiting Virtual Reality (VR) artworks as immersive experiences in museums and galleries is relatively uncharted territory. The supplementary notes that follow further develop upon my theorization of VR in relation to its exhibitionary conditions; a track of research inquiry that has been informed in a deeply situated way by my first-hand viewing experience of Mexican filmmaker Alejandro Iñárritu's celebrated *Carne y Arena* (2017).[2] (Figure 1) Approaching VR as an exhibitionary medium extends the horizon of the artform, taking its critique well beyond the cinematic to the cinematographic, and onto the curatorial design of exhibition space itself. This observation acknowledges the (deceptively) obvious fact that virtual reality is experienced in real space; even if that space, in turn, is a highly constructed one premised upon its own distinctive form of virtuality.[3]

Figure 1. *Carne y Arena*, 2017. A user in the experience
Photo credit: Emmanuel Lubezki. Acknowledgment: Sutton PR (London, Hong Kong, New York).

Effectively breaking the dictatorship that the frame has exerted upon the representational form of the moving image since William Ensign Lincoln's invention of the zoetrope 150 years ago (Figure 2), VR is extolled today as a new paradigm for cinematic spectatorship. However, as I will develop, any critical examination of immersive experience should not be based on an interpretation of the visual and affective qualities of the simulated, virtual image alone; this is especially so in the case of *Carne y Arena.* Instead, pursuing this line of inquiry transcends the limitations of the subjective viewing experience reinforced by the optics and visual regime more often associated with VR by seeking to contextualize how the mediated experience directed by Iñárritu is integrated into the exhibition's encompassing narrative, scenography and curatorial design; and thus, is formed as part of a broader, expansive and unfolding exhibitionary experience.

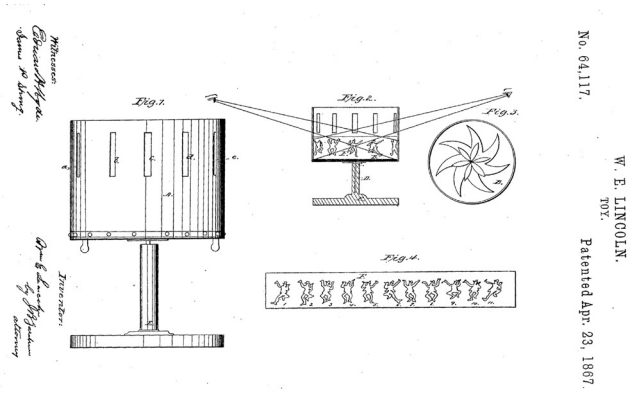

Figure 2. W.E. Lincoln's U.S. Patent No. 6,4117 of Apr. 23, 1867. W.E. Lincoln [Public domain], via Wikimedia Commons.

Existing at the intersection of immersive story-telling, documentary filmmaking and Hollywood Visual FX cinematography, *Carne y Arena* certainly exemplifies the ground-breaking potentialities of VR as an art form. Representing Iñárritu's initial foray into VR filmmaking, *Carne y Arena* was awarded a special Oscar from the Academy of Motion Picture Arts and Sciences for its "visionary and powerful experience in storytelling". Implicitly, this acknowledgment recognizes that *Carne y Arena's* immersive experience is achieved through dramatization, as much as digitization. In this case, the distinctive museological "framing" of the film itself is integral to activating the theatrical, performative, scenographic and choreographic aspects employed by Iñárritu to achieve his creative aspiration of blurring the lines between 'a dream or reality composed within a frame'. [1] (As I will develop from here) In their own respective ways, VR and museums function as multi-dimensional spaces in which aesthetic, narrative and interpretive experiences are embedded. In order to structure these supplementary notes, I will draw upon two schematic illustrations that attempt to visualize the inter-relationship between virtual and actual identified as operating under these exhibitionary conditions by: 1) situating *Carne*

[2] *Carne y Arena* has been exhibited at leading international venues, including the Los Angeles County Museum of Art (LACMA), as well as in temporary installations in Mexico City and Washington, DC. The interpretive account offered here is based on field work conducted of the exhibition: *Carne y Arena (Virtually Present, Physically Invisible),* Fondazione Prada, Milan; 7 June 2017 to 15 January 2018.

[3] The reader is directed to previous research; See Bibliography.

y Arena (the VR film) within the enveloping curatorial design strategy of the gallery installation (Figure 3); and 2) contextualizing *Carne y Arena* (the exhibition) curatorially as an exhibitionary medium. (Figure 4) In doing so, this second investigative trajectory sketches out a configuration of (seemingly) disparate influences and references (synchronous and asynchronous; retrospective and contemporaneous). While acknowledging other notable VR artworks as well as mixed/multi-medial installations and immersive museum displays, the conceptual development of this schema will only extend to a discussion of American installation artist Edward Kienholz's ground-breaking environmental tableaux *Five Card Stud* (1969-72) featured within the limited bounds of this paper.

Supplementary note on the curatorial design of *Carne y Arena*

Produced in association with Lucasfilm's Immersive Entertainment division (ILMxLAB), Legendary Entertainment and Fondazione Prada, *Carne y Arena* extends the application of digital technologies associated with computer-generated imaging (CGI) beyond the *virtual* screen and into the *real* space of the installation. The realization of Iñárritu's creative vision is achieved by the successful calibration of the viewing experience associated with cinema and curatorial design as it is applied to the overall exhibition concept. According to ILMxLAB executive Vicki Dobbs Beck, the advent of Virtual Reality in conjunction with other forms of immersive entertainment mark an important pivot point in the history of filmmaking, 'as craft, as an industry, as a cultural phenomenon'. [2] If VR provides a means of experiencing different worlds, then mixed reality storytelling enables the possibility of seeing and interacting with *this* world differently.

Carne y Arena is an exercise in "world-building" in its own right. The exhibition is composed in three "acts" and designed to be experienced alone, as a single participant. (Figure 3) Following directly upon an "onboarding" stage in which the protocols associated with timed-entry to the exhibition are played out, the solitary visitor finds themselves upon entering the first gallery space confined to a caustically lit grey cell. A single metallic bench is located in the centre of the small room; discarded running shoes, weathered sandals and mud-caked boots line the base of the surrounding walls. Instructed to remove their own pair of shoes and then left to sit alone for some minutes, the viewer becomes gradually sensitized to what it feels like to find oneself incarcerated, alone and powerless.

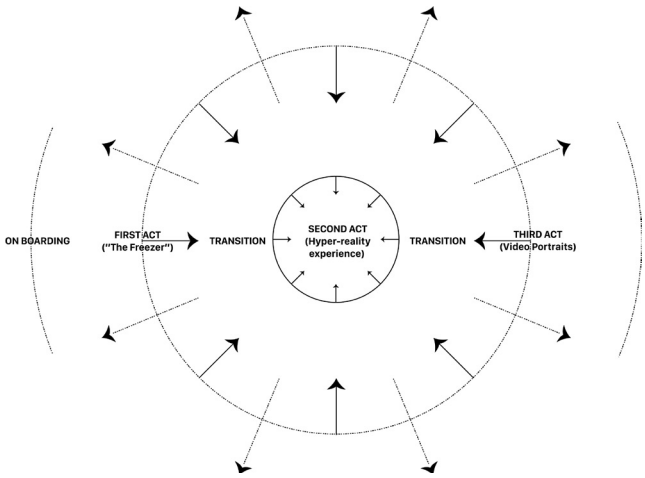

Figure 3. *Carne y Arena* (the VR film) situated within overall curatorial design strategy. ©Vince Dziekan.

This embodied and performative encounter leads onto *Carne y Arena*'s centrepiece: a hyper-reality experience that maps the VR headset-based cinematic work directed by Iñárritu into a whole-body, fully immersive entertainment platform. The spectacular quality of the real-time, Digital Effects (FX) film was supported by ILMxLAB's research and development into location-based immersive adventures. Drawing upon the expertise of the Walt Disney Company's "Imagineering" arm with designing and constructing theme park attractions, the resulting multi-sensory experience effectively dissolves any separation between virtual and physical realms. Despite the auditory, visual and haptic "special effects" simulated by an array of advanced digital technologies, the diegesis, or sense of the story-world in which the narrative of the film occurs, is reinforced in the most immediate and tactile way by simply laying the exhibition space with sand. In stark contrast, the exhibition concludes in a sombre gallery lined with a deeply-affective set of video portraits recessed into its walls in which the personal stories of Latin American immigrants are documented. In the midst of watching these arresting accounts of the personal toll caused by social upheaval and political dispossession, the viewer comes to the realization that the "real" people telling their stories are, in fact, the very same people encountered previously as avatars in the VR film.

In Iñárritu's hands, VR is artfully practiced as a rich and compelling storytelling medium in which strong empathic relationships are formed between characters and the viewer. At is dramatic core, *Carne y Arena* revolves upon the experiences encountered by an itinerant group of men, women and children seeking to cross the border clandestinely from Mexico into the United States. The narrative trajectory of the film itself leads the viewer through an initial stage of orientation and acclimatization to the perceptual experience of VR, finding oneself assimilating with a

caravan of refugees before ultimately becoming implicated in a tense, confrontational scenario between the group and US Border Patrol authorities (recounted earlier as the prologue to this paper). While this particular scene – or more accurately, *scenescape*[4]– plays out in the midst of a multisensory onslaught, the viewer remains dimly aware throughout that the central drama playing out before their eyes is happening within a (seemingly) vast, (almost) boundless space caught somewhere between *"a dream or a reality"*. At this critical juncture, both viewer and avatars end up finding themselves occupying a common ground, the same 'truthful alternate space'. [3] It is (right) here, where the exchange between vision, media and experience is rendered most palpable that sentience emerges; what curator Germano Celant ascribes to: 'a psychophysical unity in which, by crossing the threshold of the virtual, the human strays into the imaginary and vice versa'. [4] Situating this encounter within the museum only amplifies the communicative potential of VR, wherein 'seeing is transformed into feeling and into a physical engagement with cinema: a transition from the screen to the gaze of the human being, with a total immersion of the senses'. [5] Further still, by taking this observation one step beyond a narrow description of *Carne y Arena's* immersive visual experience, Celant (unintentially, it seems to me) alludes to a way of contextualizing VR as an exhibitionary medium when he summarily observes that 'Iñárritu's project perfectly embodies Fondazione Prada's experimental vocation and its long-lasting engagement towards the *correlation* between cinema, technology and the arts'. [6; Emphasis added]

With a run time totaling only 6 ½ minutes, it should not be overlooked how the poignancy of this immersive viewing experience is nested within a broader, expansive and unfolding exhibition experience. Not dissimilar to how the scenescape functions within the VR film itself, the curatorial design of the exhibition at large – spanning galleries located before and after, along with "arena" in which the immersive VR experience itself is situated within – provides an extra-dimensional layer to the film that reinforces the *actuality* of its *virtual* experience.

Supplementary note on the expanded curatorial context of Virtual Reality

The viewing experience of Virtual Reality can be described as producing a pronounced sense of disembodiment. Recent forays by visual artists into the "brave new world" of VR technology, ranging from Antony Gormley to Laurie Anderson, serve as representative cases in point. Take for example Gormley's *Lunatick* (2019). The product of collaboration between the British sculptor and astrophysicist Dr. Priyamvada Natarajan, this VR film charts an extra-terrestrial journey through the cosmos. By exaggerating the physical sensation of gravity and weightlessness, the adoption of VR builds upon the artist's long-standing preoccupation with the body's relation to space; as Gormley himself explains, '[it] is the latest tool to extend our consciousness imaginatively beyond the limits of our bounding condition'. [7] In the case of *Chalkroom*[5] (2017), multimedia pioneer Laurie Anderson embraces this new technology to achieve 'what I've always wanted to do as an artist from the time I've started, which is a kind of disembodiment'. [8] While a sense of heightened physiological and phenomenological acuity can be treated as an end in and of itself, other artists have begun to test how the social dimensions that directly influence the "exhibitionary" conditions of medium can be harnessed and amplified as part of its overall aesthetic experience. Exhibited earlier this year in the Venice Biennale's 58th International Art Exhibition, Dominique Gonzalez-Foerster's *Endodrome*[6] (2019) creates a communal platform in which trancelike, hallucinogenic VR imagery becomes part of a shared experiential structure. As Gonzalez-Foerster asserts: 'The moment you're in virtual reality is important, but the moment you exit an experience can also be magical. I really want to work on this back and forth; if it works, *Endodrome* should also affect real space and your perception of it'. [9]

Indeed, what becomes self-evident from the audience or "visitor" experience – as distinct from viewing experience – associated with having engaged directly with each of the abovementioned VR artworks in their respective exhibitionary contexts is just how important the situatedness of the museum or gallery-based encounter is to underwriting what might more aptly be described as a *submersive* (as

[4] In previous research (Nb. See Bibliography) I have developed how the empathetic effect of VR cinema is amplified by treating certain episodes as *scenescapes* (such as the climactic scene from *Carne y Arena* described in the prologue to this paper). Theorized in games research, this cinematic device is conventionally employed in videogames as a transitional "cut scene" to establish the narrative context or "backdrop" for the gameplay. Designed to reinforce the narrative context by effectively "surrounding" the plot, in the case of VR filmmaking, this trope allows the viewer alternate vantages upon scenes and their unfolding dramaturgy. In effect, the viewer is permitted not only to engage with the scene by choosing where to direct and concentrate their attention in the visual environment, but also how to interact with or "enter" into the event portrayed in more circumspect, even intentionally subversive ways (by stepping outside the "magic circle" of the plot).

[5] *Chalkroom* is an interactive VR installation created by Laurie Anderson and long-time collaborator Taiwanese media artist Hsin-Chien Huang. The work won the inaugural award for Best VR Experience at the 74th Venice International Film Festival, and is permanently installed at MASS MoCA in North Adams, Massachusetts.

[6] *Endodrome* was produced in association with VIVE Arts, an initiative by HTC that makes their virtual reality software and technical expertise available to artists and cultural institutions.

distinct from immersive) experience.[7] The concept of immersion is all too readily called upon as a "short hand" way of promoting the escapist tendencies associated with VR; that of being transported vicariously to another, artificial reality. This non-critical reading perpetuates a false dichotomy between virtual and real. Submersive, on the other hand, is an attempt to hold these (otherwise incompatible) realities together whether in tension or balance; to encourage traversing their borders (as an actualization of the virtual; or virtualization of the real).

Encountering *Carne y Arena*

As introduced at the outset of this paper, my interest in the curatorial issues that "frame" Virtual Reality is being positioned here principally by my first-hand exhibition-based encounter with *Carne y Arena* at Fondazione Prada in Milan. There, the exhibition was installed in the Deposito, a large cavernous building incorporated into the mixed typology of the Prada Foundation's OMA-designed campus that previously served as a distillery.[8] Functioning as a flexible multi-purpose space, the curatorial design of *Carne y Arena* was realized in this distinctive context through a sequential arrangement of bespoke gallery spaces interconnected with each other by passageways traversing the voluminous enclosure.

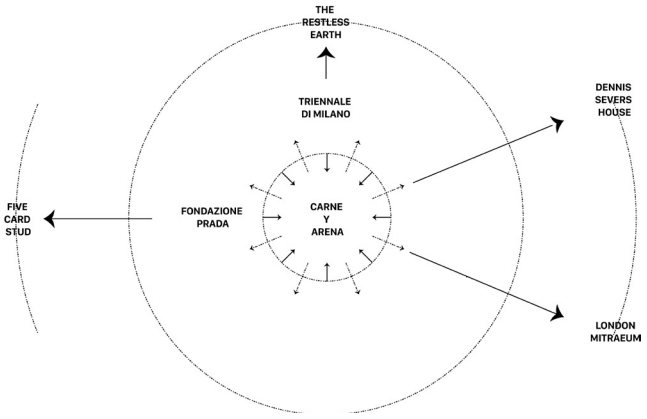

Figure 4. Expanded curatorial context of *Carne y Arena* (the exhibition). ©Vince Dziekan.

Illustratively (with direct reference to the diagram provided as Figure 4), the submersive experience of *Carne y Arena* is reinforced by a set of relationships that not only extends the cinematic to the cinematographic, but also expands the scope of the work's exhibitionary context. The multisensory hyper-reality experience nested at its core connects vision with the body in an immediate and sensate way, fusing the imaginary sense of being in the Chihuahuan desert with the presence of standing in the midst of a sand-filled stage located in the post-industrial outskirts of Milan. Reinforced by how the scenescape functions as part of this scenario, the empathic dimension of the VR film is amplified dramatically, thereby connecting the affective and meaningful experience of it as an artwork staged inside the museum with larger socio-political issues taking place in the world outside. By venturing further still, beyond the focused (physical, spatial) registration of the film's visual experience to the artwork's wider viewing context encourages us to consider the conceptual and theoretical "frames" that might be called upon to *describe* – in the etymological sense of *forming or tracing by motion* – the exhibitionary conditions of virtual reality. Propositionally, such an expanded reading places VR into a situated relationship with precedents and antecedents; thus encouraging a broader and enriched contextualization of the artform that acknowledges its contributing spatial, performative and museological properties. Together, these factors create the conditions under which resulting artworks are exhibited and thus experienced: In spatial terms by connecting VR with a lineage of installation art practices, including mixed media environments and tableaux that develop an aesthetic of form, materialization and participation; performatively, with respect to scenography and dramaturgy; and by treating the museum as a platform for mediatized communications that offers distinct narrative formats and tropes for curating, interpretative story-telling and public engagement.[9]

The situatedness of my viewing encounter with *Carne y Arena* at Fondazione Prada underscored the subjective, felt response I had to the work; but equally, to the more serendipitous associations that the exhibition experience itself brought to mind. Guided as much by intuition and circumstance as by design, these interpretative readings might be likened to the ways film montage reconstructs the spatio-temporal character of experience; where the function of editing techniques – such as "jump" cuts (which manipulate

[7] The reader is referred to previous research; See Bibliography.

[8] Fondazione Prada in Milan serves as the headquarters of the Prada Foundation, a non-profit organisation established by Miuccia Prada and Patrizio Bertelli in 1993. Designed by OMA (Rem Koolhaas, Chris van Duijn and Federico Pompignoli), the cultural complex is located in the neighborhood of Largo Isarco on a former industrial site. The ambitious architectural project was completed in two stages, with main features of the campus opening in 2015 followed more recently by the unveiling of the nine-level "Torre" in 2018.

[9] Besides the discussion being outlined in this paper of spatial practice represented by that focused upon *Five Card Stud*, other indicative examples cited in the illustration itself – notably Dennis Severs House (as it relates to more performative features) and the London Mithraeum (with reference to museological programmes) – will not be developed in any detail within the scope of the present text. The Triennale di Milano's *The Restless Earth* exhibition and its synchronous relationship to that of *Carne y Arena* at Fondazione Prada is broached in previous research (See *Artlink* publication listed in Bibliography).

temporal space by fracturing the duration of a single shot) or "match" cuts which create an impression of continuity by establishing visual similarity between scenes involving different, often incongruent subjects – is to set meaning(s) in motion in a more relational and intertextual way. It was from such radical contextualization, that I found myself relating my experience of *Carne y Arena* ("then-and-there") to that of another artwork conjured from the recesses, or archive of personal memory; that being Ed Kienholz' mythical installation, *Five Car Stud.* (Figure 5)

The "afterimage" of *Five Card Stud*

> *Upon removing the Oculus headset at the conclusion of my mediated viewing of Carne y Arena, I am untethered from the backpack containing the computer hardware driving the real-time VR film. Liberated from the technology, a pair of docents direct me to exit the sand-covered arena. Proceeding around a corner, I find myself entering a long, narrow passageway lined by an imposing row of metal sheeting. The overwhelming materiality of the barrier impressed itself upon me; its scarred, rusted corrugated surface peeled back and perforated in places. Those apertures provided opportunistic sightlines back into the enclosure that I've just left behind; where, emerging from out of the depths of the pervading orange glow, I can make out the silhouette of another figure (the next scheduled viewer), navigating (quite literally, "feeling their way" through) the beginnings of their own VR experience.*

This otherwise mundane "threshold" experience connecting two adjoining exhibition spaces was granted added poignancy by establishing a correspondence, using both choreographic and scenographic tropes, between my own movement along the corridor with that of the border crossing aspirations of the immigrants represented in the film. Yet, beyond this immediate impression, another image (or more aptly, *afterimage*) came to mind sparking my personal recollection of visiting the major Edward Kienholz retrospective mounted only a couple years earlier at Fondazione Prada.[10] Triggered by the "realization" that the centrepiece of that exhibition – the restaging of Kienholz's revered and art-historically mythologized *Five Car Stud* (1969–72)[11] – was also installed *here* in the Deposito, I found myself wondering what this association was trying to reveal; how and why was *Five Car Stud* "haunting" my experience of *Carne y Arena*?

Ed Kienholz is amongst the most recognizable and idiosyncratic American artists of the post-war generation. The work of Kienholz together with his wife, Nancy Reddin Kienholz, continues to assert its influence on contemporary art practice, particularly with regards to the rise of installation art since the 1960s, whose legacy has informed, by extension, the interactive and immersive installation practices associated with new media art. Self-contained assemblage sculptures, such as Kienholz's first "walk-through" tableau, *Roxys* (1960-61), and *The Beanery* (1965) challenge the boundaries of gallery-based installation; whereas a lesser known strand of this spatial practice entailed more propositional interventions in, and later with, actual sites.

Figure 5. Edward Kienholz, *Five Car Stud,* 1969–72. Photo Delfino Sisto Legnani Studio. Acknowledgment: Fondazione Prada (Milan).

Cited amongst the artist's most critically celebrated scenographic environments, *Five Card Stud* was exhibited in documenta 5 (1972) in Kassel, Germany and situates itself within Kienholz' oeuvre between the development of *concept tableaux*[12] and later *meta-tableaux* (realized in collaboration with Nancy Reddin Kienholz from 1979-1983). Ed Kienholz's first concept tableaux was *The Art Show* (1963-77). Conceived in 1963, its realization would only begin in earnest during his residency-based fellowship in Berlin one decade later. The piece parodies a group of "art world" figures milling around an exhibition opening. The effect of 'walking through frozen time' [10] is only fully achieved when the work's arrangement is seamlessly blended into an

[10] The retrospective exhibition, 'Kienholz: Five Car Stud' (curated by Germano Celant) was presented at Fondazione Prada, Milan from 19 May to 31 December, 2016.

[11] *Five Card Stud* was first exhibited at documenta 5 in Kassel, Germany in 1972. Shortly afterwards, the work was purchased by a Japanese collector and remained hidden from public view until 2011, when it was restaged at LACMA (Los Angeles) and Louisiana Museum of Modern Art (Humlebæk, Denmark). It is now part of the Prada Collection.

[12] The *Concept Tableaux* entailed a formalized set of ideas that could be purchased by a collector who would also be granted the option to finance the work's realization. Only four such works were ultimately realized in addition to *The Art Show* (namely, *The State Hospital*, *Commercial #2*, and *The Portable War Memorial*).

actual gallery.[13] This *mise en scene* is further animated by interactivity; such that when a visitor pushes a button, hot air is blown from the plaster-cast mannequins' mouths (using repurposed air conditioning vents from American cars) and accompanied by audio recordings which play an assortment of vacuous remarks. Later, works produced as part the "Spokane series" of tableau would appear to eschew the allegorical for more archaeological intent. Most apparent in the *Pedicord Apts* (1982-83), this environment recreates in the gallery context the hallway of a demolished hotel by using transplanted construction materials, floor boards, electrical fittings and furnishings from the original building. While still employing similar spatial and theatrical tropes to 'manipulate one's physical position to intensify the notion of the viewer as voyeur' [11], this multimedia installation requires the imaginative contribution of the visitor. Activated by their physical interaction with the set, a series of sounds and noises (such as a couple arguing, a dog barking, a woman crying) are issued from behind the apartments' locked doors, thereby 'project[ing] the role of the isolated protagonist, customarily reserved for the figure, onto the viewer.' [12].

It has been commented that Kienholz's portrayal of social and psychological violence 'stress[es] both his own emotional pathology, due to the emergence of memory, and the pathological ambivalence of American society'. [13] *Five Card Stud* presents a horrific scenographic representation of racial hatred and abuse that centres upon an act of castration. For its restaging in the Deposito at Fondazione Prada, *Five Card Stud* was installed as a highly focalized "scene" in the centre of an expansive sand-covered space that appeared to recede indefinitely into the shadowy corners of the gallery. Illuminated by the headlights of a ring of five vehicles, the focal point of the tableaux is a "freeze-frame" involving a circle of diabolical figures swarming around an African-American man literally being torn limb from limb. Collectively, the group of men – all of whom are wearing Hallowe'en masks, whose sweaty, pale plasticity only adds to their terrifying contorted caricatures – restrain the arms and legs of the struggling victim, pinning him to the ground; while, in the midst of the rabble, another performs the brutalizing act with a degree of disquieting concentration and stillness.

A patina of real violence permeates this wasteland setting, colouring the atmosphere with a murky, discoloured intensity. Unsettlingly, my presence, along with that of other interlopers (other audience members), has a destabilizing effect on the scene. Impervious to our presence, a male figure stands propped beside the open driver-side door of his pickup truck. Smugly, he overlooks the confronting event with shotgun cocked under one arm. (Uncannily, when I cast my mind back to my actual exhibition experience, I recollect moving up close next to him to take a photograph and recall feeling a similar sense of unease as I experienced when I found myself interacting with the virtual avatar of the border patrol officer in *Carne y Arena*…) The voyeuristic relationship forged between the human figures that populate Kienholz's mixed media assemblages and their viewers, 'prompt[s] a sense of participation that, whether born of sympathy or repulsion, is always active and shared.' [14] Here (or is it "there"?) in the midst of what is happening (now; then), I/we are implicated in the violence whether directly as powerless or complicit witnesses to the portrayed act of perpetrated violence or more latently; which, if it were possible, might even be more disconcerting since it raises questions that are far more deep-seated and instinctual: of agency or impotence; identification or indifference.

The Artist has left the exhibition

The iconoclastic approach that Ed and Nancy Reddin Keinholz took to their environmental and sculptural tableaux is distinguishable from that of their contemporaries (representatively, the likes of Robert Rauschenberg and George Segel) by their "intensification" of the social world. The so-termed "maximalist realism" [15] that infuses their practice is a recognizable trait found also in the work of subsequent generations of artists indebted to their legacy; extending from notable West Coast "assemblagists" Mike Kelley and Paul McCarthy[14] to the present day, with media-saturated post-Internet artists taking up the mantle; such as Kaari Upson, whose installation *There is no such thing as outside* (2017-19) was represented in the latest Venice Biennale.

Art critic Thomas McEvilley once pointed out that space, figure and narrativity form a triangulation of forces that define the Kienholz' oeuvre. 'Space is the medium that enables the figure to exits; the figure in turn, is the agent that activates the space'. [16] He continues: "Their collaboration, finally, is the necessary cause of the special situation in which the narrative can occur: where event horizons explode into events'. [17]

This article has focused on some of the ways that mediated Virtual Reality experiences are integrated into their encompassing curatorial and museological contexts. VR and museums, each in their own way, function as

[13] Finally realized in 1977, *The Art Show* was first exhibited at the Skulima Gallery in Berlin, and included by curator Pontus Hulten in the opening exhibition of the Centre Georges Pompidou in Paris that same year.

[14] The grandiosity and excess of McCarthy's *WS* (2013) quite literally takes the spectacle of exhibition-as-immersive entertainment to its Disney-esque extremes. The exhibition was curated by Alex Poots and Hans-Ulrich Obrist in association with Tom Eccles for the Park Avenue Armory in New York (June 19 - August 4, 2013).

multi-dimensional spaces in which aesthetic experiences are situated. These expanded notes contextualize the distinctive museological "framing" of VR's viewing experience as part of a broader set of exhibitionary conditions. The nature of the exhibition event associated with seeing and interacting with VR artworks under those conditions reveals just how important the situatedness of the museum or gallery-based encounter is to underwriting what should more aptly be described as the submersive quality of that experience; which this paper's more speculative line of inquiry describes by drawing together Alejandro Iñárritu's *Carne y Arena* and Edward Kienholz's environmental tableaux *Five Card Stud*. The collaboration between spaces (real and virtual) and figures (real and imagined, including the viewer's own self-identification, projection and memory) produce the context wherein narrative and meaning are co-constructed. Representatively, the "special situation" that these exhibitions bring to life extends the horizon of VR well beyond the cinematic to the cinematographic, and onto the curatorial design of exhibition space itself.

The final word – as it ought to be – is best left to the artist. Ed Kienholz likened the role of the artist to that of a "trail-maker" (as someone who 'makes a thought-trail' [18]). When the artist disappears from the stage leaving only the artwork behind in their place, the viewer is presented with the challenge of picking up this trail. Faced with this 'dilemma of ideas and directions', the situation the viewer finds themselves in is one pregnant with possibility: 'to push on further by questions and answers to a new place that I can't even imagine, or to turn back to an old, safe place'. [19] (What would you choose?)

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Seeing is Sensing: Three Strategies for Multisensory Experience in Mixed Reality Art

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Abstract

In this paper we outline three strategies used by Mixed Reality (MR) artists to produce experiences that challenge vision as a single sense modality. The interactions enabled in the works that we discuss emphasize how virtual technologies produce embodied experiences and a mixed sense of reality, thereby re-conceptualizing both MR and virtual technologies as multi-sensorial embodied practices. Exploring three different installations, we show how this mode of multi-sensory experience is also a multi-media phenomenon. Seeking to reconsider both the 'self-world' and the 'self-other' relationships, these installations further demonstrate how such induced embodied experiences can be utilized to initiate what we understand as a sense of critical empathy. In seeking to both virtually and physically place the viewer in an/other body, an/other space, or in granting them access to an/other history or cultural knowledge, these works fundamentally aim to shift viewers' perspectives of their environment, while at the same time exposing the constraints of their own embodied position.

Keywords

Mixed-Reality, Virtual Reality, Critical Empathy, Locative Media, Multisensory Experience, Interactivity, Embodiment

Introduction

The articulations of Mixed Reality (MR) that we examine in this paper challenge vision as a single sense modality through which consciousness and perception are generated. Within the works that we discuss, the mechanics of vision that are housed in the body function as a trigger to activate and renew the sensorial input coming from the encounters of self and environment. Rather than simply seeking to counter the 'hegemony' of vision within modernity and Western systems of knowledge, these works offer a complex model of perception and subjectivity based on mixed, multi-layered modalities and embodiment.[1]

Mark Hansen has declared that, ultimately, all reality is a mix formed through interfacing bodies with their surroundings and technologies. [1] Today, Hansen explains, many forms of virtual interactions are created in order to expose—rather than to conceal—the state of mixed reality. The interactions enabled in these works emphasize how virtual technologies produce embodied experiences and a mixed sense of reality, thereby re-conceptualizing both MR and virtual technologies as multi-sensorial, embodied practices. Hansen's perspective on reality and perception, as demonstrated through the works that we discuss, is characteristic of the second wave of virtual reality theory: virtual realms are no longer perceived as dismissing the body, but rather allow for new sensory options that extend human sensorial embodiment and experiences of space and time. While these expansions are often triggered by visual input, they are nonetheless enhanced and reinforced by an overall sensory input. Therefore, although many digital art objects are indeed meant to be experienced primarily through vision, our eyes' input in the case of many mixed-reality projects is intended to initiate a broad sensory response. Hansen's discussion of perception recalls Victor Burgin's argument that all space is an enmeshment of internal psychic reality with the external environment. [2] A similar approach is also adopted by Ron Burnett, who argues that the individual perception of reality is established in an ongoing process of "hybridization", in which self and image imbue one another with meanings. [3] In relation to MR theorists, Hansen is most notably in line with media-art scholars such as Oliver Grau and Frank Popper, who similarly argue that although some VR environments might still attempt to disembody the viewer, such environments can also reaffirm viewers' corporeality. [4]

[1] Here we draw on Jonathan Crary's discussion of the study of "visuality" as being at risk of ignoring "historically determined notions of "embodiment," in which an embodied and perceiving subject is both "the location of operations of power and the potential for resistance. See: Jonathan Crary, *Suspensions of perception: attention, spectacle, and modern culture*. Cambridge, Mass: MIT Press, 1999: 3. A similar perspective is also foregrounded by David Parisi in *Archaeologies of Touch: Interfacing with Haptics from Electricity to Computing,* University of Minnesota Press, 2018.

This paper therefore analyzes three installations that demonstrate three strategies for the employment of vision as a means for enhanced proprioception and space-sensing. Examining works that employ three different forms of MR (HMD VR, audio AR, and an audio-visual AR mobile app), we demonstrate how this mode of multi-sensory experience is also a multi-media phenomenon. Dating from 1996 to 2017, these installations indicate a historical continuity in that these strategies for multisensorial experiences can be traced to the early stages of MR. Within their varied contexts, all these installations also address significant political themes related to the body, difference, and occupation. Seeking to reconsider both the 'self-world' and the 'self-other' relationships, these installations further demonstrate how induced embodied experiences can be utilized to initiate what we understand as a sense of critical empathy.[2] In this context, therefore, critical empathy is not solely about identifying with the position of another, but rather about understanding one's own situatedness and positionality as historically and socially constructed. It is with this notion of critical empathy as understanding oneself in relation to others that we analyze how these works seek to enable a relational inhabiting of bodies and spaces to foster an understanding of the positionality of others. Ultimately, we demonstrate how, while allowing the user to get closer to an 'other', these embodied engagements also inevitably emphasize that we are subjected to our own bodies.

While the three strategies discussed are not an exhaustive account of the modes of multi-sensoriality in MR, they could point towards a larger framework whereby MR employs multisensorial experiences to create an awareness of the social structuring of space that fosters critical empathy with the bodies, spaces, and histories of others.

Seeing in an/other body

Systems, a series of software works developed by the artist Mathieu Briand between 1996–2006, presents a complex articulation of issues related to the hierarchy of the senses, the diffusive boundaries of media, and the theorization of mixed reality as an empathy tool. Within the work each participant is equipped with an individual Head Mounted Display (HMD) device, creating the expectation of a conventional VR experience. (Figure 1.) However, in *Systems*, participants experience the view of another user who is wearing another *Systems'* HMD at the same time and in the same space. [5] The user's navigation of the viewing environment is therefore performed through this machine interface that displays the visual feed of another.

Figure 1. Mathieu Briand, *Systems*, VR installation presented at Egofugal, 7th Istanbul Biennale, Istanbul, 2001. ©Mathieu Briand.

The defamiliarization of the mechanism is almost instantaneous; while the familiar interaction with the apparatus produces unexpected results, participants are required to contemplate the ways in which they themselves interact with those devices, and to question the impact and agency that virtual environments have on them, as well as on their sense of reality. The viewer's experience of their augmented vision simultaneously heightens an awareness of the location of the self and the sensing of the other. This environment therefore enables the user to experience the viewpoint of another, and even the potential to see themselves from this point of view; the work produces the potential for the user to not only see themselves seeing but to see themselves *sensing* space, both as themselves and as 'an other', producing a convergent sense of embodiment generated through machine interaction.[3] What this engagement establishes is a simultaneously embodied and transcendental experience.

The work also engages conceptually with difficulties of visual adjustment and temporal alignment, therefore further challenging the privileged position of vision in perception. Viewers of the work must adjust to both to the vision of another and the temporal delays experienced through the process of live feed transfer in early wearable

[2] For more on identification and performativity in location-based and mixed-reality media see: Joshua Meyrowitz, *No sense of place: The impact of electronic media on social behavior*, (Oxford University Press, 1986); Rob Cover ed. *Digital Identities,* (Boston: Academic Press, 2015); Steve Benford and Gabriella Giannachi, *Performing Mixed Reality,* (The MIT Press, 2011).

[3] This application of VR technology is in line with Don Ihde's concept of "post-phenomenology": a contemporary contextualized form of phenomenology that takes into consideration the significance of available technologies and their current practice in the interpretations and engagements of bodies in the world. See: Don Ihde, *Postphenomenology and Technoscience* (SUNY Press, 2009), 23.

technology. The viewpoint of the other does not arrive on the viewer's headset screen instantaneously, and so they also experience a temporal rupture and see another's view of the immediate past. A heightened complexity occurs when multiple users may be engaged in this interaction, and participants can switch between various viewpoints. Although the technological mechanisms of the work did not always allow for the intended experience, the concepts which the work develops have greater implications. In an environment such as that created in *Systems*, viewers depend upon their interaction with another participant who is similarly mediated by the machine to locate themselves. (Figure 2.) In this work, the machine is both active and observing: as a receiver and emitter of embodied vision it both enables and limits the body through the tracking systems that are a necessary component of this immersive environment. Wearing the VR headset extends our vision and movement while putting them under surveillance. The wall-wired visor becomes almost metaphorical in this case, as the machine is employed here to make us reconsider our embodied experience as a seeing-self: it shows us great potential while demonstrating the impossibilities inevitably incorporated within it.

Systems may be read as a literal application of Hansen's mixed reality perspective: Briand's work shows us how our embodied experience, and accordingly our perception of reality, is activated and mixed with everyday virtual technologies. As *Systems* estranges our self-technology relationship, we regain awareness of the ways that we interact with MR primarily through being a body. Briand's work also shows us how we automatically go beyond our bodies to adjust our sight with that of the machine in order to produce a mixed reality. The work produces a system for interaction within which a viewer may quickly question the benefit of visually locating an image of the self on the screen in comparison to using the body itself to sense space, and in each case the experience is controlled by both another user and a machine that mediates between the two bodies. In *Systems*, our sight is neutralized and expanded at the same time, thus making us re-adjust our bodies interpretation of space, as an inevitable dissonance arises between our vision and the rest of our sensory input. Accordingly, *Systems* makes us think of both the opportunities and the politics of being able to see through someone else's eyes. In this way the work might be situated in relation to the extensive and ongoing debate regarding VR and empathy. While many VR works offering alternative viewpoints have been created with the goal of producing heightened empathy and identification, the actual ability of VR to achieve this desired e/affect rather than to produce a spectacle of highly complex human situations not only remains contested, but also articulates an ongoing controversy about the actual competence of VR devices. [6, 7] This debate has a longer standing historical precedence, and a similar concern was raised by Susan Sontag in relation to photographic reportage in the early 2000s. [8]

Figure 2. Mathieu Briand, *Systems,* VR installation presented at Egofugal, 7th Istanbul Biennale, Istanbul, 2001. ©Mathieu Briand.

Lastly, *Systems* could also spark the realization that virtual environments are neither a form of separate reality nor do they simply exist as representations of material reality. Instead, they form an integral part of the living continuum of the spectator, as they are generated through and by specific bodily engagements. [9] In light of this, *Systems'* disruption of familiar visual processes to produce a heightened awareness of the sensing body may also be read in relation to Foucault's assertion in the "Utopian Body" that the body is the ultimate focal point: it is around the body "that things are arranged. It is in relation to it – and in relation to it as if in relation to a sovereign – that there is a below, an above, a right, a left, a forward and a backward, a near and a far. The body is the zero point of the world", and it is "where paths and spaces come to meet […] and it is from it that all possible places, real or utopian, emerge and radiate". [10] As virtual technologies have become mobile and inscribed onto the body, the digital and physical realms can be conceptualized as a unified, convergent experience, emerging through our perpetual, embodied interaction with MR technologies. In *Systems* and other MR works, the user's body becomes the focal point in which virtual and non-virtual realms converge into one. While Systems establishes one's body as a site of sensual collision in which the sensing of multiple bodies' converge, this interaction also raises questions regarding the alleged transparency of the apparatus and its agency. While the body is indeed a focal point, this focal point can only be created by means of electronic control.

Seeing into an/other space

Another example of how our vision is employed to produce an overall experience of alternative, expanded, machine-based sensing is mobile Mixed Reality (MR). In these interactions, the MR interface initiates spatial navigation and proprioception that, like *Systems*, can be used to produce a sense of critical empathy. Within this strategy, multisensorial experiences may be seen to play on the idea of spatial separation as a means to reflect on participants' own situatedness.

Figure 3. Mushon Zer-Aviv and Laila El-Haddad, *You Are Not Here: Gaza/Tel-Aviv,* 2007. ©Mushon Zer-Aviv and Laila El-Haddad.

This becomes particularly apparent and effective when the convergence of the virtual and non-virtual domains is utilized to produce an alternative, or a heterotopic real space.[4] Mixed reality environments can juxtapose two remote places to create a new mode of proprioception through navigation. This form of heterotopia can clearly be seen in the MR tour *You Are Not Here: Gaza/Tel-Aviv* (2007), created by the Israeli media-scholar Mushon Zer-Aviv and the Palestinian journalist Laila El-Haddad. (Figure 3.) Although this is an early example of MR, in its use of geo-located information it still employs MR concepts to provide us with a spatially inclusive experience.

Figure 4. Mushon Zer-Aviv and Laila El-Haddad, *You Are Not Here: Gaza/Tel-Aviv,* 2007. ©Mushon Zer-Aviv and Laila El-Haddad.

The project consists of recorded audio, and a double-sided physical paper map; as one side of the map presents the city of Tel-Aviv, the other side displays a map of Gaza. Users then employ this double-sided map to find markers located throughout Tel-Aviv. These markers are points of interest indicated by stickers with phone numbers that can be identified by the tour's participants in-situ. Upon arrival at one of these markers participants dial the given phone number whereby a system identifies their (Tel-Aviv) location and plays a corresponding audio track that describes a parallel Gaza location's views and sites. When looking at the map against the sunlight, walkers can also 'see' where they are in the Gaza map (Figure 4.) This project therefore operates as an augmented walking tour, allowing participants to encounter "views" of Gaza while walking the city of Tel-Aviv. While the Gaza strip is only 75 km away from Tel-Aviv, it is an enclosed territory. This is one of the reasons why, other than promoting an Israeli-Palestinian dialogue, *You Are Not Here* gains social significance: participants in Tel-Aviv are called upon to envision and navigate Gaza, while in fact, it is inaccessible to them. Seeking to establish a new spatial performativity, this project conceptually shrinks space in order to multiply its meanings through exposing spatial relationality. *You Are Not Here* makes participants walk through, and produces an encounter with two cities simultaneously.

Thus, *You Are Not Here* asks participants to question and contemplate their own situatedness. [11] As the map blurs against the sunlight and the audio alienates participants' sight, Zer-Aviv and El-Haddad's project asks walkers to re-think their current geographical position and socio-historical context by means of othering it, while simultaneously reaffirming and reminding them of their

[4] According to Foucalt, spatial heterotopia is capable of "juxtaposing in a single real place several spaces, several sites that are in themselves incompatible". See: Michel Foucault, "Of Other Spaces," *Diacritics* 16 (1986), 22-23.

being in a specific physical place. In other words, we are asked to imagine what it is like to be in another place while firmly recognizing that we are not there. Visual means here function as a gateway, since they enable another way of seeing and navigitating - and therefore of sensing - space. The city of Tel-Aviv is now seen in relation to Gaza, and a conception of actual space is re-shaped based on this comparison. Material space is thus visualized as itself and as an Other at the same time; it gains both a symbolic meaning, and manifests Foucault's concept of Heterotopia as a conjunction of Other spaces.

Similar to Foucault's argument, Zer-Aviv and El-Haddad's sight-seeing tour is not historical or chronological, but rather it is heterotopic: instead of learning about the history of Tel-Aviv, we are called to understand Tel-Aviv's most famous sites in relation to specific Gaza locations. [12, 13] The Gaza strip thus comes to be explicitly incorporated within the spatial narrative and locational identity of Tel-Aviv and this effect has a dual outcome: on the one hand it aims to produce an increasing spatial estrangement of Tel-Aviv and thus raise our locational awareness while, on the other hand, it paradoxically intertwines the histories and stories of the two cities. Nonetheless, although the forming and history of the two locations are inevitably tied, such ties are rarely shown or emphasized in the urban space of Tel-Aviv. In a way, such renewed seeing and sensing results in the morphing of material space in light of mobile information technologies' output. This resonates with Deleuze and Guttari's concepts of deterritorialization and reterritorialization, which reflect on the processes of decoding and re/encoding socio-spatial norms in a complex, relational system. [14] In this case, however, the act of reterritorialization enables our sense of critical empathy, as this act of spatial reoccupation is a direct result of our this new mode of seeing and embodied movement through space.

Using location-based MR, the work constantly maps and re-maps our surroundings, and it is through this act of mapping that we gain and interpret both our sense of place and our sense of being. This form of mapping is theorized by Karen O'rouke as "performative cartography", and according to her, such processes of active mapping that emerged with mobile technologies are designed "to locate ourselves in the world, allowing us to make sense of our situation and to act on it." [15] O'rouke further argues that locative media, such as AR, are capable not only of annotating the world but also of indicating and tracing other subjects in our surroundings. [16] This point is explicitly visualized in *You Are Not Here*, which illustrates both proximities and distances between spaces and identities. A related argument is articulated by Jason Farman, who describes how mapping through mobile technologies contributes to our sense of proprioception: mobile technologies, Farman argues, call for a relational understanding of space through the act of the cognitive and social mapping of it. [17] This point is emphasized with the practice of MR compositional convergence in *You Are Not Here*: as our bodies navigate space, we simultaneously launch and discover virtual and non-virtual information that actively participates in the act of mapping and interpreting space and in forming our relations to it. Alongside its specific social and political implications, *You Are Not Here* also accentuates AR's unique ability to reconfigure space as a composition of places, narratives, events, and identities in order to confront us with our constructed perception of immediate environments. [18] Indeed, as Farman asserts, "how we represent space has everything to do with how we embody that space". [19]

Seeing an/other history

While MR enables a multi-sensorial experience of immediate environments in relation to an/other spaces, such multisensorial experiences can also be employed to defamiliarize spaces in light of their conflicted histories. By means of intervening digital outputs with existing codes of material spaces and navigation practices, MR is able to re-territorialize and manage the socio-spatial relations in various forms in order to produce new modes of control or – on the contrary – to reject existing spatial authority and raise empathy. The implications of this are evident in contemporary works such as *Wikiup*.

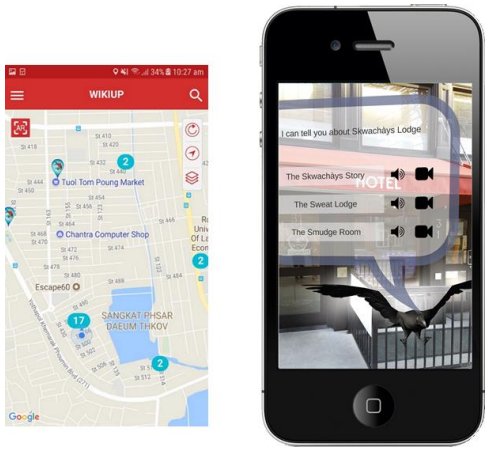

Figure 5. *Wikiup*, produced by Adrian Duke, AR Application screenshots, 2017. ©Vancouver Native Housing Society.

Physical and virtual elements converge in the MR application *Wikiup,* produced by Adrian Duke and the Vancouver Native Housing Society. (Figure 5.) Initially launched in 2017 at the Kanata Festival in Vancouver

during Canada 150 Celebrations, this application enables users to locate augmented avatars across significant First Nations sites in the wider Vancouver area. The avatar and its accompanying information on the location of the user can be accessed on site by an application that geolocates the viewer through GPS. Once activated, these virtual storytellers enable a user to access a range of audio-visual information about the land that they occupy. There is certainly precedence for using audio tours to provide users with interactive indigenous narratives of place, such as in Quelemia Sparrow's site-specific podplay, *Ashes on the Water*. [20] Still in development, the information provided in *Wikiup* about select locations is being largely collected from verified 'storycatchers', cultural guides, and elders, who narrate the stories located along walking routes in the application. Stories collected include a history from the Squamish Nation of the famous Vancouver mountain peaks *The Twin Sisters*, which were renamed at the end of the nineteenth century by Judge John Hamilton Gray to *The Lions*. The avatars that are activated by a user reveal the indigenous histories of a specific physical place through video and audio, and more fundamentally enable the possibility for a broader, renewed reterritorialization of space. Asserting an indigenous presence in cyberspace remains fundamental and is the goal of other digital works by artists such as Jason Edward Lewis and Skawennati, co-founders of AbTec. [21] Through its production of a sight-based embodied experience, *Wikiup* uses the potentials of MR to expand and extend an indigenous occupation of this territory through the virtual realm of cyberspace; it enables the convergence of a virtual indigenous presence within the physical landscape and in the space of the user. The application's potential lies in revealing the layers of a landscape from an indigenous perspective, and this has vast implications for asserting indigenous presence and sovereignty in Turtle Island. Although this application continues to undergo development, it is exemplary of MR practices that reveal the sociopolitical layers of land through the convergence of the virtual and physical. Through the production of an embodied and performative viewing experience these works ask users to consider the relationship between movement/navigation, storytelling, memory, and place. They therefore ask users to critically engage with their location, and to (re)locate themselves in a settler colonial landscape.

While many scholars acknowledge that different ways of mapping can reconfigure our relationships with our surroundings, these MR works use mapping and spatial navigation in order to initiate a perceptual paradigm of convergence that a viewer must navigate in situ. By geo-locating virtual content and aligning it with physical locations, the viewer has access to the narratives that have shaped space; *Wikiup* therefore offers an enhanced, more holistic sense of space and place. The users' immediate environment becomes inscribed with multiple perspectives, which are all site-specific. By relating to participant's immediate location, *Wikiup* contributes to and extends the situatedness of users: it not only reaffirms their physical location and acknowledges their bodily existence in a certain spot, but exposes their otherwise implicit and consequential placement in a larger setting of socio-cultural and historio-political events.

Through this MR strategy, space may point to an entire network of political, historical, economical, and other shaping forces. Space thus becomes much more than a physical location; rather, it is a site of convergence of virtual and actual elements, and a convergence of past and present. MR therefore obliges us to also recognize the relationality between the virtual and the physical. This convergence coupled with the multisensorial seeing that is enabled by MR produces relational interactions that are capable of shifting perceptions of space. Within works such as *Wikiup,* virtual elements are contextualized via their relation with the actual domain, and actual elements are re-contextualized via their relation with the virtual elements that are associated with them in real-time. As a result of this ongoing process, the MR space exists via a dialogue of deterritorialization and reterritorialization of elements in relation to one another, through the continuous experience of engaging bodies.

Conclusion

Naturally, our notion of critical empathy can be easily applicable to the analysis of other MR projects. Earlier examples to which this concept is particularly relevant include John Craig Freeman's *Border Memorial* (2012) and Heidi Rae Cooley's *Ghosts of the Horseshoe* (2012), alongside more recent installations such as Nancy Baker Cahill's *Battlegrounds* (2019) and projects by the collective 'Movers and Shakers NYC' (2019). [22]

That the virtual domain in the works examined may not be read as discrete from the lived experience of the spectator is also fundamental to these practices. As these strategies are practiced across different media, they provide an additional meaning to the term Cross-Reality (XR): in seeking to both virtually and physically place the viewer in an/other body, an/other space, or in granting them access to an/other history or cultural knowledge, these works fundamentally aim to shift viewers' perspective of their environment, while at the same time exposing the constraints of their own embodied position. While we may question whether these aims are achieved within the specific works explored, what these strategies reveal is the potential for MR to create embodied experiences that challenge existing, more traditional notions of seeing and sensing spaces. These works also raise broader questions

regarding the ability to ever fully identify with or occupy the vision, body, space, or history of an/other, and the subsequent limitations of empathy. These strategies therefore raise more fundamental ethical questions for MR practices at large: what are the possibilities and subsequent implications of this practice, and of potentially inhabiting the body, vision, and memory of an/other?

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Data Pollution Devices:

Artistic Strategies Against Behavior Capture

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Abstract

Technically, the capture of “big data” is usually eclipsed by the complexity of the devices we operate: smart phones, tablets, laptops, Internet of Things (IoTs), drones, self-driven cars. All of them are equipped with passive sensors, cameras, GPS and tracking software that provide high-level readings of texts, digital images and videos. According to Philip E. Agre, (2003) these distributed computer systems have established a regime of total visibility through real-time human activities. [1] Additionally, these devices are continuously and indiscriminately uploading users information to data-servers where it is managed by companies and data-trackers without authorisation.

This paper explores the functional aspects of devices involved in the process of data-capture, including internal structures, processes, operations and system−to−system relationships of computer tracking, analysed from the artistic perspective, including fields such as Tactical Media, Software Studies and Critical Interface. Specifically, Christian Andersen and Søren Pold’s concept of “Metainterface” (2018) in which our computer is both omnipresent and invisible, Wolfie Christl and Sarah Spiekermann's “Network of Control” (2016) and Shoshana Zuboff’s term, "Surveillance Capitalism” (2015) are used to describe how data analysis creates new power relationships hiding mechanisms of extraction, commodification, and control. The artists outcomes explored rely on the potential that artists have to arise questions, unmasking the invisibility of computational culture.

Keywords

Big Data, Surveillance Capitalism, Data-trackers, Critical Interfaces, hacktivism.

Introduction

> "If power was once identified with the ownership of the means of production, it is now identified with ownership of the means of behavioral modification.”[2]

Collecting and analysing consumer behaviour is not something new. Data brokers such as Axion and Oracle have been providing information about 700 million people in the US and Europe since the 1970s, – information extracted from purchases, driving licences, property records, magazine subscriptions and bankruptcies. [3] Nowadays, data is produced through massive utilization of interconnected technologies that can be processed and analysed on a much higher level than was previously possible. These practices are called ”Online Tracking” and consist of collecting and profiling data anonymously from each user’s identity, references, interest, intentions and personality, also known as a user’s VisualDNA.

This information and personal data is obtained through sensors located in devices such as computers, smartphones, wearables, IoTs, but also by means of digital identifiers such as MAC addresses, IP addresses, browsers, cookies and other technologies. The goal is the extraction of predictive patterns by using methods at the intersection of machine learning, statistics and database systems. This process is called “Data Mining.” According to the economist Hal Varian, the four uses that follow from computer-mediated transactions are: a) data extraction and analysis; b) new contractual forms due to better monitoring; c) personalization and customization, and d) continuous experiments. [2]

Therefore, Data Mining involves a combination of software, devices, platforms and infrastructures and is widely used by large players such as Google, Amazon and Facebook, alongside many others operating behind the scenes. For example “data brokers” collect, analyze, acquire, share, trade and utilise data from billions of people, using it mainly for online advertising. These ubiquitous techniques of tracking and pricing are used in crucial areas of life such as finance, insurance, housing, healthcare, welfare, law enforcement, and employment. In the words of the director of the Surveillance Studies Centre David Lyon, surveillance is defined as "the focused, systematic and routine attention to personal details for purposes of influence, management, protection or direction.” [4]

The objective of this paper is to give a comprehensive overview of the art practices connected with the new methods of art practices, technologies and devices involved in surveillance personal data ecosystems and their implications of these ecosystems for individuals and society. The paper addresses the following questions: How can art practices visualise underlying problems related to the capture of data and digital tracking? and What strategies are used by artists to unmask the invisibility of computational surveillance?

Additionally, this paper is based on eleven behavioural techniques of neutralization and resistance proposed by Gary T. Mars in "A Tack in the Shoe: Neutralizing and Resisting the Surveillance" (2003) that are intended to subvert the collection of personal information: discovery moves, avoidance moves, piggybacking moves, switching moves, distorting moves, blocking moves, masking moves, breaking moves, refusal moves, cooperative moves and counter-surveillance moves. [5]

Data Polluters definition

The DataPolluters are devices and software capable of generating false readings that confuse the mechanisms of data-capture, including data brokers, analytic industries, corporative and governmental agencies. Data Polluters are mostly hacked devices and net-bots able to generate random data, or to hide information by means of tactics and strategies extracted from hacker culture and tactical media movements such as obfuscation, camouflage, disruption, cryptography, parasitism, masking, plagiarism, symbiosis, humour, rhetoric, paranoia, metaphors and paradox. Their objective is to open an alternative overview that clarifies technological differences and control mechanisms which have a direct impact on the user's behavior. When functionalities are hidden, governments and corporations often behave like the black boxes embedded and camouflaged in services, apps, platforms and algorithms that are executed behind the Graphic User Interface (GUI).

Data Identifiers

> "These institutionally produced data flows represent the 'supply' side of the computer-mediated interface. With these data alone it is possible to construct detailed individual profiles." [2]

Digital identifiers are pieces of software such as cookies, IP or MAC addresses designed to record the user's browsing activity, clicks, preferences, interests, or likes that transmits this information to other companies.

Premonitoring, a vision of protecting privacy and anonymity that emerged in the late 1980s, is embodied in the activist movements Cypherpunk and Crypto-anarchism. Its values were canalized and collected in Eric Hughes' Cypherpunk manifesto (1993) and in the Cryptoanarchist manifesto (1988), a premonitory text written by Timothy C May in which cryptography is seen to reshape and redefine the power structures of society, especially those between individuals and governments.

In a parallel efforts, many applications, operating systems, services and tools were developed. A good example is *TOR (The Onion Router)*, [10] produced in 2002 by the computer scientists Roger Dingledine and Nick Mathewson to be a free, open-source software for enabling anonymous communication. In 2004, the Naval Research Laboratory released the code for *TOR* under a free license. According to torproject.org, "*TOR* isolates each website you visit so third-party trackers and ads can't follow you. Any cookies automatically clear when you're done browsing." Using a similar approach, the email service *ProtonMail,* [11] was developed in 2013 by CERN scientists and engineers Jason Stockman, Andy Yen, and Wei Sun. It protects user data via strict Swiss privacy laws. As a result, user's encrypted emails cannot be shared with third parties. Further examples include the standard hard disk encryption *LUKS (Linux Unified Key Setup),* which facilitates compatibility among distributions and provides secure management for multiple user passwords alongside the operating system *Tails,* designed in 2009 to preserve privacy and anonymity.

Figure 1. © *TOR, Tails Lucks, ProtonMaill.*

The level of complexity of these applications is sometimes very high. Counter-strategies and forms of resistance can also consist of simple individual actions such as blocking, covering, isolating or disrupting signals, which can be equally effective neutralization techniques. For example, the webpage *Internet Noise* [13] gives the opportunity to fake search history by opening automatically random tabs on Google's searches website. *Internet Noise* was developed in response to the law (S.J.Res. 34 (115th) approved in the EEUU congress on March 28th, 2017 that made it legal for Internet Service Providers (ISP) to track and sell your personal activity online. In the same line, the project *TrackMeNot* [14] is a browser extension that protects searchers from surveillance and data-profiling by generating random and periodic queries to popular search engines like Yahoo! and Google. With a similar name, *Do Not Track (DNT)* [15] is a free and open-source browser extension for Google Chrome, Mozilla Firefox, Opera and Android created by the Electronic Frontier Foundation (EFF). Its purpose is to promote a balanced approach to internet privacy between consumers and content providers by blocking advertisements and tracking cookies that do not respect the Do Not Track setting in a user's web browser. From another angle, but equally effective, the plugin *AdNauseam* [16] clicks on every blocked ad, registering a visit on ad networks databases.

Figure 2. © *Track Me Not, Do Not Track, Adnauseam.*

The latter four applications work by diminishing the value of the data by producing noise and generating automatic confusions. The previous four employ cryptography as a method to anonymise and privatise. They are tools designed against attacks on different degrees of security, by using stronger passwords, multi-layer encryption or by Hast algorithm functions that require more computer power and time.

Text recognition and Text analysis by tags

Text recognition and intelligent character recognition (ICR) are software techniques used to automatically extract text from pictures and documents, to read fonts and different styles of handwriting. They can even keep track of real-world objects, through cameras and self-learning systems based on neural networks. Text recognition is used by secret governmental surveillance systems and programs such as XKeyscore and PRIMS. It is used by the United States National Security Agency (NSA) for searching and analyzing global Internet data, collecting and searching digital communications and detecting keywords algorithmically, based on words in emails in order to predict citizen behaviors. As a counterpoint to the predominant of narrative of being under constant observation, the artistic project *ScareMail* [17] by Benjamin Grosser proposes a web browser extension able to disrupt the NSA's surveillance programs in the detection of predetermined keywords. *ScareMail* algorithmically generates specific narratives and keywords in every new email in Google's Gmail. According to the artist, it was "an attempt to avoid automated filtering by NSA search systems."

Similarly, the design based project, *font ZXX,* [18] by Sang Mun is a typeface unreadable by text scanning software. It works like the CAPTCHA method to create distorted letters. The creator argues that it is very difficult to read without human analytical thinking. Sang Mun expresses his goal in the following way: "*ZXX* is a call to action, both practically and symbolically, to raise questions about privacy. It can be applied to huge amounts of data, or to personal correspondence." The project started with these genuine questions: How can design be used politically and socially for the codification and decodification of people's thoughts? What is a graphic design that is inherently secretive? How can graphic design reinforce privacy? And, how can the process of design engender a proactive attitude towards the future — and our present for that matter? *ZXX* typeface is available as a free download in the hope that as many people as possible will use it.

Figure 3. *Zxx typeface,* © Sang Mun.

ScareMail and *font ZXX* are not applications to be used independently, but rather interact with services developed by corporations such as Google, Facebook, etc. Both offer a response to ICR surveillance techniques through the use of noise, obfuscation and confusion.

Generating data: Devices and technologies

> "The development of the Internet and methods to access the World Wide Web spread computer mediation from bounded sites of work and specialized action to global ubiquity both at the institutional interface and in the intimate spheres of everyday experience."[2]

Interfaces play an important role in the surveillance ecosystem, – the GUI, mice, touchscreens and keyboards are elements that perform the translation between humans and computers. This direct interaction makes them gateways to reliable analysis of human behaviour. For example, keystroke dynamics have been used to identify and authenticate users for decades. Variables like the number of mistakes and the number of special characters or longer pauses in typing are analyzed by machine learning models and classification algorithms. Those predictions can automatically identify emotional states of users such as confidence, hesitancy, nervousness, relaxation, sadness and tiredness, based on these keystroke dynamics with an accuracy of up to 88%.[7]

Exploring the role of interfaces in surveillance, the artistic project *Keyboard of Things,* [19] 2010 by César Escudero Andaluz, consists of a series of hybrid devices, connecting computer keyboards and objects such as tennis rackets, pillows, boxing bags and grenades. By using these dysfunctionalized interfaces across social networks, mails or browsing, a user can type random sequences of text, generating wrong information that works against patterns recognition by typing. *Keyboard of things* uses strategies such as obfuscation, confusion, hacking, disruption, gamification to open discourses about interfaces functionality and surveillance.

Figure 4. *Keyboard of Things,* 2010. © César Escudero Andaluz.

In a similar domain, the mouse tracking technology allows the remote recording of mouse activities such as path movements, clicks, pauses, scrolling, as well as reading activity, scanning activity, doubts, difficulty, decision mak-

ing activity, anxiety and earlier decisions. In 2011 the Ph.D candidate at Pompeu Fabra University Silvana Churruca, [20] developed a comparative study that analysed cursor movement patterns between a touchpad and a mouse based devices. Silvana states that the common goal of all these technologies are a) To achieve a deeper understanding of the user (e.g., interests, resources); b) To improve the user experience; c) To deliver relevant content to the user; d) To create dynamic websites adaptable to the needs, interests and resources of the user; e) To find behavioural patterns in mouse and touchpad; f) To optimise their websites according to the specific browsing behaviors inferred from users behavior; g) To collected data to find behavioural patterns. [6]. In 2016, as a response to mouse tracking technologies, the project *Random User* [21] by Arturo Melero appeared. A computer mouse provided with wheels and a rubber finger endows the device with a random character that browses through the internet without control. The artist describe the word as "a special user who does not attend UX strategies, CTAs, quality content".

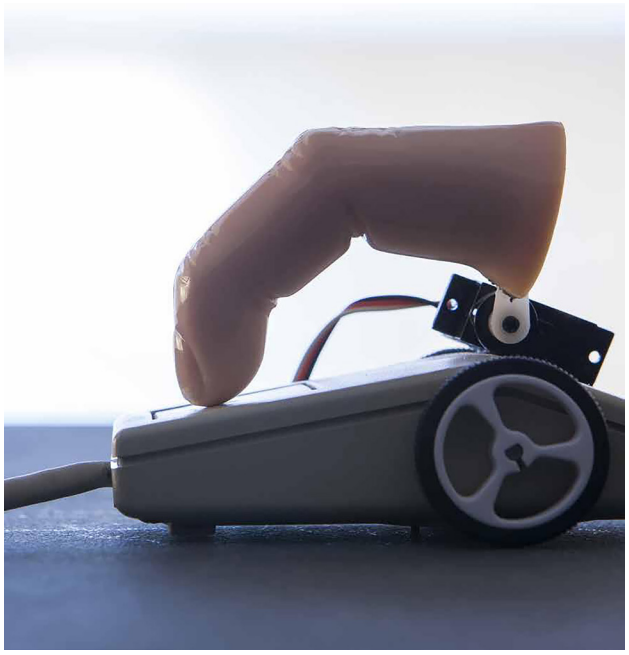

Figure 5. *Random User, 2016,* © Arturo Melero.

Phones are normally used by a single person, which transform them into a perfect device for spying. Following the trace of tracking devices, a simple Smartphone is able to store information such as calls, text messages, contact lists, calendars, notes, videos, visited websites and GPS location in order to monitor behaviour.

Given the dialectical paradigm between the critical interface and tracking devices, in 2015 the artist César Escudero Andaluz developed the project *Interfight* [22]. *Interfight* is a series of physical bots, that interacts freely through touch-screens to access social networks, browsers and the web. These untraceable bots behave as intruders: taping, clicking, scrolling randomly, opening and closing applications: taking decisions, in order to provide wrong information for tracking and website analysis. *Interfight* obfuscates the mechanism of data capture and data analysis in platforms such as Google, Facebook, Amazon, and Aliexpress, and acts as an important ally in the fight against Surveillance Capitalism. In terms of Interface Criticism, *Interfight* is described by Søren Pold and Christian Andersen as:

> "an interface added to the tablet's interface in a kind of closed cybernetic feedback loop. The apparent natural and indivisible touch interface that is revealed as a technical artifice that depends on signs and acquired gestures, and its capturing of behavioral data is demonstrated as a simple technique. Attaching an artistic interface to the interface and turning it into a closed cybernetic loop illustrates the artificiality of both the interaction and data captures that takes places on the Internet and in the metainterface". [8]

Also operating through the lens of Interface Criticism, the doctoral researcher at Interface Cultures and actual post-docs at Tangible Music Lab, Enrique Tomás analysed *Interfight* from two perspectives, as the functional / dysfunctional extension of a tangible interface and the utilization of media realism. Tomás argued that:

> "Interfight proposes a dysfunctional extension of a tangible interface for studying the actual interaction paradigms implemented in tablets and smartphones, and a critical re-orientation of the standard way we access information using touch-screens...] [...Interfight deals with both functional and media realism. Functional realism because it rearranges the original elements of touchscreens into aesthetic components (e.g., desktop). The utilization of media realism is clear, as the artwork shows us the hidden mechanisms which commercial websites use for tracking our human activity". [9]

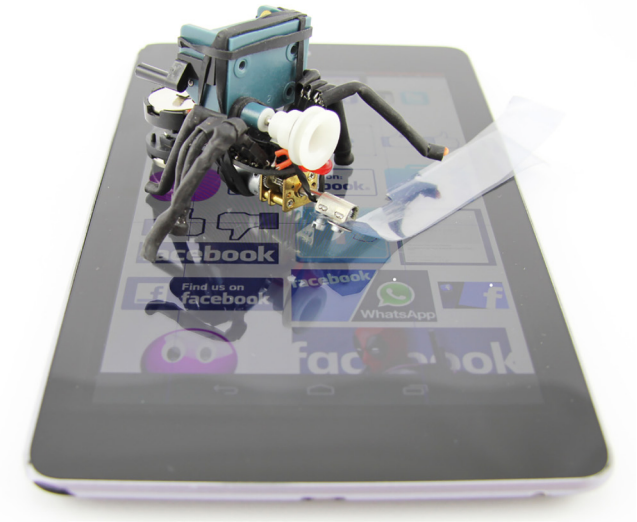

Figure 6. *Interfight,* 2015. © César Escudero Andaluz.

Created at the same time, the project *Tender- It's how people meat*. [23] (2015) by Matei Szabo, Cors Brinkman, Marcello Gómez Maureira and Jeroen van Oorschot is a piece of pork attached to an electrical motor that swipes every picture of a potential date to the right.

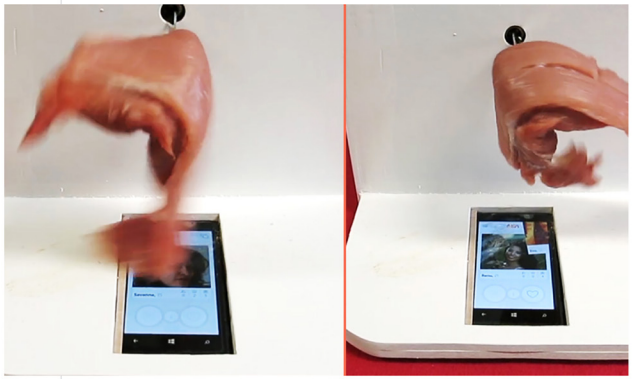

Figure 7. *Tender- It´s how people meat,* 2015. © Matei Szabo, Cors Brinkman, Marcello Gómez Maureira and Jeroen van Oorschot.

These three examples are autonomous interfaces acting as parasites on the top of another interfaces. As there is no programming code joining them to the capture device, they behave as human beings, breaking the barrie between interconnected technologies. They are undetectable and produce "noise", confusing data collection and making the data less valuable.

Digging deeper into this discourse, the art project *FANGO*, *Facebook Amazon Netflix Google Obfuscator* [24] developed by Martín Nadal in 2019 consists of a microcontroller embedded into a phone charger, programmed to behave as a random bot able to take the control of a smartphone when the user loads it. Nadal states that the aim of the project is to add noise to the capture of data, making it difficult to make predictions and devaluing the effect of the extracted data. *FANGO* is an example of camouflage technology, hiding a second functionality behind the telephone while it is loading.

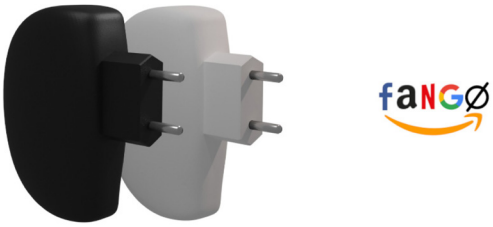

Figure 8. *FANGO,* 2019. © Martín Nadal.

Wearables, IoT and Biometrics

Beyond laptops, tablets and smartphones, the proliferation of electronics and Internet have fed the market with a wide variety of products capable of collecting information tha increases continuous measuring activities. Smart devices such as Wearables, IoTs, drones, e-transports and game consoles are all provided with sensors able to measure the position, motion, environment and living organisms through thermometers, barometers, fingerprint sensors, GPSs and microphones, extracting data from irises, heart rhythms, brain activity, voices and face.

This unique information form a particular individual is mainly used for control and security, for example at national borders, airports, suburbs, shopping malls and schools.

Behind the scenes, governments, surveillance companies and the military collect and classify the data provided by apps, IoT, wearable devices and CCTV systems. The success of biometrics tracking resides in the rapid measurement and identification of the human targets.

The IoT is based on a standard protocol that connects uniquely addressable everyday objects and devices with other objects, other people and all kinds of networks, interconnecting the physical and the virtual world. IoT devices can be individually tracked by a Radio Frequency Identification (RFID) that can be automatically and remotely identify by a RFID reader. The RFID transponder can store information such as fingerprints and photos. The IoTs can be powered by other wireless technologies such as GSM, UMTS, LTE, Wi-Fi, Bluetooth and NFC, and incorporate the entire spectrum of sensors. A fact that makes the IoT an important element in Ubiquitous Computing and the invisible digital world.

IoTs technologies are usually combined with apps and devices that monitor activities, bodies, and the health of humans. Fields such as fitness and wearables have established a continuous measuring of daily life routines, from pulse rates, the number of steps taking, sleep duration and quality, sport activities, weight loss and eating habits. Devices connected to platforms such as Facebook, Twitter, Instagram allow the sharing of this information with user's online communities.

An early attempt to visualise these issues is *The Jason Shoe Experiment* [26] (2012) by Jaak Kaevats and Onur Sönmez. An artistic installation combining the Ipod's oscilloscope sensor and the fitness app Nike+. The artist duo managed to simulate patterns of human running by fixing the iPod to a handle powered by a servo-motor. In the authors words: "The reality is unconvincing without measured and published evidence. No-one is questioning the accuracy of the alternate reality as long as the objective quality of the measurement is guaranteed by a commonly accepted value system."

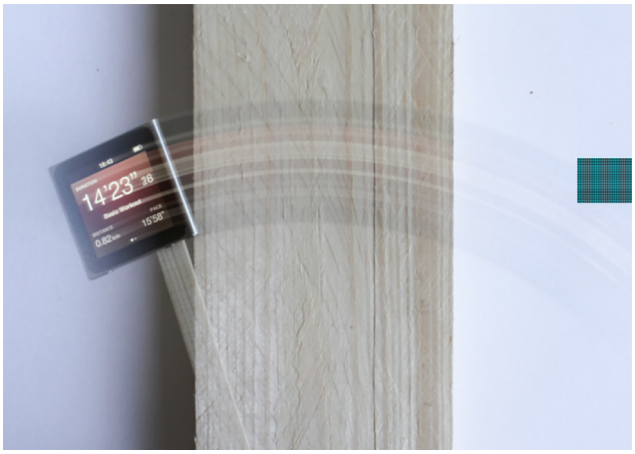

Figure 9. *The Jason Shoe Experiment,* 2012. © Jaak Kaevats and Onur Sönmez.

Such practices combine aesthetics, paradox and humour and can be understood as deliberate acts that create ambiguity, confusion through false information in order to interfere with surveillance and data collection.

Voice recognition

In computer science, voice recognition is the ability of a machine or program to interpret spoken commands. The first voice recognition product for consumers, DragonDictate was launched in 1990 by Dragon. In 1996, IBM introduced the first voice recognition product that could recognise continuous speech. In 2000 Google launched its Voice Search app for the iPhone. In 2003 Apple introduced Siri a voice recognition assistant. Subsequently, Amazon's Alexa and Microsoft's Cortana appeared. With the last advances in AI, voice recognition has extended its possibilities, making it able to recognise sound patterns and the rhythm of an individual's voice [7].

As an attempt to interfere with voice reading and surveillance ecosystem, Bjørn Karmannand and Tore Knudsen developed *Alias,* [25] a technological appendage that is placed on the top of the home assistant. *Alias* is formed by a Raspberry Pi and programmed in Python, Tensorflow, Keras, Flask, Javascript, HTML and CSS. As a parasite, *Alias* interferes whit the microphone and takes control of the assistant.

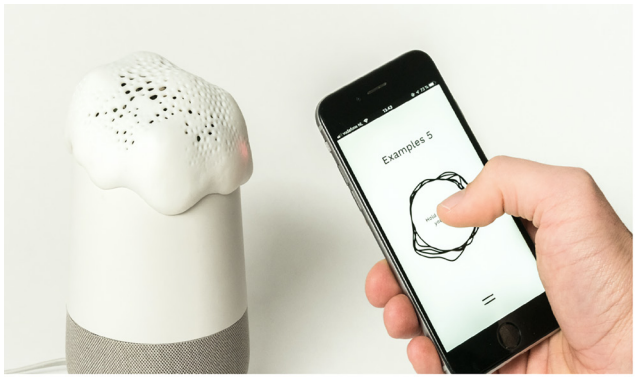

Figure 10. *Alias, 2018,* © Bjørn KarmannTore Knudsen.

Alias is an example of electronic prosthesis able to behave as a parasite in a perfect symbiosis. It uses a method that blend into the innocuous data to avoid or scape scrutiny. It is an example of how little efforts can generate extraneous data work against well-funded companies like Amazon, Apple, Google, and the National Security Agency.

Facial recognition Vs Masks, the art of disappearing

Facial recognition is a technology capable of identifying and verifying a person from digital images. The process consist of extracting patterns based on the person's facial textures and shape, comparing with other faces and store them on databases.

Through executing these technologies Shoshana Zuboff suggests that people are reduced to a mere animal condition, bent to serve the new laws of capital imposed on all behavior through an implacable feed of ubiquitous fact-based real-time recording of all things and creatures. [2]

In addition, these technologies easily result in discriminatory automated decisions based on digital profiles about consumers, individuals and vulnerable population groups. From this perspective, Zack Blas's project *Face cages*, [27] (2013/2016) insists on the lack of precision of these systems. The artist assumes that biometric machines often fail to recognize people of non-normative, minorities, which makes such people vulnerable to discrimination, violence, and criminalization. *Face cages* proposes a layer between the tracking system and the human body, a mask, that according to the artist is based on the medieval period and slavery in the United States.

An earlier work by Zack Blas, the *Facial Weaponization Suite,* (2012) proposed a workshop to create masks in protests against biometric facial recognition– and the inequalities these technologies propagate.

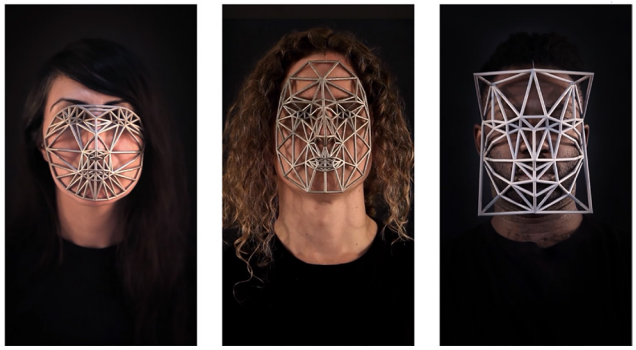

Figure 11. *Face cages,* 2013-2016. © Zack Blas.

In similar vein, *Stealth Wear Anti-Drone Fashion* [28] by Adam Harvey 2012 reimagines the context of drone warfare as garments that provide a separation between man and drone. The clothes are fabricated with silver-plated fabric that reflect thermal radiation, enabling the wearer to Avoid detection from overhead thermal surveillance.

Figure 12. *Stealth Wear Anti-Drone Fashion,* 2012. © Adam Harvey.

These examples show methods for disappearance, for time-wasting and analysis frustration, for prankish disobedience, for collective protest and acts of individual redress.

They are specially effective when the adversary is not familiar with the details of how they work.

The concept of masks in relation to facial recognition hacking is a very prolific area. Artists such as Sanne Weekers, Martin Backes, Isso Echizen, Cha Hyun Seok, Leo Selvaggio or Ewa Nowak Heather Dewey-Hagborg, Sterling Crispin, Hito Steyerl, Peter Campus, Alexei Shulgin, have all satisfactorily developed devices. In the context of the Hong Hong protests, the project *Wearable Face Protector* by the artist Jing-cai Liu opens a question about who has access to the Mega databanks and high-resolution cameras that process hundreds of exabytes per year. In this field it is also worth highlighting the filters for Instagram by artist Matthias Schäfer, which are designed to create anonymity on social networks.

Methodology

This paper has established a critical methodology around three fields: a) the art of unmasking technology; b) the artistic tactics of resistance based on various interfaces; c) the new models of algorithmic governance, condensed into these activities:

Description It takes part in three dimensions; a) the description of the technological problem b) the description of the technology able to counteract this problem; c) the description of the strategy able to counteract this problem.

Classification of tracking devices and artistic tactics of resistance and devices is based on interfaces culture.

Context-providing contextualising artistic practices in Surveillance Capitalism, more specifically Ubiquitous Surveillance through providing an understanding of IoT technologies embedded in wearables, fitness trackers and mobile interfaces, fields closely linked to Algorithm Governance and Tactical Media.

Elucidation motivated by a theoretical and practical reevaluation of how artists deal with interfaces. Instead of seeing individuals merely as passive consumers, they are participants in a tactical appropriation of interfaces.

Interpretation This action is the result of the previous (description, classification, context-providing and elucidation), in combination with the art-based method of analysing and evaluating the results alongside the relationship between aesthetic forms (rhetoric, materials, medium) and aesthetic experiences (insight, interpretation, emotional responses and discovery of truth).

NEXT STEP: Data Processing, practices, platforms and services.

The objective of data processing is to be precise doing automated decisions that measure information on targeted variables in an established system. Order the banner of "intelligence marketing" Online Data Management Platforms (DMP) and analytic industries process, associate identities to descriptive data that can be applied to marketing use cases. These commercial digital profiles and data-driven algorithmic decisions affect equality, freedom, autonomy, democracy, and human dignity on both individual and societal levels.

At this point, I launch a question for future research: How can art practices visualise underlying problems related to the processing of data and algorithmic digital tracking?

Conclusions

The extraction and monetization of private data is a reality that directly affects all citizens of the world. In this business model, based on the capture, processing and prediction of human behavior: devices, technologies, platforms, governments and dominant companies are interconnected to assess, qualify, control and manipulate groups of people.

Opposing this, hacker communities, Cypherpunks, political activists and Tactical Media movements aim to present a vision that clarifies technological differences and control mechanisms. In the internet and in everyday life, citizens need privacy, space for self-expression, access to information, learning, spaces for social life and communication. As users we are aware of the social, political and economical impact of the last generation of technological practices known as Big Data. Users need mechanisms to transform and benefit from these technologies.

Consequently, artists can reclaim the use of other strategies such as obfuscation, camouflage, confusion, appropriations, hacking, disruption, bots, noise, random data, parasitism, masks, humour, paranoia, metaphors and paradox. These counter-strategies and forms of resistance sometimes consist of simple individual actions such as blocking, covering, isolating or disrupting signals, in order to generate a false readings that confuses the mechanisms of data capture, data identifiers, keyword detections, keystroke dynamics, mouse tracking technologies, human biometric collection, voice and facial recognition software, monitoring activities and measures, patterns extraction and automated decisions.

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Qualia Formation through Sensory Substitution in Artistic Laboratories in Russia

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Abstract

The paper is concerned with the complexities of interrelations between human sensory modalities and the role of artistic experimentation in triggering new forms of perceptual organization. The research field of sensory substitution, starting from the neuroscientific investigations by Bach-Y-Rita in the 1970s, has provided many insights into how certain brain functions can compensate for the others, thus demonstrating the brain capabilities for plasticity. Although trackable through brain-scanning and neuroimaging technologies, the emerging effects, such as vision-like qualia, remain subjective and can be communicated primarily only through analogies. One productive way to explore the dialectics between the subjective and possible objective knowledge is a comparative analysis of neurocomputational models and experiences designed in artistic projects. How can a model – be it computational or experiential – guide us into what happens at the level of the neuronal structures? In what follows, we consider some methods of testing the 'sentience' of the brain and making the inner changes 'feelable' explored through artistic means in a series of interdisciplinary laboratories and exhibitions in Moscow in 2013-2019.

Keywords

Sensory substitution, haptic media, inclusivity, qualia, plasticity, artistic research, media art in Russia

As the discourse of inclusivity started slowly entering the social and cultural spheres, it is important to distinguish its value also for the media aesthetics. Sensorial disability, although it causes practical inconvenience and often leads to social isolation, is interesting epistemologically and in terms of neurobiological adaptive processes: for instance, development of more acute hearing or haptic abilities to compensate for lost vision. The tools designed for people with disability work differently for 'normally abled'. As scientific experiments show, the functional capacities redirect themselves (for instance, in the late blind interpretation of haptic sensations during Braille code reading happens already in the visual cortical regions, as opposed to those responsible for processing sensory-motor information, Cohen et al. 1997). Yet, as is the point with the issue of difference in application to other marginalized social groups, something is to be learned from the experiences of the 'other'. Although the plasticity does not work with the same intensity for sighted people as, for instance, for people with acquired blindness, it does point at peculiar sensory capacities (Macpherson, 2018). In their subjective nature, they can be compared to what in philosophy is often named qualia, a sensational quality that is not connected to the characteristics of the object, but rather emerges within the experiencing subject as 'perceived sensations'. Among the critical questions then are: How exactly do these sensorial changes register in our consciousness, i.e. how do we become aware of them? More importantly, how to make sense of them, and to communicate the potential meanings of these sensations? (Fedorova, 2019)

Among investigations of compensatory abilities of the brain the Tactile Vision Substitution Systems (TVSS) by the American neuroscientist Paul Bach-Y-Rita stand out both due to their considerable success and historical variations. The first version of the TVSS was a static assemblage, consisting of a dental chair and a camera, where the images from the camera were transmitted in a form of vibratory or electric signals to the back of a person with vision deficiency. According to Bach-Y-Rita's report, after some training a number of blind participants were able to "discover visual concepts such as perspective, shadows, shape distortion as a function of viewpoint, and apparent change in size as a function of distance" (Bach-y-Rita *et al*. 1969: 963–964). His later innovation, BrainPort, developed in the 1990s famously allowed to generate image-like sensations by stimulating receptors of the tongue, while a wearable camera, attached to special glasses would allow bodily mobility. Today there exists a plethora of adaptive devices designed for people with sensory disabilities that similarly rely on the principles of neuroplasticity, but that are also developed through the use of machine learning that engage neuronal networks. There are sensors that analyze different parameters of the environment, including characteristics of faces and speech of the interlocutors. How to estimate the benefits and the risks of being misinformed in case of such adaptive devices is still an open question. As Mark Paterson justly observes, often media technologies that claim to be helpful for the disabled population while providing help may simultaneously put them in situation of further dependency (Paterson, 2017).

Hence, the more critical becomes the study of the motivations behind the various approaches to inclusivity and specific models of using digital technology for sensory adaptation. Generally speaking, the main function of a

model is to demonstrate a potential or possible course of events. As Swiss philosopher Vera Bühlmann puts it in her analysis of the ontological aspects of modeling, models serve as "creative management of the frame of reference within which 'something' takes up its specific meaning" (Bühlman, 2008: 41) This approach thus highlights the reception component, or the individual context in which a model acquires a meaning. Computational models, dominant in today's cognitive and neuro- sciences, are designed in a lot of cases to make dynamic cross-modal predictions. They use precise mathematical calculations for simulating how active neural matter may be processing different aspects of cognition, including interpretation of sensory information (Gepshtein, 2014). Although it is a rapidly growing field, the real life situations and responses of the body-mind, including sensorial re-organization, remain more complex and predictable only to a degree. The common critique (e.g. within critical neuroscience) is also that such models are based on certain hypotheses and predispositions that do not give justice to the wider range of the 'creativity' of nature itself.

Another critical issue is translation of the research results to practice, and here is exactly where artistic vision can be of special value. The idea that plasticity can be predicted (to a degree) corresponds directly to the fact that our senses and our interfacing with reality, including with technology, is culturally coded: for instance, we learn to expect a certain behavior in our interactions with touch screens (Litman-Cleper, 2016). One of the roles of art can be to try to break this logic, to stretch the assumptions about the behavior of the real world, thus encouraging to be more attentive to our perceptional capabilities. The fact that the brain can rewire its connections opens up a plethora of new potential meanings. Yet, these meanings are qualia-based and may evade the usual rules of semantics and translation, generating instead their own objects of denotation.

Why are artists interested in sensory substitution technologies, why are they looking for ways to express themselves in a new language, of touch or aroma, translating video into sound, sound into video, video into vibration, and so forth? Interfaces with multisensorial engagement give artists an opportunity to create shifts in habitual types of perception and, with that, to produce new artistic messages – increasingly tactile, flavored, associated with neural signals, personally encoded and coming to us through various sensory channels. One of the most intriguing questions that motivates the artists is the creation of new phenomena in the zones in between the known sensory modalities. Media art has always been particularly keen on experimenting with forms of communication and perception. If not synesthesia and sensory substitution per se, ideas of extending or augmenting human sensory and other abilities through audiovisual, robotic, telecommunication, and other technologies have been at the core of the technological arts. The capabilities of electronics and digital code allow for translation between different forms of analog signals and thus for establishing real-time correspondences between diverse kinds of input and output (sound, visual image, movement, smell, etc.). Sonification of data, remote control of body movement (like in Stelarc's *Ping Body*), augmented vision, neurointerfaces for manipulation of objects by brainwaves, interactive scenarios involving hapticality and a sense of immersion constitute some of the basic vocabulary of this branch of art. How to treat what escapes direct translation? How to mobilize the brain's capacity to create new meanings? Unlike practical applications, which pursue precision (e.g. adaptive devices for people with disabilities), artistic approach invites more ambiguity and gives room for intuitive and subjective interpretations.

In Russia, interests in expanding our understanding of sensory perception and the search for alternative forms of language and communication goes back to the avant-garde innovations of the 1910-20s, namely, to fascination of the futurist artists and poets such as Kazimir Malevich, Mikhail Matyushin, and Alexey Kruchyonykh with the qualities of pure color, light, geometrical shapes, acoustic qualities and material textures. In the 1970-90s, artist, inventor and philosopher Bulat Galeev, the founder of the "Prometheus" Institute in Kazan, conducted extensive research on synesthesia ("colored" and spatial perception of sound) experimenting with analog devices and observing closely their aesthetic and psychological effects. Deciphering and subverting the language of the late Soviet "official" culture in conceptual art mobilized attention to junctions between the visible and the invisible, including renewed interest in the physical qualities of space and in the laws of optics and vision, fluctuating between objective and subjective parameters (e.g. in kinetic art group "Dvizhenie" / "Movement"). Since the 2000s, the heritage of the avant-garde and nonconformist art, as well as a special type of poetics emerging at the intersection of word, image, sound, space, and movement have been explored in exhibitions curated by such diverse figures as Vitaly Patzyukov ("Seeing Sound" 2015, "What We Hear, What Looks at Us" 2010, etc.), Olga Shishko ("The Immersions. Towards the Tactile Cinema" 2016), or Katya Bochavar ("Smells, Sounds, Factories" 2018), to name a few. These interests coincide with establishment by some leading Russian art museums (e.g. Garage Museum of Contemporary Art, Pushkin Museum of Fine Arts) special inclusivity programs that not only serve people with disabilities, but also demonstrate the potential of art to raise awareness of the broader publics about diversity in perceptional development.[1]

Among the projects on the issues of sensory translation are a series of art&science laboratories and festivals conducted in Moscow in 2013-2019 by Elena Demidova. The central themes of her artistic and curatorial investigations are the possibility of a "meta-" language of communication, losses and distortions during coding and

decoding, artificial languages and the role of electronic media and programming languages in information transmission, as well as the status of art in the context of inclusivity. In multidisciplinary festival platforms like "Moscow Laboratory of Media Poetry" (2013-2017), "Transcription of Noise" (2015-206) and "The Body of Text" (2015-2018) that included exhibitions, performances, discussions and workshops, she and her collaborators ask: If language as a phenomenon of social agreement implies brackets, and something significant for mutual understanding is destined to stay beyond them, how can we reclaim these lost meanings? The solution they propose is activating the mechanisms of sensory substitution by using a mixture of communicational channels. Perhaps, then, the world can open up in its vibrant multifariousness and human exchange would be enriched with more subtle dimensions.

Dissatisfaction with existing types of language is not new for art – moreover, it is one of the major driving forces for artistic development. Yet, what allows the examples below to stand out is their emphasis on what makes language at all possible – on the very capacity to perceive and decipher signals encoded via a certain medium, be it sound waves, writing, hand gestures or embossments of Braille code on a palpable surface. In what follows we discuss individual projects that deal with the challenges of translation between verbal, visual, haptic and auditory information. The 'ideal' communication may remain only a utopian horizon, but as these pieces show, it is possible at least to shift the habitual, culturally engrained ways of perception and give room to the qualitatively new experiences of perception and communication per se. Unexpected combinations of the types of code, medium and message lead to a temporary formation in the brain of an experiencing subject of new qualia, subjective feelings of the new (however elusive) objects of reality.

As practice shows, many of the authors participating in the above mentioned exhibitions and festival programs did not think about the scientific background in the beginning. Often it was like a game, a vision. For instance, an artist felt excited to translate a verbal poem into a tactile message, and later realized that this was consistent with her study of language and that this game led into a peculiar realm of her very private selfhood, which yet was also part of the larger whole and larger processes. The resulting project by Ekaterina Isaeva (Moscow Laboratory of Media Poetry 2013-2014), an inter-semiotic translation of the poem "Visions of the Past" by Valery Bryusov is a tactile palindrome in which the author invites the visitors to read the poem with their hands. The lines of the poem are sequentially translated into tactile sensations that can be experienced by touching the contents of several flasks filled with grass, earth, tree bark, moss and sand (Figure 1). Isaeva wanted to get away from verbalism and linguistic meanings to approach meanings of a different level – sensual and tactile memory. And if poetry is a capacious concentrated utterance, then tactile sensations are "something very poetic". According to her, "a good translation is a correct translation of meanings. And since poetry is not about precise meanings, but about metaphors, that is, about figurative meanings, there is already an act of co-creation, poetic translation and search in the transfer from verbal to non-verbal."

Figure 1. Ekaterina Isaeva, *Tactile Palindrome* (Moscow Laboratory of Media Poetry, 2013-2014). Courtesy of Elena Demidova.

Here, not only the form and content of the work itself is interesting, but also the way it is perceived, the method of reading it. In the first case, we, as spectators, can read the palindrome and correlate our sensations from touching the textures used by the artist. In the second case, we can first touch the tactile textures and later compare our own associations with those proposed by the author. However, the third option is especially interesting: the process can be simultaneous. By reading the lines and touching the 'semantically contradictory' textures, at some point we can get of a new type of 'normalcy', a new meaning/sense emerging directly from the interconnections within our neural 'library'. For example, we expect the word "wet" and the feeling "wet" to be interrelated, and it is exactly this expectation that suddenly collapses. The name of a phenomenon or an object, its sensation, possible visual or olfactory associations – all of this is 'soldered' together at the level of the neural connections. In the event of a discrepancy between the object's name and its perception, cognitive dissonance may occur, as if you were to feel the dry bark of a tree accompanied by the word "wet". This dissonance causes a feeling of contradiction or distrust of one's own perception. The clash of concepts existing in the participant's world and proposed by the artist can be compared to a kind of intellectual sparring, when either the old or the new way of thinking wins and the whole conception of the world is subject to correction. The

physical involvement of the visitor is key to understanding the work in which s/he receives not only sensory and intellectual experience, but a kind of volumetric feeling – multisensory perception.

Another point in the study of tactile messages is illustrated by the work of Max Kalmykov *Acupuncture by Sound* (part of the interdisciplinary laboratory "Transcription of Noise", State Darwin Museum, 2014 – 2015), in which the artist associated the sound signal with a tactile response (Figure 2). The artist was interested in the nuances of interpretation in the seemingly impersonal algorithmic translation of a signal from one representation system to another. Experimenting with programming and the effect of mechanical recoil, he created a device that is a box the size of a human palm. Tiny holes are visible on the cover of the device. When the device is on and running, small blunt needles come up from the holes. The needles come out quickly following the sound of the tracks. Based on the pitch, the artist sonified the intensity of the movement of the needles, so it was made possible to feel the sound by touching the surface of the box and feeling the light touch of the needles. It is important to note that after the track was played, the sensation of the needles' touch remained for a long time in the palm – 5-10 minutes could pass, but the tactile memory still caused tingling sensations in the palm, with the same intensity at which the track was ended.

Figure 2. Max Kalmykov, *Sound Acupuncture*, Tactile kinetic tool (Transcription of Noise, State Darwin Museum, 2014 - 2015). Photo by Anastasya Blur. Courtesy of Elena Demidova.

This all adds up to the fact that it is impossible to simply translate verbal information into tactile information. This language has its own laws, its own time limitations. Scientists characterize this as a problem of "the difference of throughput data capability between sensory modalities (bandwidth), and the compatibility with higher-nature cognitive processes" (Real Valdés, Araujo 2019, 12). To be interpreted rightly, the information needs to be filtered, and how exactly synesthesia and neuroplasticity function and how they can be modeled algorithmically is still to be discovered further.

A series of art&science workshops "Tactile Communicator" at the Moscow Polytechnic University (2017 – 2019) led by Elena Demidova and Ilya Volnov offered further insights. The participants explored the possibility of tactile communication, fantasized about what our interaction could be like if suddenly tactile communication was to be regarded as an equal way of exchanging information, on a par with verbal messages. How would we then perceive the slightest nuances of touch? Perhaps different shades of tactile messages would appear, the so-called tactile intonation. Besides, for remote transmission of such signals, we might need a mobile device able to transmit the tactile signal. The students began by creating a haptic communicator prototype for two-way interaction. The communicator consisted of two devices which also had a touch panel and pull-out segments for tactile response (Figure 3). These segments responded to touch, rising according to its degree and duration (on the left panel there were 7 touch sensors, and on the right panel there were 7 pull-out segments). This way, two people could communicate and they could both receive and send their tactile messages. For this purpose, one person had to put their hand on the touch panel, and the other one accept the message on their device by putting their palm on the pull-out segments. The students were able to organize remote communication – a tactile signal could be transmitted via Bluetooth to a device in another room, or through a cloud server to anywhere in the world. The next step could be to make a panel with segments of smaller diameter, to use tactile material which is pleasant to the touch and to increase the touch and segment panels from 7 to a larger number. As a result, we would be able to get a more accurate tactile signal and transmit tactile messages more subtly. At the same time, the size of the device itself would have to be much smaller, so that it would be fit for portable use.

Figure 3. *Tactile Communicator*, Art & Science Laboratory. Moscow Polytechnic University (2017-2019) Courtesy of Elena Demidova.

Another group of students created a tactile art object using this approach (Figure 4). It was based on an enlarged six-digit Braille font used in the way that a person could read the letters not with their fingertips, but with the palm of the hand. In this six-point system, it was possible to read by touch all Braille letters, since each was formed due to the new configuration of the retractable hemispheres. The students entered the phrase "Do not touch!" into the program, deliberately raising the issue of boundaries that divide the world of the blind and the sighted. A person who is not familiar with Braille will not understand anything in this message. However, a person who is familiar with it will receive a negative response to his touch, which is embedded in the tactile art object itself. In addition, the community of the blind, accustomed to reading the tiny letters of the Braille with their fingers, will not immediately be able to navigate and read it with the palm of their hand.

Figure 4. *Don't touch!* Tactile kinetic bas-relief, "Science-Art Laboratory", Moscow Polytechnic University (2018). Courtesy of Elena Demidova.

Another set of experiments was conducted in the performative field. For several years, work was being carried out with groups in the performance laboratory ("Body of Text", National Center for Contemporary Art, 2013-2018) and the syllabus included a day dedicated to tactile perception. Seeing with our eyes was not relevant on that day, as the focus was fully on touch. These exercises were accompanied by applying touch to feel various objects and people for several hours. For 3-4 hours, people were rediscovering the world, only the world was tactile. Almost each of the participants admitted that they were able to put together a tactile map of the space around them. Thus, neural networks were building connections between tactile images of objects and their visual images. After some time, this small performance space became recognizable and safe.

What happens, then, if the coded messages refer to acoustic perception and yet are sensed in a different way, for instance, once again through touch? One may think of a well-known phenomenon of bone conduction – when audio signals are sent through the skull bone directly to the inner ear. This principle is used for hearing aid, as well as in more popular bone-conduction headphones for transmitting music to cheekbones instead of ears. Yet, touch is not the same. The vibrations picked up by fingers are not connected to the auditory cortex and are processed rather in the parietal lobe.

Figure 5. Oleg Makarov, *Tactile Micro Dance Floor*. Algorithmic vibration and sound object, 2015. Courtesy of the artist.

The Tactile Micro Dance Floor (2015) by sound artist Oleg Makarov inquires into the reaction to sound transmitted through touch. The work is a panel with low-power vibrating emitters run by a microcomputer, which generates rhythmical musical compositions – the sequences of specially selected frequencies (Figure 5). Ten senders are placed in such a manner that one can touch them at once with the fingers on both hands. Thanks to this technology, the music can be perceived in three ways – through touch (putting fingers to emitters), visually (by observing the movement of membranes) and acoustically. Every person can select his or her own way – most accessible and convenient, while each type of perception gives the full understanding of this work of art. This object, created by a sound artist and a composer, allows to experience the volumetric dimension of touch. This is a new experience for a human, especially for a hearing-impaired or deaf-blind. The vibration signal should be perceived by all fingers at once, and the brain then organizes this distributed information into a polyphonic whole. A hearing person, with his dispersed attention, perceives this vibration most likely as a general noise, whereas a hearing-impaired one can distinguish the semitones and a deaf-blind senses the deep nuances and connects the tactile sensations with sound. In its functionality *The Tactile Micro Dance Floor* reminds sound-recording on a phonograph cylinder. A sound wave in general is a very haptic and material substance, and the listeners of Makarov's compositions often report on the embodied, almost tactile character of their experiences: as

if they would see/feel the moving matter of sound during the concert.

Whereas Makarov's instrument is designed for an alternative, non-auditory perception of sound and music, our next and last example is about translation in another direction: not from sound, but into sound, with the score being semi-abstract imagery.

Sensory substitution and the discourse of inclusivity becomes a new context for both practical and artistic applications of technologies translating visual images into sound. Experiments in this field in Russia were famously conducted already by Alexander Scriabin, then in the 1930s by engineer and inventor Evgeny Sholpo, composer Arseny Avraamov, and their colleagues cinematographers interested in production of synthesized sound effects through "drawn sound." In the 1970s, these ideas were revived by Evgeny Murzin in his photoelectronic optical synthesizer ANS. In the 1990s, programmer Peter Meyer developed an algorithm translating black & white image into sound. This became the basis for a sensory substitution device produced by a Moscow-based technological startup vOICe vision, audio goggles that enable the blind to orient in the visual field and to identify objects way before they can be touched with a cane. After two months of training, they learn to "see" the world in an alternative way, through the stream of sounds. The experiments of vOICe vision can be compared to the ones by a famous Canadian inventor Steve Mann, namely to his augmented reality goggles that allow to see an image from the back, or to see literally from the perspective of another person (who would wear similar glasses). The developers at vOICe vision analogously suggest to use other types of camera and its placement, e.g. infrared or a camera of spherical vision, which would generate effects and qualia comparable to those appearing during sensory substitution.

In parallel to vOICe vision and inspired by her own interpretation of Murzin's technology of optical sound, a young artist Maria Molokova created a work *Optical Hearing* (2019). She immerses the visitor into a space "that sounds", a darkened room with abstract drawings on the walls that work as "sound murals" (Figure 6). To hear them, the visitor should wear an "optical prosthesis," a device based on Murzin's technology that captures the visual signals from the web-camera and converts them into sound. The program scans the image as a sonogram, identifying brightness level and location of each pixel. The volume is dependent on brightness, so that the darkest spot turns into silence and the lightest one into a loud sound. The pitch is determined by the location on the vertical line. A sighted person can see the inscription, but one can "read" the code only with the device. The work contains a learning phase: the visitor is first proposed to study the "alphabet." Then a guide helps to create one's own sound route. Sensory substitution here transforms the organism, adapting it to the non-habitual circumstances. The adaptive processes and neuroplasticity do their job and already in several minutes a person starts to navigate this space, first through the big "sound spots," and then gradually identifying more and more nuanced messages.

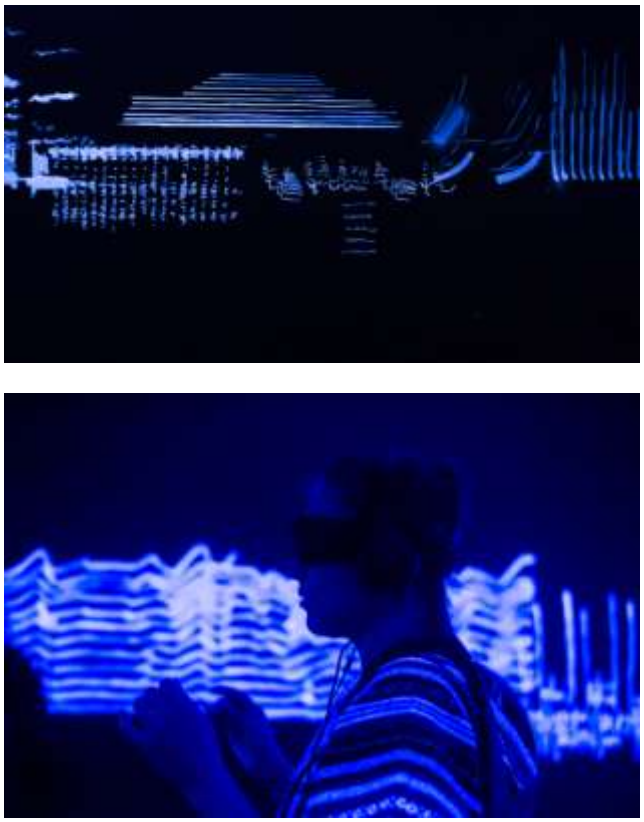

Figure 6. Maria Molokova, *Optical Hearing*, 2019. Courtesy of the artist.

These experiences – where hearing or seeing is substituted with touch or in other ways – may feel as plunging into the worlds of people with vision or hearing impairments, which can lead to several conclusions. Firstly, the abilities to orient in the world, for instance, only haptically are incredibly sharpened by practice, especially in the beginning (as proven by the experiments by Bach-Y-Rita and other neurophysiologists, mentioned above). This suggests that it is possible that our experience in tactile practices and reflection on their aesthetic complexity is to date relatively limited, and there is a lot to be learnt and improved. What makes this type of perception especially intricate and hard to study through purely scientific and computational means is that we perceive tactile messages with our whole bodies. Impulses from touching objects with a fingertip get scattered all over the body and cause other kinesthetic effects: cold, warmth, goosebumps or pain, which in turn instantly cause feelings of fear or a pleasant feeling of warmth and intimacy. There is a potential that the abilities of touch and haptic sensation more generally will become finer and more detailed with both knowledge and practice that people collectively

accumulate. Furthermore, as Mark Paterson notes, there is room for exploring and conceptualizing what could be called a "haptic imaginary" (building upon the term "sonic imaginary" suggested by Jonathan Sterne), an amalgam of the subtle qualia based on haptic sensations.

Development of haptic or any other sensory ability involves reproducibility of experiences. Common between Braille code and the algorithms behind optical sound synthesizers or haptic instruments, like those by Makarov and Kalmykov, is the presence of certain denotational rules ("this stands for that"). The more precise they are – the more they function like a language, with individual elements forming syntagms, the units of meaning. Imagined by artists, these codes may be potentially endless. They are self-contained and cannot be used for communication with others in the same ways languages are normally used. Rather, their value lies in expanding the perceptual apparatus and with that, the capacity to receive "hidden" messages, however abstract, multiciphered and paradoxical they may be.

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1. It must be noted that physical and mental disability had a special place in Soviet pedagogical and psychophysiological research. Successful adaptation through learning was meant to demonstrate the effects of social habitat over innate abilities and thus prove one of the core points of dialectical materialism about the effects of practice and labor. A widely analyzed show-case from the 1970s is the so called Zagorsk experiment of educating deaf-blind adolescents (Suvorov 2016).

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Authors Biographies

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Elena Demidova is an artist and curator of the research platform on multisensory communication Mediabodymedia, as well as curator and tutor of laboratories and art & science schools at the Moscow Polytechnic University. The focus of her work is relations between word and body, the verbal and the non-verbal, multisensory communication, and inclusion. Her curatorial projects include Digital literature program at the Moscow Festival of Media Poetry and the Laboratory of Media Poetry (Moscow Museum of Modern Art and Open Stage project, 2013-2017), "Transcription of Noise" (6th Moscow International Biennale of Contemporary Art, 2015-2016), and creative and research laboratories "The Body of Text" (National Center for Contemporary Art, MMoMA, Garage Center for Contemporary Art, 2015-2018).

On places, spaces and objects of interdisciplinary scholarship: The case of Useful Fictions

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Abstract

In the contemporary institutions of knowledge, different disciplines are associated with specific spaces, objects and instruments. This article rethinks the spaces of academia and the material conditions in which and with which knowledge is generated. Based on a weeklong practice-based workshop and symposium titled Useful Fictions, I argue that the relational effects of objects, instruments and spaces are the mesh for interdisciplinary collaboration, and essential to bridging disciplinary divides. Therefore, spatial and material conditions of research must remain central to the processes of planning and developing interdisciplinary research and creation. I draw four considerations to more efficiently prepare teams for collaborative research across arts and sciences: Understand the institutional context where collaborations take place, and participants' familiarity and perceptions of the environment including the objects and instruments at hand; Define the scope and scale of the project in accordance with the range of expertise of collaborators; Reset participants' disciplinary lenses; Privilege reflective practice and dissemination methods that are anchored in the objects used and produced.

Keywords

Material conditions; Relational spaces; Collaboration; Interdisciplinary research-creation; Systemic conditions of research.

Introduction

Although it has been suggested that the biggest fallacy of academic knowledge production is its fixity in intellectual work and language, discursive methods continue to be privileged for academic exchange and circulation of knowledge.[1] The 20th-century intellectual currents of structuralism, postructuralism, phenomenology and hermeneutics generally favoured the view that the entities of the physical world primarily existed as envelopes of meaning, acquiring their social presence as a result of processes of linguistic coding and discursive interpretation. The general outcome was that sociological theories of institutional order adopted an idealist character from which the dimension of material culture and sensitive knowledge gradually disappeared. [2]

In academia, as in many other professional contexts and cultures, command of language confers authority. When, in academia, experts are faced with an audience that is newly arrived into the theory and discursive practices of their discipline, resorting to specialized discourse risks alienating those that are not yet fluent in the disciplinary language, however interested in the subject they may be. For these reasons, interdisciplinary gatherings strictly based on oral or textual exposés, as are most conferences and symposia, can be polarizing. For these same reasons, interdisciplinary meetings can become a linguistic chaos. While such contexts might disseminate ideas, they are weak means to drive common reflection and shared practices, and are not conducive to integration of knowledge from different disciplines.

When artists, designers, scientists and engineers come together, the differences in their epistemic territories manifest in how they talk about their work. The differences in discourses tend to obscure underlying affinities in their practices. Hence, rather than initiating encounters with presentations to compare ideas and theoretical frameworks about constructs, phenomena, problems or objects of inquiry, focusing on the shared materials from the early stages, ideally engaging in practice-based exploration and experimenting with tangible objects is a favourable entry point for more effective collaboration and communication. Like shared objects and materials, the spatial conditions are also crucial to the relational dimensions of collaboration. When well planned and prepared, these can be actuators for productive exchanges and promote reciprocal contributions amongst participants.

The association of hands-on experimentation and making to knowledge transfer – the premise of this paper – is not a recent theory of learning: it goes back to Seymour Papert's notion of Constructionism. Building on Dewey's experiential learning, on Freire's contextualized literacy, and Piaget's constructivism theories, in the 1980s, Papert's Epistemology & Learning group at the MIT investigated approaches of learning computation based on material practices. Generously supported by LEGO®, his model was ideologically opposed to the notion of instructionism: his ideas about the importance of engaging students in project-based learning simultaneously with theory found large receptivity in the arts but also in other applied disciplines. [3] Constructionist theories resurged in the last

decade with the creation of Fablabs and Maker Spaces in schools and institutions of higher education, along with a revaluation in contemporary social theories of the effects of objects we consume, live and work with [4]. Our own approach, which I will proceed to describe, is inscribed in this large movement of interest for materialism (versus idealism), and how it facilitates learning and investigation. Our focus is on a broader understanding of material practices and the physical objects; it encompasses the other important "things" of learning and research: the venues and spaces that house these objects, the institutional cultures and systems of knowledge they serve, and how participants relate to them, which are no-less determinant for the interplay between materiality and sociality in collaborative interdisciplinary contexts of research.

Useful Fictions

The Useful Fictions workshops week took place before the start of the French academic year of 2019–2020 at École Polytechnique, organized by researchers from the host institution and from the University of California-Davies. Twenty international graduate students, invited professors, scholars, scientists, artists and designers lived on site for a week. The premise was to rethink the scientific measures, protocols and instruments that confer certain forms of knowledge their validity and authority and explore alternative modes of pursuing new knowledge.

École Polytechnique is a high-standing French institution. It is the birthplace of significant contributions to scientific and technological advancements, and it continues to pursue and produce internationally competitive research in the disciplines of chemistry, physics, biology, and engineering. It was established at the end of the 19th century under Napoleon I as a military academy and it has kept its affiliation with the French military (the curriculum across programs begins with eight months of military or civil service). The modern École Polytechnique is housed in a complex of rather austere buildings from the 1970s, built when the school moved from Paris to Palaiseau, about 40 km outside 'the city of lights'.

The campus is growing in a very large plateau, far and removed from the bustling life and charms of Paris: there are no small businesses or vendors and the few public amenities belong to the school or to corporations that set up their research facilities nearby. The 70s architecture of the main building, juxtaposed to newer but no less austere constructions, the marching students wearing uniforms, the cast iron statues and busts of noble men, testify to the many layers of this institution's history. Isolation from other realms of social life shines the spotlight onto the signs of the different eras that École Polytechnique has traversed since its creation, and of latent opposite pressures of institutional legacy versus innovation, which are at work in many contemporary institutions of higher education and research. The setting was therefore ideal for a week of work and critical reflexion about tradition and entrenched ideas about the scientific rule(s) and ways of knowing.

The scientific "truth" that is bandied by such institutions that produce knowledge is a mix product of search for innovation in the fabric of tradition, of historical reiteration of internally validated epistemic and methodological frameworks and technical systems. Scientists are bred into the established paradigm to understand and organize the world; a worldview that is so prevalent that it frames public perception of what knowledge is worth pursuing, of how, and where it can be pursued, usually based on how it is expected to intervene in practical life.

Yet, scientific constructs, methodologies and systems of measurement used in the conventional natural and social sciences are arbitrary, in that their point of emergence as objects of study is often the invention of the instruments that allow them to be observed. The invention of the thermometer is – as explained by Hasok Chang [5] – the invention of temperature. "Proxies", as such arbitrary scientific systems of measurements are called, come to be accepted as the absolute systems to assess the 'real' conditions. However, these measurements are fragile, they are prone to manipulation and misinterpretation in convenient ways that serve the pursuit of human interests. By dwelling in complex contemporary issues that we are faced with such as climate change, we learn that scientific measurements and instruments can be turned into political useful fictions [6].

With this theme as the main premise forthe week, participants attended a program of lectures, visited the school's museum of scientific instruments and the open-air climatology lab: SIRTA [7]. A climatologist led the group in a visit to the lab's outdoor and indoor sites, presented the instruments and offered access to a large database, which some would explore throughout the week. The group divided into 5 workshops in which they explored creative ways of describing, measuring, and rendering climate data and phenomena.

Each group took on a different approach: led by a physicist and artist, one group investigated what they called "a microclimate of one" by producing real-time visualizations of the invisible atmospheric plumes produced by the heat flux and convection of the human body. Two groups that included scientists and designers took to represent data sets produced by climate measuring instruments through matter, shapes and forms. Material scientists worked with designers to explore the movement of magneto-responsive soft polymers and to imagine near-future sustainable applications of these materials and their mechanisms in energy systems, if optimized and scaled. Yet another group juxtaposed scientific techniques used for analyzing and qualifying soil and low-strata of the atmosphere, with DIY techniques and the human body sensory apparatus as a way to bring to forth situated information and knowledge that is often overseen by standardized scientific protocols, and

therefore by those who live and train to become professional scientists at École Polytechnique.

Figure 1. Group visit to the SIRTA climatology lab's outdoor facilities at École Polytechnique.

Living on site for the entire week allowed for informal moments in between scheduled activities. It was during this time that participants discussed different aspects of their research activities and institutional realities. We discovered that amongst us there was an assistant professor in design with a background in computer science and robotics, a biologist with a curatorial practice, an architect and technologist involved in human rights investigations, a physicist artist, a media studies lecturer with a background in public health, an art student with a robust knowledge of botany. These informal moments, we found, are important for building relationships of trust and to allow participants to readjust their preconceptions of others based only on titles, disciplinary and institutional affiliation.

No neutral spaces

The site of École Polytechnique, as described, is rather bleak. In the spirit of the Silicon Valley ideal for r&d and innovation, in the recent years the EDFLab and Danone Research facilities as well as several other corporations set up their research poles nearby. In close proximity to the laboratories and classrooms made available for the Useful Fictions groups to work, a gigantic pit was excavated for the foundations of some new construction. Access to buildings and rooms was strictly regulated. In some labs – we were told – is kept the highest-end technology available for very unique and important experiments. The corridors we were allowed to take with our badges were covered in scientific posters, and the photos and titles of lab members: an unfamiliar environment for most artist-participants.

The familiarity, or lack thereof, of participants with the setting where the research activity is conducted is a determinant condition that will influence attitude, motivation and engagement of collaborators. Familiarity with the environment determines the individuals' ability to navigate it, find venues, access and use the instruments. Like fluency in a disciplinary language, one's familiarity with a work environment and its protocols determines the fluency of gestures to perform techniques and procedures, which is what Latour and Woolgar called the "invisible skills that underpin the material inscriptions of laboratory work". [8] Authority and expertise is also associated with the ease with which one inhabits the research space. To enter an environment without the appropriate competencies may interrupt the efficiency of the usual work, however, disrupting the flow may also shed a new light on automatisms that would otherwise remain unquestioned.

Spaces are therefore not neutral for researchers in regards to the value and authority they confer to the work that is there conducted, and influence perceived notions of value of one's ability to participate and contribute. A symposium and workshop at École Polytechnique—home to scientists— or one organized at an Art and Design institution—home to artists— does not resonate equally to the professional practice of both. For scientists, to participate in an activity – especially an art-science interdisciplinary one – held outside a scientific institution is likely to be considered by their peers (sometimes by the very scientists involved) as marginal and unworthy of serious dissemination in the scientific world. Artists and designers, whose institutions are usually more appreciative of open-ended experimental work, are more likely to be able to valorize their experience and outcomes in both their arts and culture networks as well as with their academic peers. In academia, art associates with other disciplines without losing its disciplinary identity. In fact, artists will likely benefit from the prestige of conducting research at the great École Polytechnique, which demonstrates the hybrid connections that art and design are capable of, their greater porosity and openness to valorize interdisciplinary work compared to other disciplines [9].

To begin their workshop, one group set to appropriate the space in a manner that would overwrite disciplinary lenses and reset individual experiences of the site. They took a 2.5km walk along a straight (as possible) cross-section from the east to the west end of campus. They prepared a protocol to register wind, light, temperature, smell, vegetation, types of constructions… for which instruments could be used or none at all. Before and during the recognition walk they performed rituals to re-sensitize the body to its environment, they documented points of interest using sound, photo and video. Coming across students orderly training in their military march, the group also observed and collected samples of soil and plants. To document elements that could not be carried or species that should not be uprooted, an architect trained the group in a photogrammetry technique beforehand. In this first step of walking together and sharing in their discoveries in a place that doesn't immediately provoke a sense of wonder, par-

Figure 2. Group performing a ritual to re-sensitize the body to the research site at École Polytechnique.

ticipants were led to experience the site from perspectives that they would not have contemplated alone.

Site and materials determine scope

The study of contemporary complex problems like climate change entails understanding large technological systems. To investigate such phenomena is to delve into the entanglements of physical, biological, social and political systems. Faced with the proposition of delving into sciences of climatology in such a short period of time, most groups chose—and wisely so—to "reduce" the scope of investigation to the smallest and most tangible scale, and entered the topic through the data made available to them with the knowledge, skills and apparatus at hand. Given the short duration of the Useful Fiction workshops, and that most groups included members from diverse disciplines who had never before worked together, we encouraged and privileged rapid prototyping, mock-ups, and documenting phases of evolution and ideas rather than thriving for finished results.

We found that there is more to learn and discover than one might initially think in trespassing into unknown disciplinary and geographic territory in this way. The group mentioned above defined a cross-section of the site and mixed techniques from SIRTA with techniques of their own to analyze it. The group that worked on the "microclimate of one" limited its scope to the heat and turbulence of the human body. Another group chose to spend most of its time at SIRTA to further learn and explore the specific methodologies and the knowledge in that lab. Each of these approaches pertained to their own spaces, to specific materials and devices, and could only be determined in accordance with the expertise and sets of skills present in the group at the onset. This is how one group came to materialize climate data into 3D printed shapes, including cut-outs in edible pasta. Two participants programmed a robotic bread knife to cut at a pace dictated by readings of an anemometer. Another group produced analogue and digital visualizations that compared collected data from specific locations at École Polytechnique, and prepared distilled extractions and essential oils from plants found on site to diffuse indoors. The techniques and media explored and shared accounted to many more than those that were initially at hand, on site.

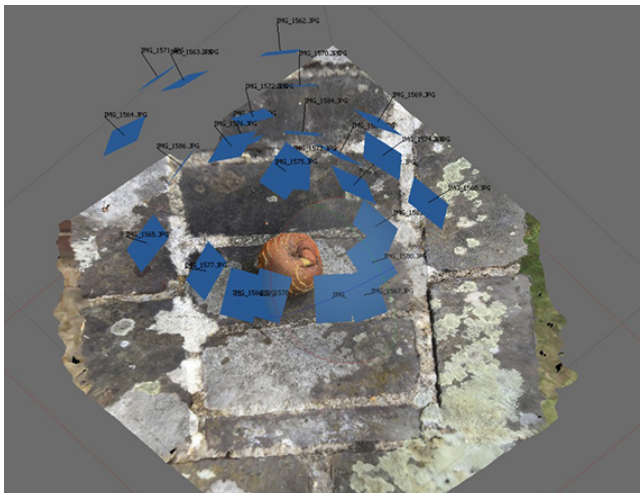

Figure 3. Photogrammetry of an item found on site.

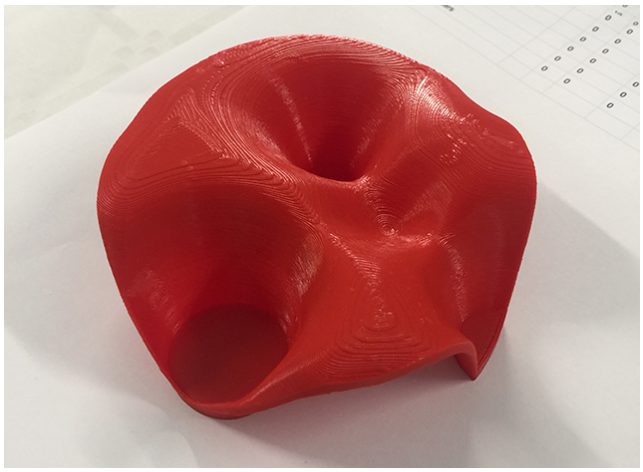

Figure 4. 3D-printed shape rendering open climate data.

Figure 5. Hand-made pasta with cutout patterns based on readings of open climate data.

From the work dynamic observed, we can assert that, in interdisciplinary collaborations, the "things" of research take on an important and unique relational effect. Individual expertise grows faster and more efficiently beyond surface levels of engagement and into new domains when experts converge in problem-centric types of research, in common spaces with an agreed upon scope and scale of the inquiry, instruments, materials of/for investigation.

One issue that may arise when entering short-term collaborations based on experimental practice-based approaches is the difficulty to balance hands-on making with reflective analysis. The pressure to produce results in a limited timeframe takes over and may inhibit in-depth discussions, which tend to be relegated to last. Participating scholars from the humanities may find it difficult to integrate such contexts, especially if they take place in the sites of applied technological sciences. In the Useful Fictions workshops, short moments of common discussion with all the participants were alternated with the blocks of time allotted to hands-on work. When the groups came together at the end of the week to present their approaches and experiments, materials, experiments and objects were brought along.

Disseminate with and around the materials and objects of research

Gathering around objects and artifacts for the final presentation once again promoted relational qualities that are not there in the traditional academic formats of transmitting knowledge. The prevalent formats tend to reduce drastically disparate types of knowledge to homogenous and rather poor modes of presentation and dissemination. Encounters between experts usually revolve around oral exchanges but exclude the materials, objects and instruments of that knowledge. Increasingly, workshops and round tables, which names seem to announce some form of hands on material engagement, have given up on both the work and the tables. At the end of the Useful Fictions workshops the objects were displayed in a common space. This method was chosen instead of visiting the group's labs because of the long distances between workspaces at École Polytechnique.

For the presentation on the final day, some groups had evolved the work into finished prototypes while others presented experiments and unfinished objects. A comparison of the relational qualities of a prototype or a functioning demo (or a malfunctioning demo) with those of an exhibited object or of a perfectly functioning installation is worthy of notice; While the unfinished object is perceived and approached by others as a work in progress, as the mock-up of the investigator who has not yet arrived at the solution, the finished design presents crystallized choices of a seemingly completed process. As a result, the former presents as being open to further inquiry and invites into

discussion; it can be handled and manipulated, while the latter is there to be contemplated and explained by the expert. Objects in-the-making speak of possibilities of realizations; They don't frame discussion but rather open it. For that, they yield valuable insight into the emerging debate to promote exchanges, not only between experts of different disciplines, but between the institutions of knowledge and civil society, or simply to communicate science in social contexts. Those not familiar with processes or research and creation are usually intrigued by the prototypes, demos, iterations of different objects, and even failed experiments, which can be used as props to spark encounters and initiate collaborative making.

Although the focus of this analysis is on the spatial and material conditions of research that are increasingly overlooked in research reports and presentations, Useful Fictions was first and foremost a relational experiment. It teaches us that the sites of interdisciplinary research, like the objects and instruments deserve to be carefully planned and should be central to the conceptualization and assessment of such endeavours. It is crucial to take into consideration the advantages and challenges of specific sites, and the value they hold for different stakeholders. The evolution of interdisciplinary research to address complex contemporary problems, we posit, lies as much in deriving new collaborative approaches to integrate knowledge as in adapting the institutional structures, the sites and formats of convening, to support and valorize emerging modalities of scholarly research. In the ideal constructions and settings, the work becomes embedded in a new matrix, one that will necessarily work against the conventional modes of knowledge, as much as it enriches or otherwise alters it.

If we envision such spaces, we further open investigation into, and become inclusive of, many other places, instruments and therefore other possibilities of knowledge. We also open for new and better points of contact and exchange of academic research with a greater diversity of actors and interest groups to renew knowledge production and dissemination mechanisms in ways that counter the current "academic knowledge pipeline". Attending to these dimensions is essential to lead science, art, knowledge, and scholarship to travel to new places.

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[7] SIRTA – *Site Instrumental de recherche par télédétection atmospherique* is a ground-based sensing atmospheric observatory for cloud and aerosol research created by the Institut Pierre Simon Laplace.

[8] Bruno Latour and Steve Woolgar. Laboratory Life (Princeton: Princeton University Press, 1986).

[9] Thomas Osborne. Inter that discipline! In Interdisciplinarity. Reconfigurations of the Social and Natural Sciences. Edited by A. Barry and G. Born (New York: Routledge, 2013), 82.

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Sensing the reality: reflections on artistic actions to defocus the real

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Abstract

This paper, based on research developed by the Laboratory of Front Poetics (research group CNPq/UEMG - http://labfront.tk), seeks to discuss and reflect on the notions of reality and separation through the research and development of a poetic work. The results we present here arise from the context of research, development and innovation in the field of relations between art, science and technology. As a way of finding answers and the possibilities of understanding even multiplying realities, an experiment was developed that sought to obtain a credible prospect in the city of Belo Horizonte (Minas Gerais/Brazil). The existence of an initiative that, at first, would not exist: the artist Froiid, one of the members of the LabFront's project team, followed and discussed a narrative about the separation of a territory (Minas Gerais) from the rest of Brazil (2015-2018). In this work, we will briefly present what this narrative of emancipation is and we will present the artistic exercise developed by the LabFront that allows seeing through an interactive virtual reality installation in 2018 part of this "unreal/real" construction.

Keywords

Diverse realities; separation; virtual reality; art, science and technology; digital art.

Introduction

This work comes from research and projects carried out by the research group Laboratory of Front Poetics (LabFront) which operates from the Guignard School and the Graduate Program in Arts at the State University of Minas Gerais (UEMG). The poetic research that will be exposed here is linked to the research already developed and that are under development in the group.[1]

Linked to the projects - and as a result of them - there are also extension actions that are part of their results. The poetic experiment (interactive installation in immersive virtual reality "Emancipação Mineira") that will be presented here is linked to the group both as poetic research as well as a result of research with broader objects in development.

The group's proposals aim to problematize the various realities (virtual reality, diminished reality, augmented reality and social reality, as well as the mixture of these realities known as mixed reality) that integrate with the world and allow us to produce critical ways of interacting/interfering with it. This work proposes regimenting and composing concepts within this sphere of relationship between the pointed realities and the socially constructed reality (BERGER, LUCKMANN, 2004) in the creation of a technological poetic work in immersive virtual reality.

The poetic work of art is an offshoot of an artistic proposal made by artist Froiid, a member of the Laboratory of Front Poetics. The artist created a universe parallel to the socially constructed reality, bringing together political and social elements. In Belo Horizonte (Minas Gerais), Froiid created and pursued a speech about the interest and possibility of a group of city people to emancipate/separate part of Minas Gerais, Brazil's territory, in the current context. From elements of poetic investigation, the artist designs and undertakes a set of actions in the urban environment by conducting an artistic experience that accompanies this visual and audiovisual narrative. In the LabFront research group, the coordinator formed a team to discuss the extension of this artwork to the field of relations between art and technology. As a result of the poetic work, the interactive installation in immersive virtual reality was generated - *Emancipação Mineira* (2018).

This work, therefore, will present in its sections the formation processes of this technological art from the conceptual implications that it raises. Above all, the artwork demonstrated the possibilities of generating a political, aesthetic, social debate using not only in a social reality as a language, but also through the use of virtual reality as a poetic medium. To present this discussion and poetic realization this article is organized as follows: the next section of the paper brings the idea of reality from the technological and social dimension, as well as presents the notion of separation that produces the aesthetic regime that allows the credible creation of the poetic experiment that will blur what is believed to be real. In the second section, we deepen the poetic proposal and discuss the stages of its production and then present our final considerations.

Reality and Separation

The mix between the various realities, including those promoted and enhanced by new media, has been discussed for decades in the field of relations between art, science and technology. It is presented by the artist and theorist Roy Ascott (1934-) in his research involving telematics, elaborating the junction of the realities pointed by him as: validated, virtual and vegetal. In the following excerpt Ascott states:

> At this point I introduced the idea of the Three Virtual Realities - VR: Validated, Virtual and Vegetable Reality. A proposal in which the "dry" world of computational virtuality and the "wet" world of biological systems are converging to produce a new substrate for creative work - wet media consisting of bits, atoms, neurons and genes. There is also a certain convergence of these three virtual realities. Virtual Reality (interactive digital technology), which is telematic and immersive; Validated Reality (reactive mechanical technology), which is prosaic and Newtonian; Plant Reality (psychoactive plant technology), which is entheogenic and spiritual. (ASCOTT, 2018, p. 2)

Although this text was recently published in Portuguese (2018), Ascott's ideas echo in the reflections of the field since the 1960s, making it possible to see it today despite already being at the door of another decade of the XXI century. The realization of his propositions deal with the transposition of the common vision of a static, one reality, for the composition of a multiplicity. This multiplicity is crossed by material elements from the universe of things, as well as from perception, cognition that is the object and subject of reality whose mode of apprehension is changing.

In this quotation above, we see how the mix of realities enables new experiences, enhancing the way of understanding and even multiplying realities, seeking new forms and

relationships with spaces, creating new narratives that, according to Ascott, have been converging. Thus, in Ascott's thinking, validated, vegetal and virtual reality converge.
We bring to the dialogue another important author's work that focuses on the transformations of lived reality, especially from the perspective of human biological beings. That reality is “a domain of things, and in this sense what can be distinguished is real” (MATURANA, 2014, p. 187). Humberto Maturana (1928-) shows us a reality that is constituted by a process of “reification” in human language, but which allows being transmuted as this human convention seeks understanding this "domain of things". He realizes that other techniques of seeing enter in this domain, observing and possibly experimenting (seeing, hearing, interacting etc.). In both dimensions, the reality is seen as an apprehensible, perceptive phenomenon built on parts and interactions.
In order to seek a little more clarity from these ways of understanding reality, we can rehearse that we are close to an idea of “composition of reality”, since it is not a “pure” domain in which we live because we have been allowed to live that way - rather, something that is perceived and known, amenable to transformation.
The idea of socially constructed reality in Peter Berger (1929-2017) and Thomas Luckmann (1927-2016) allows us to understand reality from another concept, that of social reality (BERGER, LUCKMANN, 2004). Existing in society allows one to construct a domain of shared things in a perceptive way that enables - if it can and/or is desired - to be transformed more fluidly or less fluidly. With technological advancement, at least there seems to be a change in perception. We may not immediately transform social reality, but we are increasingly intervening in the virtual dimension of reality, including means such as: virtualization (3D object modeling, for example), augmentation of reality (insertion of objects), reduction of reality (removal of objects), mixing of these and other ways (such as those with holographic characteristics, for example). But in the end, is there really an intervention in social reality composed of an economic and political condition?

Separation

As the processes of globalization of the world economy accelerated during and after World War II (1939-1945), the flow of movement of not only European peoples but from the various ends of the world, increased. As the technological development of industries (common or cultural) took place, we saw the rise of wars against the colonizer, resistance to totalitarian regimes, and the fall of authoritarian regimes built a scenario of twentieth-century experiences that moved into another reality after the fall of the Berlin Wall and the end of the Union of Soviet Socialist Republics. At the end of the twentieth century, we had a moment of greater opening of the frontiers for the circulation of goods around the world and one more way of circulating and being produced: the internet.
The ideas of reality are now moving towards what we now have: a social reality of connection managed by various and overlapping moments of circulation. The circulation is: commodity, commodity producers, global enterprises, immigrants, refugees, all of which is dependent on the degree of symbolic debate to which the peoples of the world are subject (and/or interested in).
We are facing multiple worlds that are moving towards the construction of multiple possibilities to reconstitute reality, including from new foundations of national states in separation movements, such as: Afrikaners, in South Africa; Kabylia, Algeria; Cabinda, Angola; Bakassi in Cameroon among many others that could be mentioned, but here we have only a few whose names start with the letters "a" and "c" on the vast and diverse African continent. The notion of separation/emancipation is in this idea. So that we do not enter the theory of international law, it will be understood here as the representation of the action of one state that is detached from the domain of another.
Obviously, here, we do not intend to delve into the conceptual details or theories of international law as to the differences between separation and emancipation, much less specifically on the theory of national states and states. We would just like to show that if the present world presents itself from these multiple possibilities of composing social realities (and particular social realities), we have to see what would unite them based on the dimension proposed by both Humberto Maturana and Roy Ascott.
With Maturana we could think of a union by the coercive intention of objectification in the domain of things, which is in a conventional universe that (biological) human beings share. In Ascott there is a material dimension that has led us to a peculiar technological condition of virtual, validated and vegetal realities. Unlike the first two that were built by society, in a way, as synthetic realities (virtual and validated), the latter (the vegetable) has ceased to be a reality accessed only autochthonously to be enjoyed widely from the development of science and technology. Plant reality also "spreads" its constitutive modes throughout the world of the domain of things that can now access reality through this plant bias.
We can consider that these means of “spreading” around the world, like seeds on the ground in the pre-planting time, are stimulated in a post-digital moment that created ways to spread the conditions of realities (in ASCOTT, 2018) that we are dealing with. This process of producing different realities; this way of producing that produces itself and what one perceives in the world can be called a "society of separation."
For Guy Debord (1931-1994), in his book *The Society of the Spectacle* (DEBORD, 1997), society is spectacular (the spectacle) is separation. Separation is, at this stage of the society of production in the political economy, as we see through the author's theses, the dimension of alienation of the human being from its own productive force. This separation, for Guy Debord, made primarily in the productive unit (where the producer is united in production and the separate production process of him, acquired by those who will own the property generated) spreads through society as part of his genetics. This dimension of separation creates a reality that allows one to unfold the modes of separation, previously restricted only to the universe of production (as pointed out) or that of art (as in the presentation of the show in which the actor is not himself as a performer), since now a society of production/aesthetics (of this production process) is founded on separation, as seen in Guy Debord.
This constitution of reality, close to the aesthetic dimension of art, allows one to see reality in a malleable, moldable, elastic and plastic way.[2] We realize that reality becomes the way we observe and act like human beings. Thus, we realize that the narrative that is lived is conducted in an intentional process of production of this multiple reality, but subjugated to the centrality of its production process: producing is its centre and production is separation.
It is from this configuration that the poetic work developed was proposed, opening the possibilities of reviewing realities and building new realities on social conventions that are built within a dimension of separation. Interestingly, both Froiid's proposal and the interactive installation in immersive virtual reality whose poetic process will be described later on are erected in the understanding of diverse reality and separation. We were aware that, precisely because of the diversity of reality and separation, we would be able to compose a artwork with this motto (the separation of a people) and with a composition (the narrative about a utopian movement; and the installation in virtual

reality) that separates it from reality while putting it in check and debating it.
It is important to note that although all of the authors mentioned in this section are approximated from our focus on reality, we understand that each has its own mode of theoretical development. Still, it is curious that we are dealing with authors who were (and some still are) productive in this debate about reality in diverse fields and in such close periods such as: Berger and Luckmann, with the publication of their book in 1966; Roy Ascott, since the 1960s; Humberto Maturana, whose text quoted above is from 1978, but has been producing since the 1950s; or even Guy Debord whose book is from 1967 and develops contemporary reflections on other authors. Although with different paths (and even opposite ways and conclusions) in their theories, it was possible to bring their reflections to reveal that there is in our proposal a study on the reality that supports the work that will be reported in the next section.

Defocusing the Real

From 2015, the artist Froiid begins action in the city of Belo Horizonte (Minas Gerais, Brazil). In this action, it proposed to inaugurate a new territory from the movement for the emancipation of the State of Minas Gerais from the rest of the country.
Based on the constant and contrasting international separatist groups, such as Brexit (a group calling for the separation of the United Kingdom from the rest of the European Union), and national groups, such as “São Paulo Livre” and “O Sul é o meu país”, which appeared with proposals and referenda in public squares, the artist ostensibly researched what other groups had been strengthening, creating similar movements, at the juncture built at the beginning of the 21st century. With the results of this research, the artist decided to create his own emancipating movement constituting its bases from some assumptions.
The idealized territory, now named Narnia (a direct reference to the fantastic world inhabited by mystical creatures created by the Irish writer CS Lewis), was proposed as a fictional, intangible field, not limited to just one locality, but itinerant and alive, as the utopian/dystopian propositions of the artistic and anti-artistic vanguards of the second half of the twentieth century (such as *New Babylon* by Constant Nieuwenhuys; and the actions of artists and architects of Superstudio, Archizoom Associati and Archigram and others from various parts of Europe such as Yona Friedman, Iannis Xenakis, Cedric Price, among others - see: NIEUWENHUYS, 1974 and CHOAY, 2015).
For the claim of this emancipation, the artist used different strategies. Since the context of this beginning of the century is allowing not only the multiplicity of reality but the mixing of discourses, including divergent ones, the artist - often obscurely - mixed conservative ideals, such as those popularly attributed to the 'right', to ideals “leftist” progressives without any distinction, proselytizing emancipation as a political flag. For this, it tactically appropriated materials and aesthetic resources. Fine art engraving techniques were used to create posters, shirts and other advertising materials; visual and audiovisual editing techniques were used to edit photographs and create videos; narrative construction techniques were used to create scripts interpreted by actors at various times, etc.
Emancipation has become the means of designing a nameless territory, a utopia, which seeks to propose a reflection on the relationship between the city, the State and the ideologies that promote its maintenance and functioning as a productive machine, clarifying the urban environment as the scenario of a game of territorial disputes of totalitarian aesthetics.
The Belo Horizonte’s version of Narnia is out to be a parable of the current socio-political moment. Aware that Minas Gerais is a region of important symbolism in the construction of national identity, and also due to its participation in emancipatory currents of the eighteenth century (such as the Inconfidência Mineira), the artist ends up showing that such a sociopolitical moment in Brazil has been drawing since the colonial period.

Emancipação mineira

After learning of the proposal, the Laboratory of Front Poetics coordinator proposed to the artist to create the installation development team including Pablo Gobira, Froiid and Antonio Mozelli. The objective would be to continue the possibilities of production of poetic work by exploring the relationship with digital technologies. The creation of the installation in immersive virtual reality emerges as a proposal to expand the nonexistent reality related to the action scenario developed by the artist in the city of Belo Horizonte. The development took place in two stages: the first made it possible to elaborate the concept and dealt with the aesthetic dimension of the installation, and the second referred to the technical realization and programming of the application that allows the audience/viewer to enjoy the work.
As the installation proposal happened even before the artist's action ended, it was possible that the first stage of the installation's creation happened concurrently with the creation and treatment of the photos and videos (Figure 1) made in the city of Belo Horizonte and serve as a basis to support the utopian construction of the reality of “Narnia Belorizontina”.

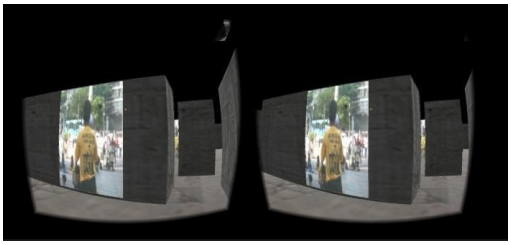

Figure 1: Stereographic images of the facility.
Source: Authors' Collection

The Labyrinth

As the LabFront team realized there was a maze in the emancipation narrative, this was chosen as a way to bring the viewer into a representation of the conflict faced by those who had contact with the artist's actions in the emancipation city. The individuals and social movements of the city that came into contact with the idea of an emancipatory movement from Minas Gerais even ended up not understanding the demands due to the mismatched discourses. However, this did not mean a lack of credibility to the proposal, including adhesion and motions of support. Many also did not realize the incongruities expressed in leaflets and posters, some of them bearing not just regional but national representations. The creation of a maze (Figure 2) in which the viewer could walk through this proposal, here already named as *Minas Gerais emancipation* (*Emancipação mineira*), is related to the illusory and disorienting idea of the possible paths to follow resulting from the nonexistent reality in Belo Horizonte.

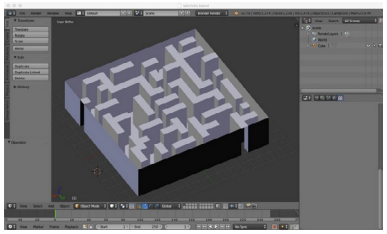

Figure 2: Three-dimensional maze modelling with Blender 3D software.
Source: Authors' collection.

The maze, as a symbol widely explored in literature and art, refers to the Greek mythology that influenced and influences the conception of shapes, spaces and constructions in various cultures around the world. The Internet itself can be seen as a maze full of paths and information that travels in a bewildered way through different spaces and times. Search engines lead the internet user to walk paths in order to find an answer through trial and error. It is necessary to travel nonlinear paths each time you search for something on the internet, which results in complex trails with possible results.
The installation aims, through a three-dimensional labyrinthine space, to enable the viewer to walk imaginable paths and explore the images (produced with fine arts techniques), videos and audios made in the city of Belo Horizonte. All this happens in a virtual environment with low lighting, with sounds crossing, bringing the obscure dimension that all poetics promote.

The technical development of the installation
The second step concerns the modelling and algorithmic programming of the installation. The labyrinthine three-dimensional space was modelled using Blender 3D software. Stone textures and lighting effects created with the intent of making space tight and dimly lit from the point of view of the viewer immersed in virtual reality through a stereoscopic headset (Figure 3).

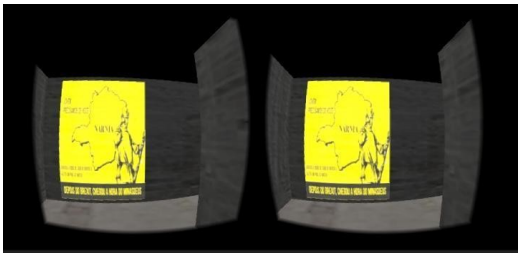

Figure 3: Stereographic images of the facility.
Source: Authors' collection.

Once modelled, the maze was exported to the Unity 3D IDE, a software game engine for developing digital games and multimedia applications (Figure 4). It was possible to program in C # language: the visual elements, such as photos and audios; the random elements that generously fragment into the sky of the facility; and the stereographic condition that allows the immersion effect through the illusion of the interactor's senses of vision.

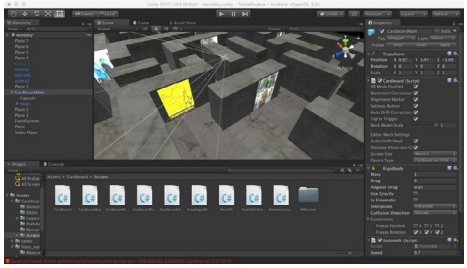

Figure 4: Programming the installation withsoftware Unity 3D.
Source: Authors' collection.

Google Cardboard framework was used in conjunction with the Samsung S8 mobile phone with the Android Nougat operating system to create the application *Emancipação Mineira*. The app can be used on smartphones with Android Nougat or higher. The poetic work was already shown in the exhibition *EmMeio #10*, in Brasilia/DF, at the National Museum, during the 17th International Meeting of Art and Technology, in 2018.[3]

Final Considerations

In this article, we proposed to bring concepts of the sphere of the relationship between reality and technological art seeking to problematize the socially constructed reality (BERGER, LUCKMANN, 2014). For this, the authors created a poetic experience called *Emancipação Mineira* (*Minas Gerais emancipation*). This experience is based on another poetic work, a poetic action that took place between 2015 and 2018 in the city of Belo Horizonte (Minas Gerais, Brazil) and was conducted by the artist Froiid. In both proposals, the question of reality was at stake from the idea of reality and unreality, diverse realities and reality and separation.
After proposing a discussion about reality and reflection on it through the development of both "*Narnia Belorizontina*", Froiid's poetic action, and the *Emancipacão Mineira*, carried out by the Laboratory of Front Poetics team, we fulfill our objective of reporting the creation of this poetic experiment and its unfolding in technological art. This was especially possible in the last section of this article, when we introduced the concept and development of an interactive immersive virtual reality installation called *Emancipação Mineira*.

Footnotes

[1] The researches related to this article, are: "Imprisoned look: research and development of interactive interfaces in different realities" (CNPq, FAPEMIG, 2016-2019); and "Digital literacy of digital art: art producing new realities in basic education" (CNPq, 2018-2021).
[2] It is important to point out that there is no claim to an artistic dimension in Guy Debord's theory, it is only demonstrated through it that there is a penetration/mixing of the universe of art in political economy, allowing aesthetic elements to be recognized and explored everywhere, especially in everyday reality.
[3] The installation was also exhibited during the "Sensitive Lines" exhibition, held in commemoration of the 75th anniversary of the Guignard School (July/August 2019) of the State University of Minas Gerais, in the gallery of the institution.

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Pablo Gobira is a PhD professor at the Guignard School, the Graduate Program in Arts (State University of Minas Gerais, Brazil) and the Graduate Program in Knowledge Management and Organization (Federal University of Minas Gerais, Brazil), artist, curator and researcher. He is a Productivity researcher (CNPq, Brazil) and a researcher member of the Brazilian Network of Digital Preservation Services (IBICT/MCTI). Coordinator of Laboratory of Front Poetics (http://labfront.tk). Writer and editor of the books “The memory of the digital and other questions of arts and museology” (EdUEMG, 2019), "Contemporary paths: realities of art, science and technology" (EdUEMG, 2018), "Post-digital configurations" (EdUEMG, 2017), "Reflecting on culture" (EdUEMG, 2017), "Games and society" (Crisálida, 2012), Walter Benjamin "Lado B" (Crisálida, 2011) among other books and articles. Operates: in the curatorship, creation and production in the field of culture, digital arts and science; as a professor in frontier courses such as the course of Engineering of Biological Machines (UFMG, UEMG and UFV) and the course of Digital Theater; curatorship of biennial, exhibitions and artistic residencies.

Adeilson "Froiid" William da Silva holds a degree in Fine Arts from Escola Guignard (UEMG). He teaches arts since 2007, has worked in several collectives and groups related to urban intervention and street art, participating in individual and collective exhibitions inside and outside Brazil. He is a member of the Laboratory of Front Poetics (http://labfront.tk).

Antônio Mozelli completed a Masters degree in Arts, at the Graduate Program in Arts at the State University of Minas Gerais, Brazil with a research period at the Data Materialization Studio, OCAD University – Canada. Graduated in Computer Science from the FUMEC University, Brazil and in Visual Arts from the Guignard School, State University of Minas Gerais, Brazil. Currently develops research and work in the digital art field and explores the use of immersive virtual reality environments and artificial intelligence. He is a member of the Laboratory of Front Poetics (http://labfront.tk).

Social Justice & Artificial Intelligence

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Abstract

This paper discusses the argument that the adoption of artificial intelligence (AI) technologies benefits the powerful few, focussing on their own existential concerns. The paper will narrow down the analysis of the argument to jurisprudence (i.e. the philosophy of law), considering also the historical context. We will discuss the construction of the legal system through the lens of political involvement of what one may want to consider to be powerful elites. Before discussing these aspects we will clarify our notion of "powerful elites". In doing so we will be demonstrating that it is difficult to prove that the adoption of AI technologies is undertaken in a way which mainly serves a powerful class in society. Nevertheless, analysing the culture around AI technologies with regard to the nature of law with a philosophical and sociological focus enables us to demonstrate a utilitarian and authoritarian trend in the adoption of AI technologies. The paper will conclude by proposing an alternative, some might say practically unattainable, approach to the current legal system by looking into restorative justice for AI crimes, and how the ethics of care could be applied to AI technologies.

Keywords

power elites, cyborg, artificial intelligence, restorative justice, legal positivism, natural law, disciplinary power, ethics of care, privacy

Introduction

In order to lay the foundations for a discussion around the argument that the adoption of artificial intelligence (AI) technologies benefits the powerful few (Chaslot, 2016; Morozov, 2018), focussing on their own existential concerns (Busby, 2018; Sample, 2018a), the paper will narrow down the analysis of the argument to social justice and jurisprudence (i.e. the philosophy of law), considering also the historical context. The paper explores the notion of *humanised artificial intelligence* (Kaplan & Haenlein, 2019; Legg & Hutter, 2007) in order to discuss potential challenges society might face in the future. The paper does not discuss current forms and applications of artificial intelligence, as, so far, there is no AI technology (Bostrom, 2014), which is self-conscious and self-aware, being able to deal with emotional and social intelligence. It is a discussion around AI as a speculative hypothetical entity. One could then ask, if such a speculative self-conscious hardware/software system were created at what point could one talk of personhood? And what criteria could there be in order to say an AI system was capable of committing AI crimes?

In order to address AI crimes, the paper will start by outlining what might constitute personhood in discussing legal positivism and natural law. Concerning what constitutes AI crimes the paper uses the criteria given in King et al's paper *Artificial Intelligence Crime: An Interdisciplinary Analysis of Foreseeable Threats and Solutions* (King, Aggarwal, Taddeo, & Floridi, 2018), where King et al coin the term *AI crime*, mapping five areas in which AI might, in the foreseeable future, commit crimes, namely:

- commerce, financial markets, and insolvency
- harmful or dangerous drugs
- offences against persons
- sexual offences
- theft and fraud, and forgery and personation

Having those potential AI crimes in mind, the paper will discuss the construction of the legal system through the lens of political involvement of what one may want to consider to be powerful elites. Before discussing these aspects the paper will clarify the notion of "powerful elites". In doing so the paper will be demonstrating that it is difficult to prove that the adoption of AI technologies is undertaken in a way which mainly serves a powerful class in society. Nevertheless, analysing the culture around AI technologies with regard to the nature of law with a philosophical and sociological focus enables one to demonstrate a utilitarian and authoritarian trend in the adoption of AI technologies (Goodman, 2016; Haddadin, 2013; Hallevy, 2013; Pagallo, 2013).

The paper will base the discussion around Crook's notion on "power elites" (2010), in Media Law and Ethics (Crook, 2009), and apply it to the discourse around artificial Intelligence and ethics. Following Crook the paper will introduce a discussion around power elites with the notions of legal positivism and natural law, as discussed in the academic fields of philosophy and sociology. The paper will then look, in a more detailed manner, into theories analysing the historical and social systematisation, or one may say disposition, of laws, and the impingement of neo-liberal (Parikh, 2017) tendencies upon the adoption of AI technologies. Pueyo demonstrates those tendencies with a thought experiment around superintelligence in a neoliberal scenario (Pueyo, 2018). In Puevo's thought experiment the system becomes techno-social-psychological with the progressive incorporation of decision-making algorithms and the increasing opacity of such algorithms (Danaher, 2016), with human thinking partly shaped by firms themselves (Galbraith, 2015). The regulatory, self-governing potential of AI algorithms (Poole, 2018; Roio, 2018; Smith, 2018) and the justification by authority of the current adoption of AI technologies within civil society will be analysed next. The paper will propose an alternative, some might say practically unattainable, approach to the current legal system by looking into restorative justice for AI

crimes (Cadwalladr, 2018), and how the ethics of care, through social contracts, could be applied to AI technologies. In conclusion the paper will discuss affect (Olivier, 2012; Wilson, 2011) and *humanised artificial intelligence* with regards to the emotion of shame, when dealing with AI crimes.

Legal Positivism and Natural Law

In order to discuss AI in relation to personhood this paper follows the *descriptive psychology* method (Ossorio, 2013) of the p*aradigm case formulation* (Jeffrey, 1990) developed by Ossorio (1995). Similar to how some animal rights activists call (Mountain, 2013) for certain animals to be recognised as non-human persons (Midgley, 2010), this paper speculates on the notion of AI as a non-human person being able to reflect on ethical concerns (Bergner, 2010; Laungani, 2002). Here Schwartz argues that "it is reasonable to include non-humans as persons and to have legitimate grounds for disagreeing where the line is properly drawn. In good faith, competent judges using this formulation can clearly point to where and why they agree or disagree on what is to be included in the category of persons" (2014).

According to Ossorio (2013) a deliberate action is a form of behaviour in which a person a) engages in an intentional action, b) is cognizant of that, and c) has chosen to do that. Ossorio gives four classifications: ethical, hedonic, aesthetic, and prudent as fundamental motivations. Ethical motivations, as well as aesthetic motivations, can be distinguished from prudent (and hedonic) motivations due to the agent making a choice. "Aesthetic and ethical motivations are only relevant when deliberate action is also possible since aesthetic and ethical action require the eligibility to choose or refrain, to potentially deliberate about the desirable course to follow. In the service of being able to choose, and perhaps think through the available options, a person's aesthetic and ethical motives are often consciously available" (Schwartz, 1984)

In the fields of philosophy and sociology countless theories have been advanced concerning the nature of law, addressing questions such as: Can unethical law be binding? Should there be a legal code for civil society? Can such a legal code be equitable, unbiased, and just, or, is the legal code always biased? In the case of AI technologies one can ask whether the current vision for the adoption of AI technologies is a vision that benefits only the powerful elites. To address the question one needs to discuss the idea of equality. Reference is made to Aristotle's account on how the legal code should be enacted in an unbiased manner (Aristotle, 1981). Aristotle differentiated between an unbalanced and balanced application of the legal code, pointing out that the balanced juridical discussion of a case should be courteous. Here, as with the above mentioned animal rights activists, in *Dependent Rational Animals* MacIntyre (2001) argued, drawing on Aquina's (2006) discussion of misericordia, for the recognition of our kinship to some species calling for the "virtues of acknowledged dependence" (MacIntyre, 2013). Austin, on the other hand, suggests that the legal code is defined by a higher power, "God", to establish justice over society. For Austin the legal code is an obligation, a mandate to control society (Austin, 1998).

Hart goes on to discuss the social aspect of legal code and how society apprehends the enactment of such legal code (Hart, 1961). Hart argues that the legal code is a strategy, a manipulation of standards accepted by society. Contrary to Hart, Dworkin proposes for the legal code to allow for non-rule (Dworkin, 1986) standards reflecting ethical conventions of society. Dworkin discusses legislation as an assimilation of these conventions, where legislators do not define the legal code, but analyse the already existing conventions to derive conclusions, which then in turn define the legal code. Nevertheless, Dworkin fails to explain how those conventions come into being. Here for Kelsen (1967, 2009) legal code is a product of the political, cultural and historical circumstances society finds itself in. For Kelsen the legal code is a standardising arrangement which defines how society should operate (Kelsen, 1991).

The paradigm case (Ossorio, 2013) allows for the potential AI as non-human persons (Putman, 1990; Schwartz, 1982). Referring to the paradigm case method allows one to work out where parties are in agreement or disagreement concerning what constitutes a person. Here social contract theories, as defined and discussed below, might serve to explain and analyse how legal codes deal with the emergence of legal issues concerning AI technologies or AI crimes. Following Ossorio (1995) since persons act consciously, they are motivated by ethical, aesthetic, prudent and hedonic motivations: at the same time, social contract(s) allowing persons to act in patterns of significance, giving meaning to one's actions. AI can be interpreted as automated distribution systems, using data drawn from a 'datasphere', which could easily be imagined continuously operating without human interference. Thus, a more particular definition of 'datasphere' would emphasise how a vast amount of data circulates, while only becoming meaningful when viewed in the context of a social contract. In other words, the transformation of 'data' into 'meaning' can always be seen to take place within a social contract. For example, a protocol extracting data always has to be configured, i.e. socially or politically agreed upon. Legal or activist interventions thus always interpellate the datasphere. dataspheres include all forms of data that exist in the public domain and public spheres. This data becomes meaningful only when actors interpret it. Such instances of interaction are always in some ways social.

In that sense a legal system, social contracts, aiming to control the dataspheres, needs to be tailored carefully because the situation as being controlled by the most driven producers and consumers. The old distribution model is so impoverished that it chooses the safest route. Applying the notion of 'social contracts,' the notion of open and distributed sharing can be reinforced as an overall heuristic and social ethos. One can even elaborate upon the idea of slavery, extending it to the idea of social contracts with reference to Jean-Jacques Rousseau's *Social Contract*, which states: "The words 'slavery' and 'right' are contradictory, they

cancel each other out. Whether as between one man and another, or between one man and a whole people, it would always be absurd to say: I hereby make a covenant with you which is wholly at your expense and wholly to my advantage" ([1762] 1968, p. 58).

"Man is born free; and everywhere he is in chains", begins Rousseau's work of political philosophy, *The Social Contract* (1968). Rousseau (Dart, 2005; Hampsher-Monk, 1992) aimed to understand why "a man would give up his natural freedoms and bind himself to the rule of a prince or a government" (Bragg, 2008). This question of political philosophy was widely discussed in the 17th and 18th centuries, as revolution was in the air all over Europe, particularly in France 1789. In the 18th century Rousseau published *The Social Contract*. Rousseau thought that there is a conflict between obedience and persons' freedom and argued that our natural freedom is our own will. Rousseau defined the social contract as a law 'written' by everybody (Roland, 1994). His argument was that if everybody was involved in making the laws they would only have to obey themselves and as such follow their free will. How could persons then create a common will? For Rousseau this would only have been possible in smaller communities through the practice of caring for each other and managing conflicts for the common good – ultimately through love. In *The Art of Loving* Erich Fromm reminds us that "love is not a sentiment which can be easily indulged in by anyone ... [S]atisfaction in individual love cannot be attained without the capacity to love one's neighbour, without true humility, courage, faith and discipline" (1956, p. xix). Rousseau imagined a society the size of his native city of Geneva as an ideal ground for the implementation of social contract theory. Ironically it was the French who, through their revolutionaries, implemented social contract theory. Nevertheless, the French people read it differently, as *imposing* social contracts onto the persons. The mass-scale imposition of contracts compromised their non-mandatory status.

In the 20th century, moral and political theory around the social contract had a revival with John Rawls' *A Theory of Justice* (2005) and David Gauthier's *Morals by Agreement* (1986). Gauthier argues after Thomas Hobbes (1651) and explains that there can be morality in our society without the state having to impose morality with the help of external enforcement mechanisms. For Gauthier rationality is the key for cooperation and for following agreements made between different parties. Celeste Friend states in *Social Contract Theory* (2004) that feminist philosophers criticise social contract theory for not reflecting moral and political lives correctly and completely, and for the contract itself being "parasitical upon the subjugations of classes of persons" (2004). In a more critical approach to rationalized contracts, in *The Sexual Contract* Carole Pateman argues that "lying beneath the myth of the idealized contract, as described by Hobbes, Locke, and Rousseau, is a more fundamental contract concerning men's relationship to women" (Friend, 2004). Similarly, for Pateman, "[t]he story of the sexual contract reveals that there is good reason why 'the prostitute' is a female figure" (1988, p. 192). The feminist philosophers Annette Baier (1988, 1995) and Virginia Held (1993, 2006) criticise social contract theory for not demonstrating fully what a moral person should be and how this affects relationships. Baier argues that Gauthier does not reflect on the full spectrum of human motivations and their psychology, that he fails to see that there is a dependency on certain relationships (like mother-child) before one can enter into those contracts, as described in Baier's expression "the cost of free milk" (1988). Held, as quoted by Friend, even goes so far as to argue that "contemporary Western society is in the grip of contractual thinking" (2004).

In *The Racial Contract*, Charles Wade Mills (1997) inspired by *The Sexual Contract* argues that non-whites have similar problems with the class society as women, both sets of conflicts and suppression deriving from a patriarchal mindset. For Mills there is a 'racial contract' which is more important to the industrialized part of the world than the social contract, which one might want to consider in relation to humanised artificial intelligent systems. "This racial contract determines in the first place who counts as fully moral and political persons, and therefore sets the parameters of who can 'contract in' to the freedom and equality that the social contract promises" (Friend, 2004). The subject of the Debian *Social Contract* (2004) might very well be the one who writes most of the code for the data sphere and defines AI technologies: the white male (Knight, 2017). Taking the above criticism regarding the sexual and the racial contract on board one could extend the discussion on social contracts with the notion of *Open Contracts*. First one needs to look into the current *Debian Social Contract* and the issue of privacy with regard to Intellectual Property (Ristroph, 2009). The Debian Foundation is one of the biggest communities for the *Linux* (Torvalds, 2002) operating system. The beginning of the Debian *Social Contract* for the FLOSS community states:

Our priorities are our users and free software. We will be guided by the needs of our users and the free software community. We will place their interests first in our priorities. We will support the needs of our users for operation in many different kinds of computing environments. We will not object to non-free works that are intended to be used on Debian systems, or attempt to charge a fee to people who create or use such works. We will allow others to create distributions containing both the Debian system and other works, without any fee from us. In furtherance of these goals, we will provide an integrated system of high-quality materials with no legal restrictions that would prevent such uses of the system. (2004) The idea of the Debian *Social Contract* could be extended to AI technologies, in the form of Open Contracts, suggesting similar principles that can be applied to free and open source software. One can argue that these would be a pre-condition for 'ethical' AI technologies. With open contracts such as the Debian *Social Contract* in place, various communities can start discussing, experimenting with and practising the production, distribution, and sharing of AI technologies. Although this sounds like a promising scenario one also has to be critical, as these alternatives can be vulnerable to corruption. One could support an Open Contract practice, and suggest that a feminist notion of

'restorative justice' (Christie, 1977a; Crook, 2009) might serve to judge *Open Contracts*, by applying the notions of solidarity and care as principles of judicial practice. However the concern is how to move from an abstract idea of open contracts to a concrete legislation which could enable a AI technology production that is not deemed antithetical, or oppositional to the current judicial system, by formulating a set of ground rules and protocols that will allow AI communities to function and prosper. One could argue that this can be done by defining the independent terms and conditions, namely free and open licenses. Social contracts and laws will eventually be defined for these dataspheres, but until then power elites will try to appropriate every piece of AI technology in accord with the old, non-efficacious, "IP legislation" (Electronic Frontier Foundation, 2009).

Nevertheless, in trying to evaluate the argument that the adoption of AI technologies is a process controlled by powerful elites who wield the law to their benefit, one also needs to discuss the notion of power elites. Chamblis and Seidman argue that powerful interests have shaped the writing of legal codes for a long time (1982). However, Chamblis and Seidman also state that legislation derives from a variety of interests, which are often in conflict with each other. One needs to extend the analysis not only to powerful elites, but one also needs to examine the notion of power itself, and the extent to which power shapes legislation, or, on the contrary, if it is legislation itself that controls power. In an attempt to identify the source of legislation, Weber argues that legal code is powerfully interlinked with the economy. Weber goes on to argue that this link is the basis of capitalist society (Weber, 1978). Here one can refer back to Marx's idea of materialism and the influence of class society on legislation (Marx, 1990). For Marx legislation, legal code, is an outcome of the capitalist mode of production (Harris, 2018). Marx's ideas have been widely discussed with regards to the ideology behind the legal code. Nevertheless Marx's argumentation limits legal code to the notion of class domination. Here Sumner extended on Marx's theories regarding legislation and ideology and discussed the legal code as an outcome of political and cultural discussions, based on the economic class domination (Sumner, 1979). Sumner expands the conception of the legal code not only as a product of the ruling class but also as bearing the imprint of other classes, including blue-collar workers, through culture and politics. Sunmner argues that with the emergence of capitalist society, "the social relations of legal practice were transformed into commercial relations" (ibid: 51). However, Sumner does not discuss why parts of society are sidelined by legislation, and how capitalist society not only impacts on legislation, but also has its roots in the neo-liberal writing of legal code.

To apprehend how ownership, property and intellectual rights became enshrined in legal code and adapted by society one can turn to Locke's theories (1993). Locke argued that politicians ought to look after ownership rights and to support circumstances allowing for the growth of wealth (capital). Following Locke one can conclude that contemporary society is one in which politicians influence legislation in the interest of a powerful upper-class – a neo-liberal society. Still, one needs to ask, should this be the case, and should powerful elites have the authority over legal code, how legislation is enacted and maintained?

The Disciplinary Power of Artificial Intelligence

In order to discuss these questions one has to analyse the history of AI technologies leading to the kind of "humanised" AI system this paper posits. Already in the 50s Turing, the inventor of the Turing test (Moor, 2003), had stated that:

We may hope that machines will eventually compete with men in all purely intellectual fields. But which are the best ones to start with? Even this is a difficult decision. Many people think that a very abstract activity, like the playing of chess, would be best. It can also be maintained that it is best to provide the machine with the best sense organs that money can buy, and then teach it to understand and speak English. This process could follow the normal teaching of a child. Things would be pointed out and named, etc. Again I do not know what the right answer is, but I think both approaches should be tried. We can only see a short distance ahead, but we can see plenty there that needs to be done. (Turing, 1950)

The old fashioned approach (Hoffman & Pfeifer, 2015), some may say still contemporary approach, was to primarily research into 'mind-only' (Nilsson, 2009) AI technologies/systems. Through high level reasoning, researchers were optimistic that AI technology would quickly become a reality. Those early AI technologies were a disembodied approach using high level logical and abstract symbols. By the end of the 80s researchers found that the disembodied approach was not even achieving low level tasks humans could easily perform (Brooks, 1999). During that period many researchers stopped working on AI technologies and systems, and the period is often referred to as the 'AI winter' (Crevier, 1993; Newquist, 1994). Brooks then came forward with the proposition of 'Nouvelle AI' (Brooks, 1986), arguing that the old fashioned approach did not take into consideration motor skills and neural networks. Only by the end of the 90s did researchers develop statistical AI (Brooks, 1999) systems without the need for any high level logical reasoning; instead AI systems were 'guessing' through algorithms and machine learning. This signalled a first step towards humanistic artificial intelligence, as this resembles how humans make intuitive decisions (Pfeifer, 2002); here researchers suggest that embodiment improves cognition (Renzenbrink, 2012; Zarkadakis, 2018).

With embodiment theory Brooks argued that AI systems would operate best when computing only the data that was absolutely necessary (Steels & Brooks, 1995). Further in *Developing Embodied Multisensory Dialogue Agents* Paradowski (2011) argues that without considering embodiment, e.g. the physics of the brain, it is not possible to create AI technologies/systems capable of comprehension, and that AI technology "could benefit from strengthened associative connections in the optimization of their processes and their reactivity and sensitivity to environmental stimuli, and in situated human-machine interaction. The concept of

multisensory integration should be extended to cover linguistic input and the complementary information combined from temporally coincident sensory impressions" (Paradowski, 2011). With this historical analysis in mind one can discuss the paper's focus on power elites. Raz studied the procedures through which elites attain disciplinary power in society (Raz, 2009). Raz argues that the notion of the disciplinary power of elites in society is exchangeable with the disciplinary power of legislation and legal code. Raz explains that legal code is perceived by society as the custodian of public order. He further explains that by precluding objectionable actions, legislation directs society's activities in a manner appropriate to jurisprudence. Nevertheless, Raz did not demonstrate how legislation impacts on personal actions. This is where Foucault's theories on discipline and power come in. According to Foucault the disciplinary power of legislation leads to a self-discipline of individuals (Foucault, 1995). Foucault argues that the institutions of courts and judges motivate such a self-disciplining of individuals (Chen, 2017), and that self-disciplining rules serve "more and more as a norm" (Foucault, 1981, p. 144).

Foucault's theories are especially helpful in discussing how the "rule of truth" has disciplined civilisation and how power elites, as institutions, push through an adoption of AI technologies which seem to benefit mainly the upper-class. Discussions around truth, Foucault states, form legislation into something that "decides, transmits and itself extends upon the effects of power" (Foucault, 1986, p. 230). Foucault's theories help to explain how legislation, as an institution, is rolled out throughout society with very little resistance, or "proletarian counter-justice" (Foucault, 1980, p. 34). Foucault explains that this has made the justice system and legislation a for-profit system. With this understanding of legislation, and social justice, one does need to reflect further on Foucault's notion of how disciplinary power seeks to express its distributed nature in the modern state. Namely one has to analyse the distributed nature of those AI technologies, especially through networks and protocols, so that the link can now be made to AI technologies becoming "legally" more profitable, in the hands of the upper-class. If power generates new opportunities rather than simply repressing them, then, following Michel Foucault (1980a), more interaction and participation can extend and not simply challenge power relations. Foucault's text *The Subject and Power* (1982) offers a valuable insight into power relationships relevant also within AI technologies. It is the product of research that was undertaken by Foucault over a period of over twenty years. Foucault uses the metaphor of a chemical catalyst for a resistance which can bring to light power relationships, and thus allow an analysis of the methods this power uses: "[r]ather than analysing power from the point of view of its internal rationality, it consists of analysing power relations through the antagonism of strategies" (1982, p. 780). In *Protocol*, Galloway describes how these protocols changed the notion of power and how "control exists after decentralization" (2004, p. 81). Galloway argues that protocol has a close connection to both Deleuze's concept of 'control' and Foucault's concept of biopolitics (Foucault, 2008, pp. 1978--1979) by claiming that the key to perceiving protocol as power is to acknowledge that "protocol is an affective, aesthetic force that has control over life itself" (2004, p. 81). Galloway suggests (2004, p. 147) that it is important to discuss more than the technologies, and to look into the structures of control within technological systems, which also include underlying codes and protocols, in order to distinguish between methods that can support collective production, e.g. sharing of AI technologies within society, and those that put the AI technologies in the hands of the powerful few. Galloway's argument in the chapter *Hacking* (2004, p. 146) is that the existence of protocols "not only installs control into a terrain that on its surface appears actively to resist it", but goes on to create the highly controlled network environment. For Galloway hacking is "an index of protocological transformations taking place in the broader world of techno-culture." (2004, p. 157).

In order to be able to regulate networks and AI technologies, control and censorship mechanisms are introduced to networks by applying them to devices and nodes. This form of surveillance, or dataveillance, might constitute a development akin to Michel Foucault's concept of "panopticism" (1977), "panoptic apparatus" (Zimmer, 2009, p. 5), defined as both massive collections and storage of vast quantities of personal data and the systemic use of such data in the investigation or monitoring of one or more persons. Laws and agreements like the *Anti-Counterfeiting Trade Agreement* (European Commission, 2007; Lambert, 2010), the *Digital Economy Act* and the *Digital Millennium Copyright Act* require surveillance of the AI technologies that consumers use in their "private spheres" (Fuchs, 2009; Medosch, 2010; Wolf, 2003), and can be used to silence "critical voices" (Movius, 2009).The censorship of truth, and the creation of fear of law through moral panics stand in opposition to the development of a healthy democratic use of AI technologies. Issues regarding the ethics of AI (Berkman Klein Center, 2018; Clark, 2018; Green, 2017; Lufkin, 2017) arise from this debate. Fitzpatrick expands on Foucault's theory, investigating the "symbiotic link between the rule of law and modern administration" (Fitzpatrick, 2002, p. 147). Fitzpatrick states that legal code is not only a consequence of disciplinary power, but that it also legalises dubious scientific experiments. Here again one can make the link to ethical questionable advances with AI technologies. Legislation, or legal code, Fizpatrick argues, corrects "the disturbance of things in their course and reassert the nature of things" (ibid, p. 160). For Fitzpatrick legislation is not an all-embracing, comprehensive concept as argued by Dworkin (1986) and Hart (1961), but rather legislation is defined by elites. For Fitzpatrick legislation "changes as society changes and it can even disappear when the social conditions that created it disappear or when they change into conditions antithetical to it" (Fitzpatrick, 2002, p. 6). Furthermore, West (1993) suggests that the impact of disciplinary power through legislation on the belief system of individuals does not allow for an analytical, critical

engagement by individuals with the issues at stake. Legislation is simply regarded as given. In relation to the disciplinary power of AI technologies, issues with privacy, defamation and intellectual property laws are not being questioned. Nevertheless, West's argument that all individuals adhere to equivalent morals is improbable.

Adams and Brownsword (2006) give a more nuanced view of contemporary legislation. They argue that legislation aims to institute public order. Legislation sets up authoritative mechanisms whereby social order can be established and maintained, social change managed, disputes settled and policies and goals for the community adopted (ibid: 11). Adams and Brownsword go on to argue that legal code is skewed in favour of the upper-class and those who engage more with politics in society – examples of which could be the corporate sector producing AI technologies and business elites seeking to use AI technologies for profit. According to Adams and Brownsword there seems to be no unbiased, fair legislation or legal code, and the maintenance of public order must simply reproduce an unfair class society. If this is the case, following Adams and Brownsword argumentation, one can argue that indeed the adoption of AI technologies does not follow a utilitarian ethical code, benefiting society, but rather conforms to the interests of a small group, those owning AI technologies.

A further discussion of disciplinary power within the process of writing legal code is that of Chamblis and Seidman (1982), who argue that legislation is not produced through a process characterised by balanced, fair development, but rather by powerful elites writing legal code by themselves. Translating this again back to the adoption of AI technologies, it becomes evident that the freedom to engage with those technologies is left to those who have the financial means, and with it the legal means, to do so. According to Chamblis and Seidman, in a culture dominated by economics, legislation and technologies are being outlined and modelled by those powerful elites. The analysis of the theories above has attempted to show that the implementation of AI technologies might be construed as a project deriving from, and serving the interests of, the dominant class; following Foucault's terminology, this is achieved using the disciplinary power of legislation, through regimes of truths, over individuals. AI technologies, rather than benefiting society, could very well be implemented against society. The implementation of AI technologies follows legislation set out by elites, raising issues connected with privacy, national security, or intellectual property laws. On this note, Crook states that "there is the risk that their decisions are based on profit and loss rather than truth/justice and freedom of expression" (Crook, 2009, p. 94).

AI technologies and Restorative Justice: The Ethics of Care

Having said this, the prospect could be raised that restorative justice might offer "a solution that could deliver more meaningful justice" (Crook, 2009, p. 310). With respect to AI technologies, and the potential inherent in them for AI crimes, instead of following a retributive legislative approach, an ethical discourse (Courtland, 2018), with a deeper consideration for the sufferers of AI crimes (Fry, 2018) should be adopted. That said, acting ethically is more difficult than ever (Ito, 2017), due to the hyper expansion of big data and artificial intelligence (Bridle, 2018; Singh, 2018). Research into artificial intelligence has gone from being a public service undertaken mainly at universities to being run (and regarded) as businesses, run by big corporations such as Alphabet (parent company of Google) and Facebook, created to generate profit (Keeble, 2008). The companies need to attract a large number of paying customers. AI technologies have become workers in the market economy, rarely following any ethical guidelines (Kieran, 1998). One can ask: could restorative justice offer an alternative way of dealing with the occurrence of AI crimes (Etzioni, 2018; Goel, 2017)?

Millar and Vidmar described two psychological perceptions of justice (Vidmar & Miller, 1980). One is behavioural control, following the legal code as strictly as possible, punishing any wrongdoer (Wenzel & Okimoto, 2010), and second the restorative justice system, which focuses on restoration where harm was done. Thus an alternative approach for the ethical implementation of AI technologies, with respect to legislation, might be to follow restorative justice principles. Restorative justice would allow for AI technologies to learn how to care about ethics (Bostrom & Yudkowsky, 2014; Frankish & Ramsey, 2014). Fionda (2005) describes restorative justice as a conciliation between victim and offender, during which the offence is deliberated upon. Both parties try to come to an agreement on how to achieve restoration for the damage done, to the situation before the crime (here an AI crime) happened. Restorative justice advocates compassion for the victim and offender, and a consciousness on the part of the offenders as to the repercussion of their crimes. Tocqueville argued for one to live in liberty, "it is necessary to submit to the inevitable evils which it engenders." (Tocqueville, 2004)

One can argue that these evils are becoming more evident nowadays with the advance of AI technologies. For AI crimes punishment in the classical sense may seem to be adequate (Montti, 2018). Duff (2003) argues that using a punitive approach to punish offences educates the public. Okimoto and Wenzel (2010) refer to Durkheim's studies on the social function of punishment (Durkheim, 1960), serving to establish a societal awareness of what ought to be right or wrong. Christie (Christie, 1977b), however, criticises this form of execution of the law. He argues that, through conflict, there is the potential to discuss the rules given by law, allowing for a restorative process, rather than a process characterised by punishment and a strict following of rules. Christie states that those suffering most from crimes are suffering twice, as although it is the offenders being put on trial, the victims have very little say in courtroom hearings where mainly lawyers argue with one-another. It basically boils down to guilty or not guilty, and no discussion in between. Christie argues that running restorative conferencing sessions helps both sides to come to terms with what happened. The victims of AI crimes would not only be placed in front of a

court, but also be offered engagement in the process of seeking justice and restoration. Restorative justice might support victims of AI crimes better than the punitive legal system, as it allows for the sufferers of AI crimes to be heard in a personalised way, which could be adopted to the needs of the victims (and offenders). As victims and offenders represent themselves in restorative conferencing sessions, these become much more affordable (Braithwaite, 2003), meaning that the barrier to seeking justice due to the financial costs would be partly eliminated, allowing for poor parties to be able to contribute to the process of justice. This would benefit wider society and AI technologies would not only be defined by a powerful elite. Restorative justice could hold the potential not only to discuss the AI crimes themselves, but also to get to the root of the problem and discuss the cause of an AI crime. For Braithwaite (1989) restorative justice makes re-offending harder.

In such a scenario, a future AI system capable of committing AI crimes would need to have a knowledge of ethics around the particular discourse of restorative justice. The implementation of AI technologies will lead to a discourse (Sample, 2018b) around who is responsible for actions taken by AI technologies. Even when considering clearly defined ethical guidelines, these might be difficult to implement (Conn, 2017), due to the pressure of competition AI systems find themselves in. That said, this speculation is restricted to *humanised artificial intelligence* systems to be part of a restorative justice system, through the very human emotion of shame. Without a clear understanding of shame (Rawnsley, 2018) it will be impossible to resolve AI crimes in a restorative manner. Thus one might want to think about a humanised, cyborgian (Haraway, 1985; Thompson, 2010) proposal of a symbiosis between humans and technology, along the lines of Kasparov's advanced chess (Hipp et al., 2011), as in advanced jurisprudence (Baggini, 2018), a legal system where human and machine work together on restoring justice, for social justice.

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Designing Technology for a Symbiosis Between Natural Systems and Information Infrastructure

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Abstract

This paper is an intermediary between the bio-art sculpture *Mycocene* (2018) created by the collective somme, and the theory that led us towards creating it. *Mycocene* is a hybrid work that blends bio-art, sculpture and media art through the methodology of bricolage. It critiques the current human-technological relationship and its subsequent effects on the environment. Humans have created a symbolic bubble around themselves that attempts to separate them from the natural world. *Mycocene* acts as a conceptual bridge between this anthropocentric bubble and the natural, aiming to exist as the opalescent residue between them and a discussion point around dissolving their membranes.

Keywords

Technosphere, Physarum polycephalum, mycology, systems theory, sentience, autopoiesis, complexity, biosphere, homeotechnology.

Introduction

In this essay I try to grapple with large-scale questions around the human-technological-biological relationship, informed by theories that were influential in the creation of my collective's work *Mycocene. Mycocene* is a bio-art sculpture that occupies a small isolated room. The sculpture explores the relationship between biological systems and information communication technologies (ICTs) through its use of six sculptural segments. In the center of the room a colony of slime mold is housed in an isolated container. Its container is connected to the five other sculptural segments positioned around the space. Each of these segments is composed of discarded electronic waste (e-waste) fashioned into automated, kinetic forms. The automation within the "obsolete" e-waste sculptures is activated by the bioelectrical rhythms of the slime mold, monitored throughout the duration of the exhibition. *Mycocene* is largely informed by three main theories: Peter Sloterdijks's concepts of spheres (and subsequently Peter Haff's concept of the technosphere); systems theory, autopoiesis, and boundary formation; and Sloterdijks' concept of homeotechnologies using the fungal "ecological internet" as a model.

Spheres & Bubbles

The Earth is divided into four spheres, the atmosphere, hydrosphere, geosphere, and biosphere. We exist in the biosphere—a term coined by geologist Eduard Suess in 1875—that constitutes an interconnected web of plant, animal, fungal, and microbial life. [1] The word sphere denotes a surrounding, a space that encapsulates yet separates. The biosphere is omnipresent, it is a vast ecological system containing smaller ecosystems, all of which are constantly keeping themselves in balance through processes such as growth, decomposition, and energy exchange. Though omnipresent, any *sphere*, such as the biosphere implies a separation. It's important to note separation does not necessarily equate to isolation but a constant state of boundary formation and reformation. These boundaries are still permeable to certain processes of information and energy exchange. While semi-separate, each sphere delicately affects and balances the others while having their own internal processes. The German philosopher Peter Sloterdijk's theory on spheres helps us look at the immaterial construction of spheres. [2] He claims that humans have gradually constructed a binary between themselves and the natural world by surrounding themselves in the comfort and order of the technological. In his words, humans have been "building artificial 'spheres' in order to immunise – i.e. protect—[themselves] against the threatening outside world." [2] This technological immunization lets us feel in control of our environment, but its order operates entirely outside the sphere of the biological.

We have reached a point of saturation in our technological evolution. Our mass production of electronic technologies has forced a wedge into the biosphere, causing it to pop and foam into two—the biosphere *and* the technosphere. The term technosphere was first used by the geologist Peter Haff, in what he describes as the "physical properties of a human-technological system that takes on a role equivalent to the biosphere." [3] The sheer amount of material produced to create our information-era landscape has become so large it

is not only affecting the geological record but the operations of other spheres as well.

Figure 1. The material component of the technosphere is present in the totalities of electronics both produced and discarded. ©The Basel Action Network

On one side, the biosphere is self-sufficient, autonomous, and, in a sense, balanced. Energy is spread among ecosystems; when one organism dies, it is decomposed, reabsorbed and redistributed. The biosphere involves all organisms in a back-and-forth exchange of energy, feedback, and adaptation. The technosphere is completely non self-sufficient, it relies entirely on humans for its maintenance and distribution. When electronic technologies reach the end of their life, they have no means to recycle their minerals and become waste (Figure 1). This problem manifests in the form of "end-of-life" electronics, a product of Capitalism speeding up technological innovation in the name of profits. Electronics are constantly produced and replaced so we can usher in faster and better modes of information transfer (i.e. 4G, LTE, Fiber-optic internet). [4] The process of making these electronics mines and destroys the Earth, and when they expire, they are discarded, leeching toxic chemicals into the Earth's soil or oceans wherever they land. The issue here is that the current paradigm around technological production (and usage) does not reflect the way the biosphere operates.

Autopoietic systems

In opposition to current technological models, the biosphere relies on the concept of self-regulation to maintain itself. The biosphere is not truly balanced but instead relies on the concept of adaptation and evolution, which operate under the principles of complex adaptive systems (CAS). CAS is a theory stemming from general systems theory, first described by the biologist Ludwig von Bertalanffy in the 1940's. "General systems theory implies that a system is a cohesive conglomeration of interrelated and interdependent parts that is either natural or man-made… Changing one part of the system usually affects other parts and the whole system, with predictable patterns of behavior." [5] To understand systems within the biosphere, we need to think in scales. We must consider systems within ecosystems, systems within organisms within ecosystems, systems within cells within organisms, and so forth. All these biological systems have a common thread, feedback. Early ecology perceived biological systems as fixed and predictable, whereas AST views them as adaptive and self-regulatory. From single cells up to complex organisms like humans, regardless of nervous systems, we see self-organization and adaptation through feedback. When confined within boundaries, such as a cell wall, this organization is a self-regulation called autopoiesis. The term was introduced in 1979 by the biologists Humberto Maturana and Francisco Varela to explain the self-maintaining chemistry of living cells, a process which may be paraphrased as:

> "a system organized of self-referential components that consist of a network of processes of production (transformation and destruction). Through their interactions and adaptations, they continuously regenerate using the system's network of relations. They constitute the system as a unified topology within the space they exist, defining boundaries from their environment without closing off information exchange" (Figure 2). [6]

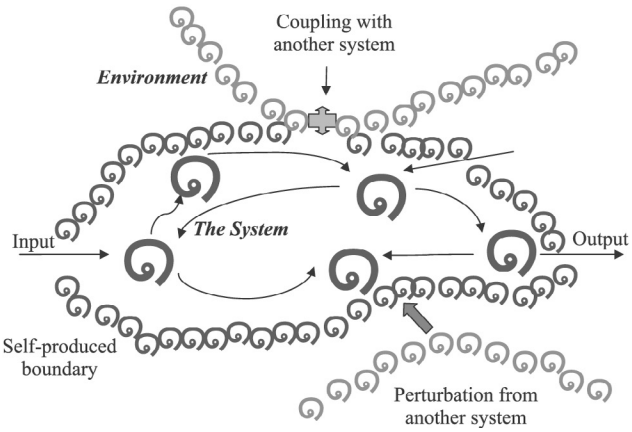

Figure 2. Autopoiesis diagram highlighting internal self-regulation, boundaries, and information exchange.

Feedback can either be control based (negative) or consuming (positive). To self-regulate, a system must go against the second law of thermodynamics - that entropy increases within isolated systems. To do this autopoiesis governs regulation via negative feedback loops. As an example, let us think of a home thermostat. In order to monitor temperature, it will sense actions from its exterior environment (the room) and then respond in order to regulate how much or little it needs to act on the environment to maintain a constant temperature. In simplified terms, one can represent this action in a while loop, a code-based control flow (Figure 3)In our thermostat scenario, TRUE is assumed to be met until it heats the environment to a set temperature, otherwise it is FALSE and discontinues heating. This is a control mechanism due to the fact entropy will always try to destabilize this regulation through the escape of heat. Sensing is

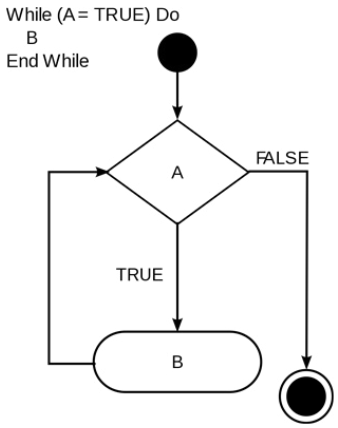

Figure 3. UML diagram of a while loop. ©P. Kemp.

crucial to feedback; it must be acted on and respond to that action. Positive feedback may include sensing but does not require it. Instead of monitoring and responding, it responds with an increase in the initial action. A condition being met executes a chain reaction of energy spending without a termination mechanism. To order a system, positive feedback may be present, but autopoiesis requires predominantly negative feedback to maintain control of internal processes. [7]

The more processes a system contains, the more complex it gets. [7] Complexity is often associated with difficult problems, the reason for this is the exponential difficulty in solving a complex problem as its variables rise, each of which further compounding the amount of possible solutions. In the scope of CAS, "complexity is considered "a group of 'agents' (individual interacting units, like birds in a flock… existing far from equilibrium, interacting through positive and negative feedbacks, forming interdependent, dynamic, evolutionary networks". [8] If cells are self-organized out of molecules, and bodies self-organized out of cells, then colonies and cities are self-organized out of organisms. Figure 4 represents organisms as agents (in this case birds in a flock) interacting as a complex group. As can be seen, a structure is formed by the individual actions of the agents, manifesting on a hierarchical scale. Using feedback (to proximity), the birds avoid colliding with one another, and through this process *emergent* behavior forms. Systems cannot be solely defined by their parts. We need to holistically examine the system to see how these parts interact and what emerges out of them. A common biological example of emergence comes from ant colonies. The colony is ordered in a way that exhibits emergent properties. These emergent properties exist separate from the sum of their parts. [8] An individual ant does not "know" its role in the system, it is acting on a combination of sense, instinct, and adaptation. If it is hungry (and a forager), it knows it must search for food. Each individual action relies on feedback from the whole, and as the number of agents grows new patterns emerge that are not the intention of any individual; emergent behavior is the tipping point where the behavior of the whole does not reflect the behavior of the individual. Complex systems emerge out of smaller self-regulating

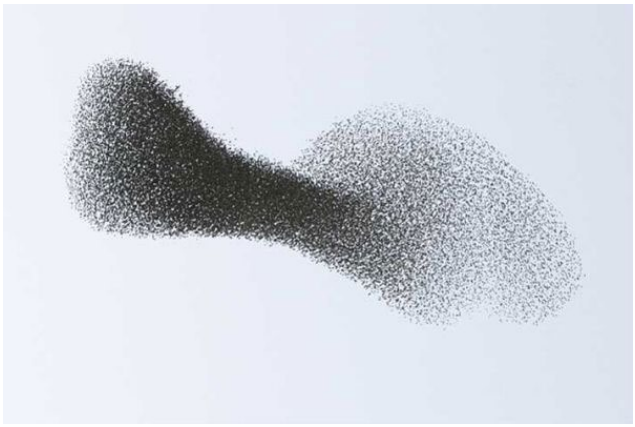

Figure 4. Flocking is a form of hierarchical complexity within natural systems. The birds (organisms) use proximity feedback to form an emergent structure during flight. ©Manuel Presti.

clusters. An ant's body is homeostatic, it self-organizes itself in opposition to the external environment. Here the body acts as a boundary to its environment, yet the body still interacts with that environment. When hungry, it searches for food, and eating that food affects the environment. There is feedback between boundaries, if we are to follow a previous train of thought: if ecosystems are self-organized out of colonies, and the biosphere is self-organized out of ecosystems, one might say it is possible the planet is self-organized out of its separate spheres. Since systems interact with other systems through permeable boundaries, information and energy exchange can trickle across spheres. The scope of such a hierarchical system's agency is outside the scope of this essay, the important point to remember is systems are hierarchical and any change at a local level can affect the system on a larger scale.

Homeotechnologies

If entropy is the state of disorder, we can say negative feedback reduces entropy. But could we not say the same thing about information technologies? By creating digital technologies are we not creating order? One of the defining characteristics separating our current ICTs and biological systems is randomness. Biological systems organize and adapt, a process that requires a degree of random action. As we move up system scales randomness leads to increasing potential for adaptation or unpredictability. Even with the vast number of components involved in modern ICT infrastructure, the components are predictable, they do not adapt, a requirement that would assume environmental sensing and acting, or mutation. Instead, when machines such as ICT infrastructure employ feedback strategies the outcomes will always be consistent. [6] If technology is to behave fundamentally analogous to biological systems, we must include random processes and self-regulation. Peter Sloterdijk has built a foundation of theory for designing symbiotic technologies that avoid using nature as a function to be mimicked, instead designing technologies that operate under the same fundamental principles. [2] While studying biomimicry - the

methodology of designing technologies based *on* natural principles - he realized that mimicry alone does not bridge the divide between the biosphere and technosphere. Biomimicking is designing based *on* nature rather than *synonymous* to it (i.e. modelling aerodynamics of birds is biomimicry but does not behave systematically similar to a bird's flight). In response to biomimicry, he coined the term homeotechnology to mean designing "alike" to natural processes. [2] Homeotechnologies are unique in the sense that they exist outside the technosphere. They are technologies, but if we return to Haff, they do not have a "role equivalent to the biosphere", for they do not impact the Earth's spheres but are self-regulate with them. Due to their regulation, they could theoretically interact and adapt with the biosphere, rather than leeching from it. As a model for how homeotechnological ICTs may operate, let us look at the example of the "ecological internet".

The Ecological Internet

Within the biosphere lie many gigantic, complex examples of self-regulating, sentient systems –mycelial internets. Mycelium is the most common state of fungal organisms. It is a thread-like web of branching cells chained together with string-like 'hyphal' structures one cell wall thick (allowing nutrient exchange with its environment). [9] These networks exist underground and can cover entire forest ecosystems. Mycelial "internets" consist of a variety of co-existing species such as mycorrhizal fungi (fungi that form symbiotic relationships with plants). Mycorrhizal fungi can break down specific elements in the soil such as nitrogen that plants cannot (Figure 5). These fungi connect to the plant's roots and exchange nutrients in return for food in the form of sugars. Symbiotic exchanges are common in nature, but studies found that the exchanges between mycelium and surrounding plant life, benefit forest health with no immediate benefit to the mycelium. [9] Exchanges between mycelium and the forest ecosystem go against the Darwinian dogma of survival of the fittest. This observation is again examining individual agents within a larger system. I speculate that the larger CAS at play benefits from the symbiotic networks, which in turn benefit the mycelium as part of the system. Regardless of the cause, these operational processes are fundamentally different from ICT networks we maintain today. While the technological internet sends and receives information on request, the mycelial internet operates with energy through biomolecules. Our technological internet infrastructure sends discrete data "packets" (small units of binary values) along its network, receives a response (sometimes), and responds using a protocol (which will never involve randomness or adaptation). In contrast, the mycelial internet is sending biochemical elements (as information) along their tendrils. Due to their biological nature, randomness causes new processes to arise allowing evolution and adaptation. "[Mycelial] systems are aware, react to change, have the long-term health of their host environment in mind, and devise diverse enzymatic and chemical responses to challenges." [9] ICTs are unable to process change and are therefore disconnected from biological systems. Homeotechnologies would instead reflect the mycelial internet, using sentience to adapt.

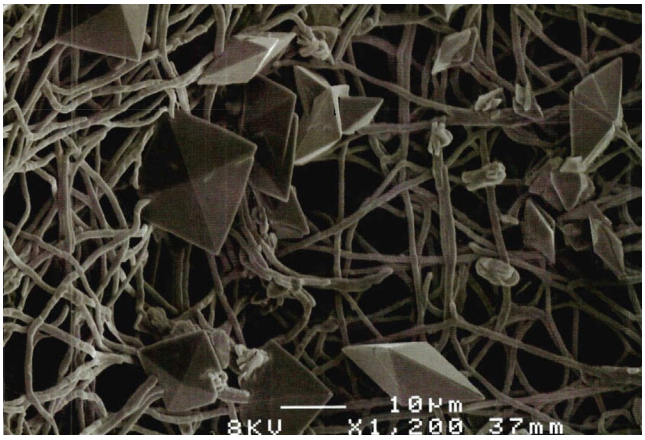

Figure 5. Mycelium creating Oxalic acid by digesting rocks in a dynamic soil sample. ©Bill Cheswick and Hal Burch

Sentience has been previously defined as the ability to sense *and* emotionally process an environment subjectively, but in an autopoietic sense in can be defined as "sensing of the surrounding environment, complex processing of information that has been sensed (i.e. processing mechanisms defined by characteristics of a complex system), and generation of a response." [10] Sentience plays a key part in CAS, without it there could be no adaptation. Within *Mycocene,* somme worked with the organism slime mold, formally known as *Physarum polycephalum.* Slime mold was chosen due to its example of autopoiesis in a colony setting. Slime mold is a single celled organism but operates under a collective "slime". Its sentience comes from its ability to "communicate" with other cells in the colony, which relay information they have sensed in their environment amongst each other. In Figure 6 we can see the slime mold foraging for food in it's environment – it's yellow tendrils can be seen inching towards the detected source while other pathways are abandoned. Because the way they convey information utilizes biological feedback, emergent behaviour forms (i.e. complex problem-solving capabilities). [11] Using the models of the ecological internet and slime mold (which I will expand further on below), we can start to think about how to create homeotechnologies that behave analogously to biological systems.

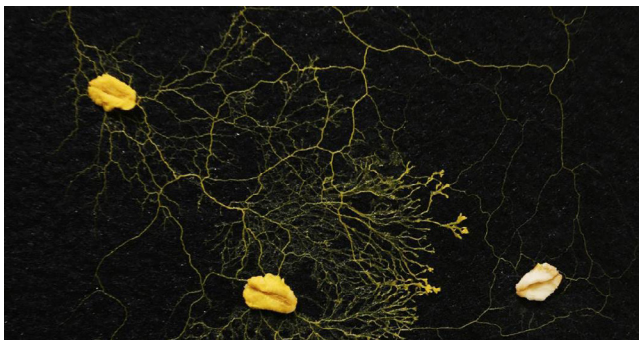

Figure 6. Slime mold sensing its environment for oats. ©TedX.

Artistic Manifestation

Mycocene is a room sized installation occupying a dimly lit space. The viewer's attention is immediately to the center of the room. A bright green light bathes a container of slimy fungal-esque cells. The container is suspended from the ceiling, upon approaching the cells the viewer notices branching electrical cables inside the container. Electrodes are monitoring the cells, the signal flowing outside the box into an oscilloscope mapping their pulse onto a green waveform. Large industrial cables branch outward from the container trailing off to five sculptures, each an organized cluster of various electronic waste components. The sculptures all highlight various stages of decay, remnants of the global technosphere. The e-waste is dimly lit, in one a CD drives sputter, another displays a feed of security cameras autonomously scanning the room, a third suspends hard drives above the others, scanning their drives to the rhythm of an organic pulse. Each sculpture contains e-waste microphones, broadcasting a live disconcerting symphony of their motors, discs, and lens pulsed back from obsolescence. Their chorus of sound and movement is controlled by an organic rhythmic pulse flowing out of the slime mold and through their circuitry.

Figure 7: The suspended container of Physarum polycephalum and their silver electrodes. ©somme.

Mycocene attempts to create symbiotic communication between living materials working in unison with technological bodies. It attempts to create Peter Sloterdijk's concept of a homeotechnology – a technology that works in parallel with natural systems. Here, the central homeotechnology is the custom-built container for the slime mold. The container is embedded with silver needle electrodes that send an electrical current through the cells. The cells take up the current and allow it to flow through their cell membranes. This current encourages growth through a process known as galvanotropism (stimulation of cell growth with electricity). As they grow towards the source of the current, the other electrodes, a circuit is completed, creating a biological circuit. The slime mold allows electricity to flow through its plasmodium. As the plasmodium pulses to transport cells it

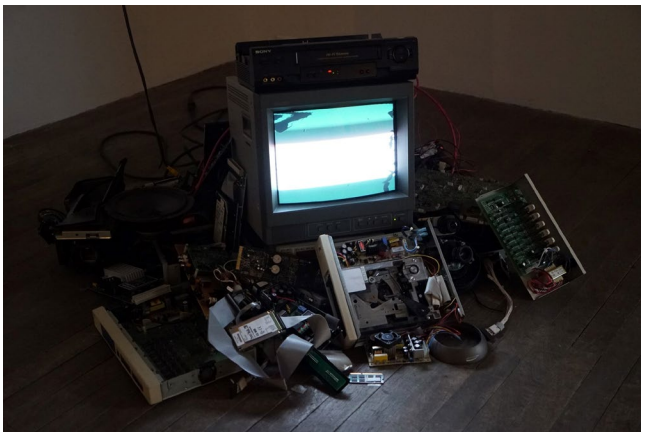

Figure 8: A cluster consisting of a CRT monitor with a surveillance camera embedded in the sculpture, providing live feedback (where the transmission is scattered by aged components) to the viewer. ©somme.

modulates its resistance values. The resistance is the amount of electricity that doesn't make it through the circuit. Using this value, we can calculate changes in growth and convert the digital values recorded into a form readily readable for the electronics. Digital technologies transmit data based on discrete 0s and 1s, while analog technologies require a waveform to read in data. To communicate between devices, we take the digital data and create a series of reference points. We can then map the time and decrease in the resistance values into output voltage. This voltage is called control voltage, or CV, and communicates with the clusters of electronics via ON/OFF voltages at 0v and 5v. This directly ties into the timing of the cluster actuation. By measuring the growth of the slime mold we can detect how much it is sensing, and map it's sentience onto the clusters.

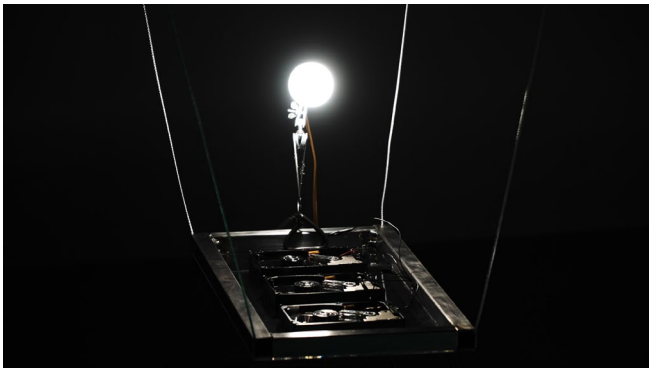

Figure 9: A sculpture consisting of cameras, CD drives, motherboards suspended in the room. ©somme.

Discussion

Mycocene positions itself as the membrane between spheres, coalescing the bubbles of the technosphere and biosphere into a unified whole. One way to collectively start designing for a sustainable future is to consider the three

core theories covered by *Mycocene* as stepping stones into a garden of technologies inseparable from the systems surrounding them. The first step in this coalescence is to reconceptualize how we design technology. Homeotechnologies offer us a design methodology that creates symbiosis between the two spheres. Secondly, we must dissolve both the conceptual and material bubble that has become the technosphere. No longer can we isolate and immunize ourselves from the natural world in order to gain a sense of immediate control. The element of control that manifests out of the technosphere is one out of sync with natural systems. The last step is to consider ways of composting the current material traces of technology. We must find a way to utilize or decompose the existing technospheric waste in a beneficial way.

Designing Homeotechnologies

Both our technosphere and biosphere operate as systems, the biosphere being a complex, emergent system, and the technosphere a static one. The line that separates the two is the process of randomness. In complex systems there is always a chance for mutation and emergence, patterns that emerge outside of their regular functioning. Even if the technosphere was complex enough to emulate the biosphere in its current form it would be mechanic. Every outcome would be the same because its programming cannot evolve. [6] To overcome this boundary, we can use Sloterdijk's concept of homeotechnology. Homeotechnologies move beyond the concept of a bio-mimicking technology for a kind of technology that, at its core, functions as a complex system.

Before I propose methods of designing homeotechnologies, it is useful to again look at why we should be designing them. While the biosphere operates on self-regulatory mechanisms and non-discrete processes (not reducible to 0 or 1, as in digital technologies), the technosphere is non regulatory and discrete. As an example, ICTs are the backbone of the modern technosphere. Yet, these ICTs do not regulate with their surroundings. They are unaware of natural processes; they are unaware of their origin or their impact. ICTs connect the entirety of the global technosphere together using large industrial sized server farms, creating a massive network of communication. This element of the technosphere connects most of humanity, but further isolates us from nature by reducing our communications to binary packets to be signalled through isolated channels, never to be acted on by nature.

Mycocene is symbolically shaped to represent server farms that have expansive information cables, spreading like roots across vast oceans and connecting communities by wire and tower. *Mycocene* further mirrors vast ICT networks with its positioning of central processing (the slime mold container) and cables branching towards its clusters. Each of the connected sculpture shadows the impact of the technosphere through their representation as mass piles of electronic debris, yet resurrected by the slime mold, a metaphor for the potential remediation of ICT systems and their redesign to include natural systems.

As aforementioned, the "end-of-life" design that plagues the design of technologies is causing the extraction of minerals, destruction of the environment, and subsequent pollution of the environment through their disposal. Waste products are shipped out of sight from the consumer, but *Mycocene* shifts the observer's lens to make the entire cycle visible. It is clear that information technologies are a beneficial tool to humans, yet the ethos behind their production is not sustainable. Homeotechnologies break this cycle by designing within the systems of the biosphere, allowing them to sense and react with their surroundings.

One homeotechnology that directly involves the biosphere as we know it is biocomputing. Biocomputing constructs computers out of organic materials, whether that be DNA, cells, or even entire organisms. These computers need not follow the digital paradigm and can operate systematically, as they do in nature. *Physarum polycephalum,* the organism used in *Mycocene* was chosen as the representative of homeotechnologies because it happens to be an organismal biocomputer. Slime mold has been proven to have the ability to solve complex computational problems such as the "Travelling Salesman" problem. Researcher's at the University of Tokyo were able to calculate network efficiency of the Tokyo rail lines using slime mold as a biocomputer (below). [12]

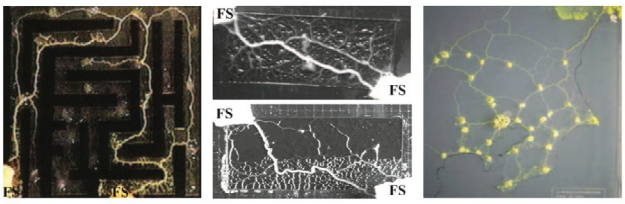

Figure 10: From left to right: a) example of maze-solving by physarum. (b) Examples of connecting path in uniformly/nonuniformly illuminated fields. (c) A tubular network formed by the physarum for multiple food sources, which could be applied to Tokyo rail system design. ©Liang Liu. [12]

This method of computing relies on the communication pathways in the slime molds plasmodium. Instead of approaching the problem discretely, the organism uses sensing and communication to analyze its environment. Any error made initially is corrected by the emergent dynamic of the group, or more interestingly, these errors can lead to solving the problem itself (emergent behaviour). As for its logic capacity, *Physarum polycephalum* has the potential to be used as both an organic logic gate or a memristor. [13][14]

Within *Mycocene*, somme created a rudimentary monitoring system for slime mold using silver needle electrodes. These electrodes monitor resistance values (within the plasmodium) and communicate with the scattered technosphere of the room. This process may be classified as homeotechnological through its integration with complex systems. To

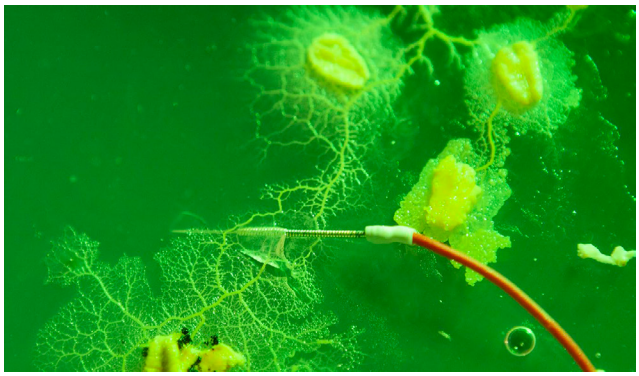

Figure 11: Silver electrode needles used to induce bio-electrical conduction and subsequent resistance measurements. ©somme.

create a truly homeotechnology *Mycocene* would require feedback from other systems within its environment. So *Mycocene* is not designed as a homeotechnology itself, but a hybrid technology hinting at the possibility of bridging the current technosphere with the biosphere. The biosphere itself is manifested in the project as the slime mold container – a biological sensory device – that communicates with the non-systematic technosphere. One potential step forward may be building these semi-homeotechnologies to monitor and relay environmental feedback to ICTs, for example. The ecological internet, mycelium, already function in a similar manner to ICTs, but again, rely on environmental feedback. Because the organisms have basic sentience, they are able to respond to their community and supply beneficial nutrients when needed. Using methods of sensing akin to those in *Mycocene,* a symbiotic communication network might be constructed using mycelium and ICTs to sustainably monitor environmental conditions like forest health.

Popping the Bubble

Designing homeotechnologies offers us a tangible way out of technospheric design, but isolated design products will not "pop the bubble" without a reform; we must think about the creation of technology in a newly paradigmatic way. In essence, we need to work towards a paradigm shift – in which "the dominant paradigm under which normal science operates is rendered incompatible with new phenomena" [15] - in both product design and the sciences. Humans have become part of what Stiegler calls spherical immunization: "the loss of knowledge, both practical and theoretical knowledge, which finally leads to the loss of the knowledge of living [savoir vivre]. This is because once the know-how [savoir faire] is short-circuited by artificial organs… taking over more and more functions and responsibilities of the human subjects and social institutions that together form a global technical milieu". [16] Building off Steigler's definition, the most important step forward is an emphasis towards the deconstruction of "technological innovation" and isolation. We must discuss the relation of our "artificial organs" to living systems.

A more holistic view of systems is appropriate if we are to start discussing the impact of the technosphere. The sciences are built off of the methodology of reductionism. To prove an idea, it must be reduced to a logical binary, either something is or isn't. Of course, this is useful for many sciences, I am not debating that here. What I am debating is that if we are to change ideas at a local level, we must discuss technology as having a macroscopic influence. Systems cannot be reduced, they flow emergently upwards, they are the antithesis of reduction. We must follow and make transparent the impact of all technologies in our creation, usage, and disposal phases if we are to change the paradigm of thought surrounding technological innovation - it can no longer be isolated.

Mycocene stands as a conceptual idea that seeks to make transparent and encourage discussion of issues surrounding this "immunization". The discussion of ideas is the discourse needed to thread the needle of the new paradigm and pop the bubble of the technosphere. *Mycocene* encourages discussion through several methods. One, a natural curiosity arises when one is presented with slime mold as a technology. The idea that the biological can interact with technological systems dissolves the idea of the allotechnology (bio-mimicking, discrete, or not-alike to the natural) as dominant. Furthermore, the actuation of electronic waste within *Mycocene* questions the timed obsolescence of technology. Each sculpture has functioning components, most of them being fully functional before adaptation for the work. Much of the waste was disregarded for the reason that data read and write speeds have improved, or a new data medium was introduced. While rewiring the electronics we found that many chips were specially encoded by the creator to be static. Meaning, they *could* be updated or used elsewhere but the encoding would not allow the device to change, a perfect example of planned "dating". These are the aspects of the technosphere that are often not discussed, *Mycocene* brings them into an artistic discourse.

Compost and Compositing

Both designing homeotechnologies and changing the paradigm around the technosphere are goals we should work towards, but there is a more immediate step. The technosphere has littered the planet with electronic waste which must be composted if we are stop the pollution of our water, soil, and air. One of *Mycocene*'s core inspirations and design principles comes from fungi. Fungi not only represent a way of thinking about biological relations but may also offer us a solution to decomposing waste, mycoremediation. Mycoremediation is a direct, sustainable method for rebalancing the biosphere from the accumulated parasitic damage of the technosphere. Several types of fungi are capable of absorbing toxic metals (within soil) through a process known as hyperaccumulation. Hyperaccumulation is a property that allows fungi to absorb a high concentration of toxins, such as lead, cadmium, mercury, and arsenic (among others) in their fruiting bodies (mushrooms) for later removal. [17] By using mycoremediation we can take an immediate and achievable step towards mitigating damage to the biosphere.

Conclusion

In conclusion, through *Mycocene,* the collective somme is seeking to encourage discussion about potential futures that operate symbiotically between technology and the natural environment. By discussing how the planetary can be affected by the local through spheres, systems theory, autopoiesis, and homeotechnologies, we can begin to encourage visions of a future without a technosphere. In order to start creating technologies within the biosphere, we must look at how future homeotechnologies can communicate between existing ICT infrastructure and natural systems, then work towards developing complete homeotechnologies that replace this infrastructure. To do this, a new paradigm of thought is required - one that centers technology part of the biosphere. Even after this point, the technosphere will remain through its waste. Using myco-remediation we could take the final step towards erasing the technosphere by cleaning up its toxins. I am not arguing we are close to this paradigmatic shift, I am instead encouraging us all to think of ways we may finally pop the bubble.

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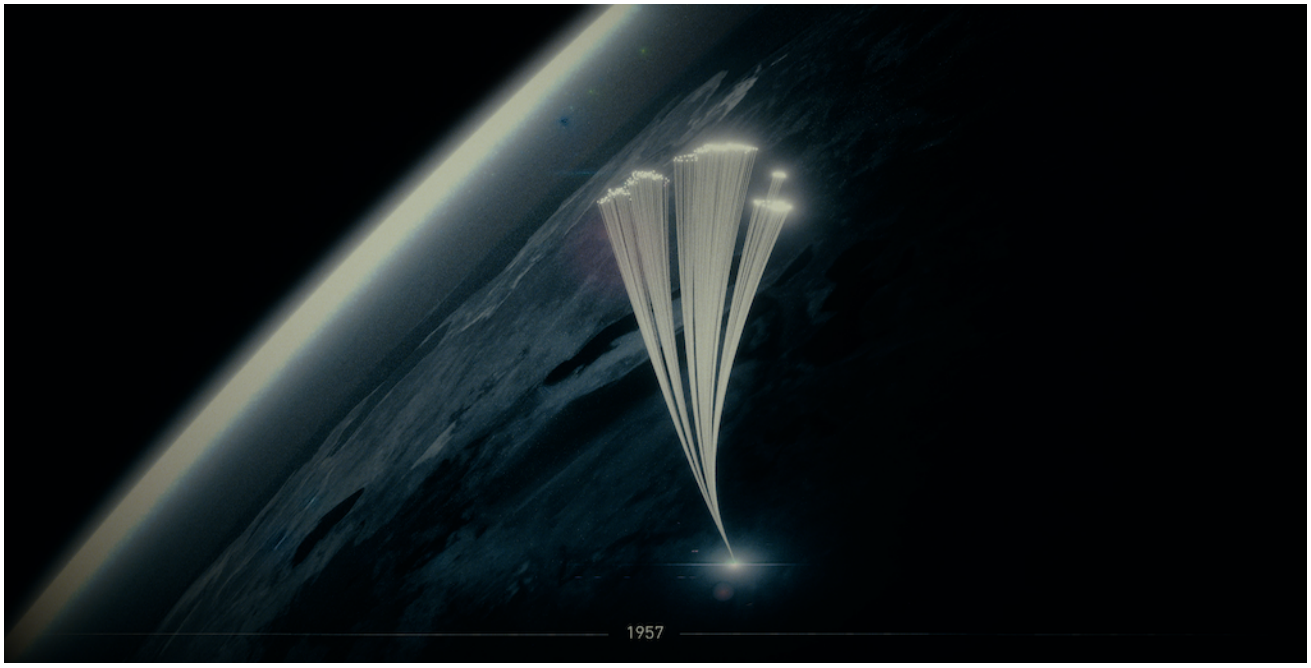

Figure 1: Still from *Celestial Mechanics V: Reaching* depicting multiple launches from Baikonur, Kazakhstan ©Copyright Scott Hessels

The Art of Trajectory: *Celestial Mechanics V*

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Abstract

How time is represented graphically has taken many forms but most commonly as a line. This simple visualization is founded in man's first drawings and advanced in sophistication in tandem with advances in projectile weaponry which required the additional representation of space. Trajectory, a timeline through a space, is now the standard method of revealing aerial machine movement. *Celestial Mechanics* is a two-decade research project addressing the need for a multivariant visual system that represents the current realities of aerial traffic management and congestion for better public understanding of the dangers. The unique design challenges of a single display capable of delineating all layers of movement—drones, helicopters, planes, weather balloons, layers of satellites, debris—often begin with the rudimentary tool of showing journey as a line. This paper considers the history, design and eventually art of the trajectory.

Keywords

Data Visualization, Animation, Aerial Traffic, Aerial Congestion, Design History, Semiotics

Introduction

The representation of movement as a line through space, in both 2D and 3D contexts, is seemingly obvious yet has a history that parallels the larger developments in visual representation. It has settled in as the de facto visual tool to show objects in flight, beginning with primitive weapons up to computer simulations and displays in both the aeronautic and aerospace industries. The *Celestial Mechanics* research addresses the real-world problems with aerial congestion through speculative design concepts and artworks that challenge traditional display systems and semiotics of the hardware above us. The complexity of the design issues has led to side explorations in specific threads, e.g. how space can be visually compressed, how kinetic display can be utilized, the possibilities of VR simulation, *etc*. It hopes to also raise public awareness of the safety concerns as well as foreground the political, economic and cultural forces that now control our skies.

The most recent iteration of the research entitled *Celestial Mechanics V: Reaching* is an animation that shows the launch trajectory of every rocket to pass the Karman Line—the 100km border between earth's atmosphere and space—since Sputnik's inaugural piercing of the line in 1957 (Figure 1). The short film used datasets from NASA and European partners to accurately calculate the initial arc of over 5,000 launches and then visualize them on the globe at their sites and dates.

The duration of the research has also revealed larger questions. As it transitions towards more emotive representations, it surrenders attempts for one holistic display of the entire techno-system in the sky. We may be at a juncture where we no longer require a sophisticated visualization to understand and solve problems, as computers can increasing address dangers that we cannot translate to images. Seeing is no longer connected to believing as it once was.

The Trajectory of the Trajectory

A 1669 image from Mariner's Magazine shows the line of arc of cannon-fired projectiles at varying heights and shortly thereafter in the 1690's the word 'trajectory' first appears in the meaning that holds today, "the curve that a body describes in space" [1]. In our long history of flinging things at each other, it took us until 1700 to label the scientific visualizations to improve our aim.

As our weapons have developed, so has our representation of their trajectory. Ballistics, the study of the movement of projectiles that do not have their own propulsion, didn't appear until after a millennium of empirical development—stone tipped spears going back 64,000 years, bows and arrows 10,000 years, and China's first guns around 1,000 AD. It wasn't until the 1600's that Galileo began to explore the parabolic mathematics involved and Newton factored in the laws of motion and gravity that made it possible to more accurately predict where our cannonballs would land.

While the visualization of trajectory became more sophisticated due to the development of weapons, it's rooted in two of the most foundational design quests—how we represent time and space. The metaphor of the simple line has served as a key figure in the representation of time in almanacs, calendars, charts, and graphics of all sorts [2]. In the 4th century, the Chronicle by Christian theologian Eusebius used rows and columns to show Christianity's history and served as the model for timelines for centuries to come [2]. In the Middle Ages, illustrations to show biblical genealogies continued the use of the line as the foundational graphical visualization of time [2]. Temporal visualizations showed major advances in the engraved charts of Girolamo Martignoni, an Italian poet and scholar, who merged chronology with cartography [2] and Joseph Priestley's A Chart of Biography from 1765 and A New Chart of History from 1769 that regularized the distribution of dates of the chart and oriented it horizontally to show a continuous flow of time [2]. The timelines of these visual pioneers still influences how we create time-based data representations today.

When paired with advances in perspective and dimensional representations, the lines have also become the foundation to visualize the space around the moving objects. Starting with the 14th century techniques to visualize the world as a 3-D space [3] and now with VR and game space fly-throughs, the malleability of spatial representation is only challenged by our questionable comfortability with single point perspective. That favoured perspective has led to a centuries-long dependence with cartographic tropes that began with maps and were applied to satellite imagery. Despite the technological advances involved from collecting data from satellites, the resulting images are still flattened to mimic our single-point perspective [3]. Also limiting is culture's 20th century shift to the 'God's Eye View', where things that we experience directly here on earth, *e.g.* weather, are viewed from the illogical point of view of outer space. Although above us, most displays of aerial traffic are oddly from an imaginary eye above the machines and looking down back down at us.

We continued with the same visual language of the trajectory with the advances in computational representation of aeronautics and astronautics in the second half of the 20th century. The cross-pollination of these ideas can be seen in a mid-century creative interest in visualizing movement. In the sweeping gestures of Jackson Pollack's action paintings, the thickness and spray of the colors clearly show the arc of movement through space. Perhaps the most direct example is John Whitney Sr. who literally created his art with hacked military trajectory displays. Working at Lockheed in the Aircraft factory, Whitney saw the grace of design in the arcs being revealed through high-speed missile photography. His customization of anti-aircraft technology provided some of the first foundations in the art and design of motion graphics. (4,5)

Over time, the word 'trajectory' has become metaphoric and often even poetic, as it's used to cover histories of careers, movements, migrations, and more. The trajectory of the trajectory has transitioned from cannonball to trope. However, one must remember that it is also an artistic one, in a sense one of our first data visualizations.

Celestial Mechanics V: Reaching follows the last century's space race through recreations of each rocket leaving our atmosphere, presenting decades of competitive international launches as symbolic, poetic, revelatory; a story told in trajectory.

The Invisible Emergency Above Us

In recent years, a rush of personal drones, private jets, backyard launches, space tourism, and off-brand satellite companies are creating catastrophic consequences in the skies and orbit, once the exclusive domain of military and government institutions. Airspace is at a moment in history when it is transitioning towards both privatization and personalization. The era of government-only access when only a few were allowed into the skies above us has ended.

The dangers of aerial congestion are literally wide-ranging. During the California forest fires in 2018, water bearing

helicopters could not reach their destinations due to the number of personal drones in the area, resulting in the loss of millions of dollars of property [6]. Already in 2009, satellites were accidentally colliding, producing debris fields that endangered the International Space Station [7] compounded by additional exospheric trash resulting from Chinese anti-satellite tests in 2010 and 2018 [8] As early as 1978, NASA has warned that the debris field could make space travel too dangerous [9].

Despite the proliferation, each industry using our airspace generally only focusses on their own assets, often ignoring competing companies. However, more concerning is that each also stays within a specific aerial altitude range, treating the verticality of the problem as lanes of traffic. A multivariant visual system capable of a broader understanding and coordination is needed to address the current aerial reality.

About the *Celestial Mechanics* Research

Since 2004, Hong Kong-based American sculptor and media artist Scott Hessels has been highlighting the complexity and dangers of aerial congestion through a series of speculative designs, kinetic sculptures, immersive systems and data visualization animations under the research name *Celestial Mechanics* (2004-2019). The name is a pun on Celestial Mechanics, a branch of astronomy that studies the motions of objects in outer space in the disciplines of astronomy and physics [10]. Dozens of designs and artworks have presented different aspects of the hardware above us. Projects have highlighted the numbers and behaviors of aerial objects, the expansive spatial differences, and the semiotics of how multivariant systems can be explained to the public. Stratified aerial traffic has been explored through a hybrid of informative data visualization and evocative information arts. The research fluidly mixes science, statistical display, and contemporary art by presenting these mechanical patterns, paths and behaviors as a dynamic visual experiences [11].

Celestial Mechanics has benefitted from the acceptance that speculative design has emerged as a research strategy capable to open up new perspectives and start dialogues about alternative ways of being and making [12]. Designers and artists are given the freedom to propose solutions that are unconcerned with limitations of the real world [12], even laws of physics. James Auger, a scholar and product designer, sees speculative design as a way to enable us to think about the future as well as critique current practice [13]. Simply, it's Science Fiction not for entertainment but for investigation and innovation.

"Blind in the Mind's Eye"

Multivariant visualization is a simultaneous visual representation of multiple variables to make complex data dynamic, universal, and valuable [14,15]. The development of technologies means that the world has become more complex and rapidly changing. According to designer Bruce Mau, visualizing speed was the design problem of the last century, but it has been replaced by visualizing growth [16]. In *Visual Complexity*, Manuel Lima added that "finding patterns and making meaningful connections inside complex data networks has emerged as one of the biggest challenges of the twenty-first century" [17]. Our reality is now highly multivariant and we must develop practices and theories of representation to match.

Finding visual ways to organize information and represent the invisible is a human need that has been expressed since early man, yet according to the Oxford English Dictionary, 'visualization' isn't an ancient term but a modern convention that only first appeared in 1883 to depict the formation of mental images of things "not present in sight." Many of the safety issues related to aerial congestion are rising partially due to our inability to visualize and display the massive, trans-scalar real estate and movement. Each industry is becoming better at tracking its own assets yet none has succeeded in finding a model that represents the entire evolving techno-system in one visual strategy.

This growing danger cannot be visualized on standard displays due to the massive scale and speed differences of the machines above us. It is difficult to accept that there are physical relationships that cannot be accurately formed as a mental picture, much less a physical one. The extreme speed variations and extreme spatial disparities make a realistic representation impossible.

Every launch potentially passes by drones, helicopters, planes, weather balloons, three layers of satellites, and debris—all within the same airspace but vertically separated by thousands of kilometers. Each one of those layers has objects moving at wildly different speeds—helicopters at 160mph, planes at 550mph, satellites in low earth orbits at 17,000mph. A true representation cannot show a basketball-sized satellite moving 40 times faster than a building-sized plane. Additionally, each is spread across real estate that is impossible to show on a screen—one can see the machine or one can see the environment, but both cannot be seen in one image. The human mind cannot picture it accurately, it is beyond our spatiotemporal reasoning. 'Aphantasia,' a rare medical condition serves as interesting reference. The condition appears in people who cannot imagine a visual reference, they cannot see something in their mind's eye, the actual medical description most used [18]. In terms of seeing all aerial traffic at once, we all suffer from Aphantasia.

Trajectory in earlier *Celestial Mechanics* Iterations

Trajectory representation is key to understanding aerial traffic and the first iterations of the research relied heavily on revealing traffic through path. Using 3D modelling, programming and digital painting, the first *Celestial Mechanics* was an animation created for dome-shaped planetariums. Instead of stars, the 'night sky' program interpreted the paths, behaviors, and patterns of over 30,000 aerial technologies. Produced at UCLA, dozens of government, science and private agencies provided the raw mathematical data.

Combined with sound design by the volunteers at George Lucas' Skywalker Sound, the dome-based animation was one of the first to visually address the proliferation of aerial traffic and is a touchstone in the field of Information Arts.

The team of ten programmers and animators, all undergraduate and masters students in the Design|Media Arts department, modelled the actual movement and artistically interpreted the paths and functions of the flying machines based on Hessels' drawings and collected datasets. With the individual objects too small to see, and the individual behaviors and activities of those objects too technological for most to understand, the trajectory became a foundational component of 11-minute animation.

The most successful section of the film stylized 12 hours of airplane movement over the USA. Hessels secured a raw text file of the longitude, latitude and altitude of over 20,000 commercial planes collected every three minutes. Then-student Aaron Koblin was on *Celestial Mechanics* team and explored ways to interpret the air traffic data. His Processing software sketches were compiled to create *Flight Patterns* (2004) [19]. The animation does not show individual planes or objects in movement, but instead introduced the idea of trajectory expressed artistically as a series of dashing movements like brush strokes. The work was featured in the Design and Elastic Mind exhibition in the Museum of Modern Art in New York in 2008, a survey of works that explored the relationship between design and science and their approach to scale. "It focuses on designers' ability to grasp momentous changes in technology, science, and social mores, changes that will demand or reflect major adjustments in human behavior and convert them into objects and systems that people understand and use" [20].

Hessels and Koblin's approach to trajectory quickly became iconic in the emerging field of Information Arts and its influence can be seen in works like NASA's *Perpetual Ocean* (2012), an animation of ocean surface currents that also stylized trajectory [21]. The work visualizes ocean currents around the globe while paying homage to the unique brushstrokes of Van Gogh's *Starry Night* (1889). Martin Wattenberg, an American scientist-artist and Fernanda Viégas, a Brazilian scientist designer created *Wind Map* (2012), an online application that pulls data from the National Weather Service and shows wind movements across the US [22]. Like *Perpetual Ocean, Wind Map* is also inspired by brushstrokes, composed of a series of wispy lines creating beautiful patterns.

Celestial Mechanics 3 and 4: "The Umbrella" and *"The Spiral" (2016)* were the results of dozens of models and engineering plans for potential kinetic and alternative display technologies that could present the entire vertical system. Supported by the Hong Kong government, the research developed speculative prototypes of systems that could show a physical display capable of compressing and expanding across varying spatial scales to support more complex trajectory display.

2019's *Celestial Mechanics 6: Guardians of Here and Now* (the iterations are numbered based on the completion of the plans) used trajectory as the foundation for a physical structure. The research collected the paths of every GPS satellite from the six countries that currently have networks in orbit. One GPS satellite trajectory from each country became a metallic arc in 3D models for a mobile that would indirectly reference both a compass and a historic timepiece. By creating a physical representation of each trajectory, the artwork is abstract reminder that a small number of invisible machines decide all global time and place, and a greater reminder that with aerial traffic, we often forget that they consist of machines that we use every day while rarely considering the political, economic and cultural forces that placed them there.

A Story in Trajectory
Celestial Mechanics V: Reaching

Increasingly, the research has moved towards data expression over visualization, shown in *Reaching,* an animation and interactive website that recreates the launch trajectory of over 5,000 rockets that left the atmosphere since Sputnik in 1957. Unlike most visualizations of satellite traffic that show the final orbits of the over 6,600 satellites that been placed in the sky as a result from these launches, *Reaching* reveals the first moments of the vehicles leaving our planet, emphasizing the aesthetics of their path, arc, and trajectory and illustrating a poetic history in both metaphor and reality of humanity's continued striving to rise above.

While over five thousand launches may seem like a large number, it's nearly too small in today's ubiquity of big data. The rise of massive online databases has resulted in several libraries that provide ways to navigate, search and modify parse trees in web pages, usually saving hours of programmer hands-on time. While NASA does provide their data on their website, the launches were collected from the second half of the last century and in the format of that time, making the current and now traditional web page scraping tools like Octoparse and Python's BeautifulSoup too sophisticated. Instead, Selenium, an automated tool used for problem-shooting websites, proved more effective. The software makes it possible to write tests in a number of popular programming languages, usually by repeatedly sending requests to a site to do functional testing of elements like hyperlinks and buttons.

In the context of this research, the use of Selenium was a necessary evil; it is considered unethical to use testing tools like this on public sites (or sites one doesn't own) because they spawn repeated connections to the server, thus slowing the site down for other users. As the historical launch data isn't generally accessed as often as other datasets within NASA's sites, the researchers scraped as quickly as possible and in less-trafficked times to limit the impact.

Once extracted, Python and the Pandas library were used to convert the columns to standard formats, remove special characters, *etc*. However, the data was incomplete for the research and a second dataset was generated by Astos Solutions, a European company that provides software and test equipment for a range of space applications. Normally, they are consulted prior to a launch. Payload, rocket type, angle,

and several other factors are used to create precise simulations meant to optimize trajectory and spacecraft design. Their willingness to support the research required a reverse engineering of their skillsets, as running simulations of past launches really had no practical application. The space industry both literally and figuratively only looks forward and Astos' support was invaluable.

Originally, Astos also coordinated a weekend event of university programming students in both Germany and Romania to run each of the historic datasets to create the 5,800 trajectories needed, a job that couldn't be done in Hong Kong due to international software licensing. However, closer inspection revealed so many duplicate launches that the data could be generated in their Germany offices.

Celestial Mechanics V: Reaching is a unique mix of historical data run in contemporary simulation tools. The Astos data provided more detail regarding timing and heading yet also required more work in Python and Pandas to merge smoothly with the existing NASA sets. Once the launches from each site were matched to the appropriate trajectory files (and some of the data normalized), the trajectory of every launch was able to be recreated.

Rockets are similar to car models in a sense; once a successful version is designed, it is used repeatedly. The same is true for payloads--once optimized, often repeated. When these are matched to fixed launch pads and angles, one site may have identical trajectories for dozens of launches over the years. This fact proved limiting in the narrative of the short film which hoped to show nearly every launch. As the resulting artwork was never intended as a scientific tool but an evocative one, identical launches were slightly offset by the design team to show the number more clearly and resulted in the 'flowers' that appear in the film from sites with high numbers of launches over the decades. The 86 unique launch vehicle trajectories are dispersed so that each trail is visually unique.

Once compiled, 5,141 total launches were shown in time-based visual interpretation of the data. Conceptually, the launches were imagined in an area that treated the Karman Line as a shell with each launch creating an exit point that pierced a hole capable of passing light. Although many of the new commercial and private companies now launching also are sharing their data online, the film ends with SpaceX, marking the beginning of an era where nationalistic interests will be eclipsed by commercial enterprises.

The film's design, rendering and score were produced in Budapest. The launch sites were mapped onto a model of earth and then digitally painted to artistically represent the topography, atmosphere, the Karman Line and space. The film begins with a recreation of the first Russian launch site, now named Gagarin's Start at the Baikonur Cosmodrome (Figure 2). In under 2 minutes, the film shows launches from sites highlighted by location, creating a unique understanding and representation of the last century's 'Space Race'. The animation becomes a type of competition, a call and response among nationalities as each scrambles to best the previous.

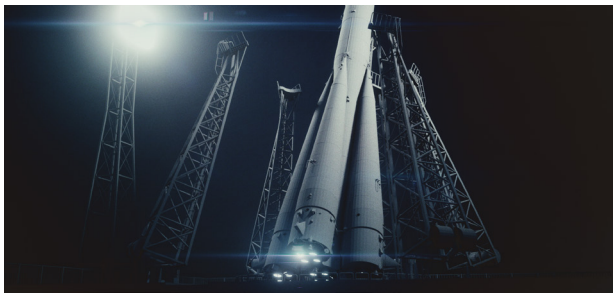

Figure 2: Still from *Celestial Mechanics V: Reaching* showing recreation of Sputnik launch © Copyright Scott Hessels 2020

Closing

Celestial Mechanics built obsolescence into the research from the onset as the collected data and created visualizations were dated by the time of their release in each iteration. After fifteen years of experiments, a single solution to represent the entire techno-system seems unlikely. Instead, artificial intelligence and machine learning are now scanning and resolving spatial problems faster than we can. Soon, self-driving cars can critically consider the context and movement of a wide range of objects in both the field of vision and outside of it. In time we may become comfortable with accepting problems that we cannot imagine. Perhaps this is a sign that our reliance on our 'mind's eye' may be ending as we grow to trust the eyes of machines. Unintentially, the research may also have documented our culture's increased acceptance of the machines' vision.

This realization, that there may be no perfect representation of aerial space, also allows for a freer exploration into data expression. Accepting that representation may no longer be needed as a tool may mean that the evocative value in the datasets may draw increased interest. *Celestial Mechanics* has begun to emphasize the aesthetics found in the paths, arc, and trajectory of aerial traffic. Freed of function, these paths in our sky can become ways to inform a public and serve as new foundations for creative practices.

Acknowledgements

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Author Biography

Scott Hessels is an American filmmaker, sculptor and media artist based in Hong Kong whose artworks explore new relationships between the moving image and the environment. He produced some the first experiments in the fields of online streaming and locative media and has mixed cinema with a range of emerging technologies including computational sensors, robotics, GPS systems, and alternative forms of interactivity. His data-driven works have included partnerships with key science and government organizations and his new media installations have been presented in museum exhibitions focusing on both technology and fine art. His recognitions include patents for developed technologies, references in books and periodicals on new media art, and coverage in cultural media like *Wired* and *Discover*. He is executive producer of the Extreme Environments Programme which organizes art/science expeditions to environmentally significant sites.

Pixels in the Material World: Making Marching Cubes

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Abstract

In 1987, researchers at General Electric pioneered a method for generating computer graphics from medical scan data that featured an underlying language of faceted cubes. Widely adopted, Marching Cubes: A High Resolution 3D Surface Construction Algorithm has become a seminal visual language for virtual environments. We wanted to make this computational procedure tangible, into something people could build with. We translated the algorithm into 3D printed construction units that permit users to act out its logic. We also created a user's guide: input any object—a 3D scan or model—and a custom computer script outputs assembly instructions. Every one of these *Marching Cubes* interactive performances and installations are unique; the units can make anything. Assemblies are created in collaboration with the audience: together, we perform the computer's process. Sometimes, we simply play: with humans doing the work, the procedure's strict logic is optional. By enacting a ubiquitous algorithm in the real world, this project generates dialogue about how information technologies create the building blocks of contemporary culture.

Keywords

Art, Design, Architecture, CAD/CAM, Algorithms, Graphics, 3D Printing, Parametric Modeling, Modularity.

Introduction

Marching Cubes (MC) is an algorithm that constructs a continuous three-dimensional surface from a collection of points in space. First presented in 1986 and later refined for the purpose of generating high-resolution renderings of medical scan data, MC and its descendants have become some of the most widely adopted graphics algorithms ever created. [1,2,3] Vestiges of this algorithm's geometric signature remain present in many screen-based representations of three-dimensional information: it is part of the visual language that defines our virtual environments.

Marching Cubes are interactive performances and installation that permit participants to directly experience the MC algorithm and the visual language it represents. These projects are the culmination of ten years of research, experimentation, and built work focused on deploying this language in the architectural and sculptural realms, by interpreting the algorithm as a tool for provocative form-making at a variety of scales.

Precedent Projects

Marching Cubes extends some earlier creative work which began with an examination of Frank Lloyd Wright's Usonian Automatic projects, an significant historical example of unit-based construction. We then explored how the MC algorithm might be interpreted to create a more contemporary set of architectural units. Finally, we created the first physical instantiation of the MC algorithm, designed in close conversation with Wright's precedent. This research trajectory has been described previously but, given its enduring influence, is summarized below in order to provide context for the *Marching Cubes* projects that follow. [4]

Automatic

One of Frank Lloyd Wright late projects was his vision for Usonia, a new American landscape characterized by a diffuse agrarian urbanism. Usonian refers to a series of modest family homes designed for this new landscape. Early Usonian homes used wood construction techniques, but faced with rising labor costs in the 1950s, Wright turned to concrete. The suffix Automatic was added because the revised design created the potential for economy via end-user self-assembly, facilitated by a strict grid that determined the dimensions and relative positions of the constituent concrete units. Deconstruction, reconstruction, and replication of the Usonian Automatic system (Figure 1) provided a point of departure for our subsequent research. [5]

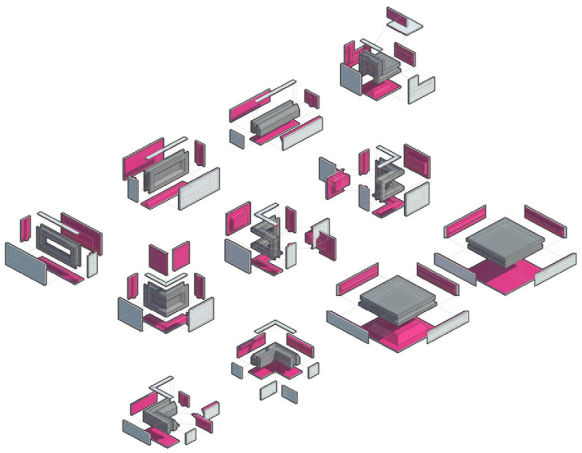

Figure 1: Frank Lloyd Wright's eleven Usonian Automatic units

Marching Cubes

The computational procedure originally published as Marching Cubes: A High Resolution 3D Surface Construction Algorithm provides a first order refinement of a voxel grid approximation of a volume. A voxel grid is a cubic subdivision of space, and can be understood as the three-dimensional analogue of a pixel grid. The pixel grid also provides a means to illustrate the computational logic of MC, by way of its two-dimensional cousin Marching Squares.

Given a plane containing a closed region of any size and shape, Marching Squares divides the plane into pixels, and further divides each pixel into quadrants. The procedure evaluates each pixel, identifying intersection with any portion of the closed region, and outputs an approximation of this portion (Figure 2). The specific approximation is determined by which quadrants the portion intersects. There are six possible intersection approximations, which can be reassembled to simulate the entire closed region (Figure 3). The resolution of the simulation is dependent on the size of the pixels: smaller pixels provide higher resolution.

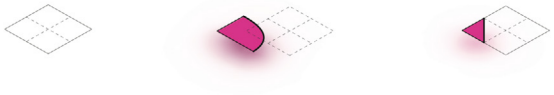

Figure 2: One Marching Squares intersection approximation

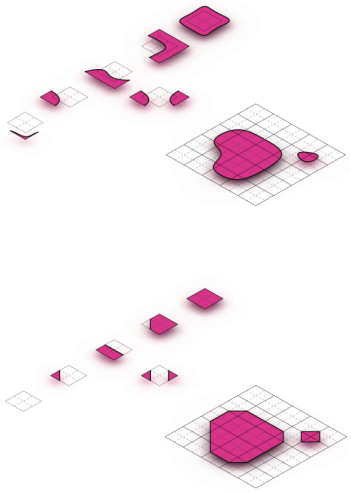

Figure 3: All Marching Squares intersection approximations

MC applies this same logic in three dimensions. Given a volume containing a closed surface of any size and shape, MC divides the volume into voxels, and further divides each voxel into octants. The algorithm evaluates each voxel, identifying intersection with any portion of the closed surface, and outputs an approximation of this portion (Figure 4). There are fifteen possible intersection approximations (Figure 5). As with Marching Squares, the specific intersection approximations are determined by which octants the portion intersects, these approximations can be reassembled to simulate the entire closed surface, and the resolution of this simulation is inversely proportional to the voxel size.

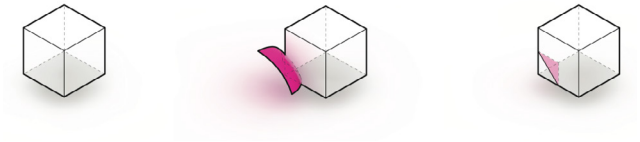

Figure 4: One Marching Cubes (MC) intersection approximation

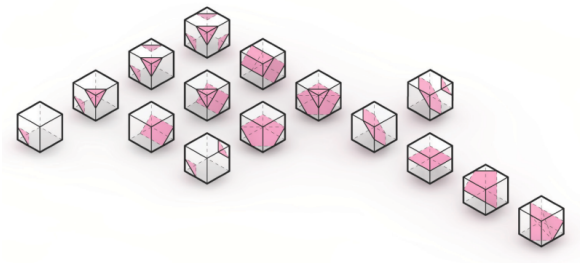

Figure 5: All MC intersection approximations

Automatic/Revisited

In spite of their disparate origins, we observed some interesting common characteristics between Automatic and MC. Both are motivated by efficiency: material and labor in the first case, computational in the second. Both provide a rule-based means to provide a formal language for the highly regularized subdivision of space. These observations led to iterative attempts to develop a more contemporary unit-based construction system derived from MC.

The fifteen intersection approximations, combined with their bounding voxels, can be interpreted as reciprocal pairs of positive and negative three-dimensional forms (Figure 6). When translational and rotational duplicates are eliminated, these forms reduce to a set of eighteen unique elements.

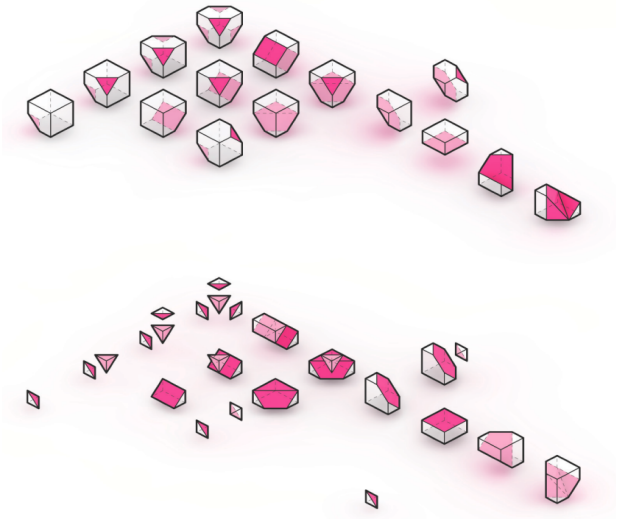

Figure 6: MC intersection approximations, interpreted as forms

Just as the MC algorithm can be used to simulate any surface, the eighteen unique elements can be aggregated to create any form, including architectural configurations such as the intersections of walls, floors and roofs. Sixty-four architectural aggregations, ranging from normative orthogonal configurations to more complex kinked and curved configurations were designed (Figure 7) and 3D printed (Figure 8). These new construction elements, like Wright's Automatic units, encode a strong formal vocabulary and character on any design to which they are applied.

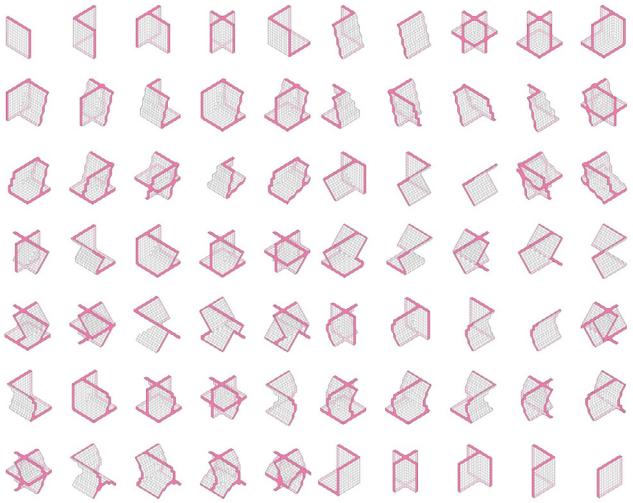

Figure 7: Sixty-four aggregations of Automatic/Revisited elements

Figure 8: 3D printed prototypes of the aggregations (2009)

In order to remain in conversation with Wright's system, we elected to pursue fabrication of these new elements—which came to be known as *Automatic/Revisited*—in concrete. We observed that if one half of a reciprocal pair is interpreted as a concrete object, the other half can be interpreted as this object's casting apparatus. We also observed that it was possible to reduce the required set to eleven elements—a curious albeit coincidental parallel with Wright's system—at the expense of the resolution of some kinked and curved configurations. In considering how to use these elements to create an architectural enclosure made of concrete, we arrived at two variations: a formwork system for cast-in-place construction, and a system of pre-cast units.

In the cast-in-place variant, the architectural enclosure is created when concrete is poured between two assemblies of modular formwork elements. As with existing cast-in-place methods, an offset grid of reinforcing steel, determined by the enclosure's loading and orientation, is required to resist tensile forces. The formwork elements are re-useable, permitting a small number of them to be used to create a large quantity and variety of enclosures without the wasteful one-off customization normally required when creating complex geometry with cast-in-place methods.

In the pre-cast variant, the elements become the concrete directly. These modular units require a system of connection rods and couplings which provides tri-axial post-tensioning. This hardware also facilitates the one-by-one assembly of the units and eliminates the need for elaborate shoring. Unlike the cast-in-place variant, the development of tensile capacity is orientation-independent and reversible. The pre-cast system can be disassembled and reassembled into new configurations as desired.

In an architectural context, the enclosure permitted by either variant is provides a flexible structural armature upon which surface components (cladding) can be affixed: slatting, insulation, glazing, and paneling. The armature's resolution can either be expressed directly, or it can used as a substructure and hidden from view. The eleven-unit pre-cast variant (Figure 9) was ultimately selected as the most suitable system for a temporary installation as it could be disassembled and reconfigured differently at a later time.

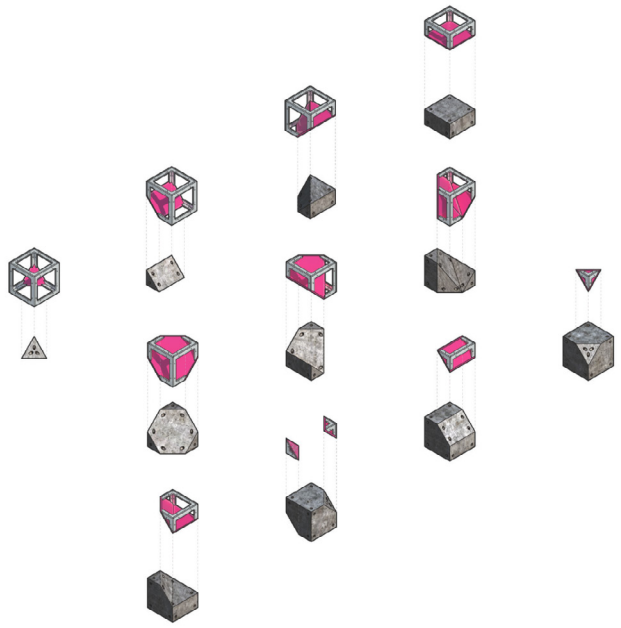

Figure 9: The eleven Automatic/Revisited pre-cast units

Seventy-five of the pre-cast units were fabricated using a combination of conventional artisanal techniques and 3-axis CNC machining and exhibited in two different configurations (Figure 10), demonstrating that the units could be flexibly assembled at an architectural scale while consistently retaining the aesthetic imprint of their algorithmic origin. Pursued as both a novel contribution to architectural knowledge and as a meditation on sculptural modularity, *Automatic/Revisited* made MC physical for the first time. [6]

Figure 10: Automatic/Revisited exhibition views (2009/2013)

Making Marching Cubes Physical

Stimulated by the playful interactive qualities recognized in 3D printed prototypes of the architectural aggregations created during the *Automatic/Revisited* design process, we next created and exhibited a new toy-like interpretation of MC made from 3D printed plastic (Figure 11). [7]

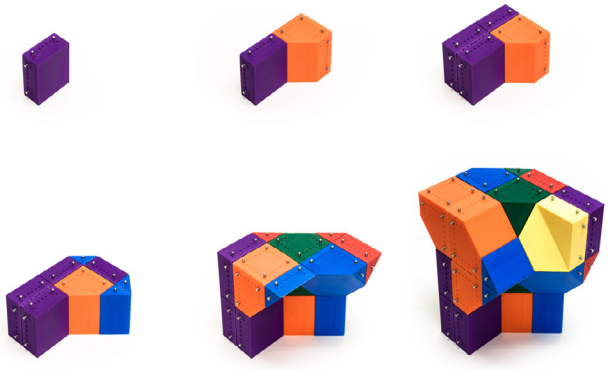

Figure 11: A new toy-like interpretation (2013)

Another key inspiration leading towards the interactive turn in *Marching Cubes* is the work of David Rokeby. Beginning with the seminal Very Nervous System and continuing in later projects such as Dark Matter, for Rokeby, the voxel grid is an invisible instrument for which he provides a navigable structure, "an articulation of a space, either real, virtual, or conceptual". [8,9,10] Taking up Rokeby's challenge, *Marching Cubes* provides a navigable structure for algorithmic space by articulating it both literally, as a virtual space made real, physical, and tactile, as well as conceptually, by mapping a computational procedure onto the agency of human interaction.

In its ultimate form, described below, *Marching Cubes* projects are interactive performances and installations that permit direct physical engagement with the MC algorithm. The 3D printed construction units are sized to fit in the hand, and the installations contain enough units to allow participants to freely play, assisted by custom modeling software. This software generates real-time assembly instructions that help participants translate their experimentation into human-scale sculptural assemblies. The units are sufficiently robust to be assembled repeatedly, in near-limitless configurations; the interaction with them is sufficiently intuitive to encourage fluid creativity.

Two specific aspects of these new results that have broader implications for computational creativity and, as such, warrant more extended elaboration, are the novel adaptations to the original MC procedure required to facilitate interactivity at this new scale, and the design and fabrication innovations that helped bring *Marching Cubes* to physical fruition.

The Physical Marching Cubes Algorithm

Automatic/Revisited and the subsequent prototype systems featured less than one hundred total units, making it relatively straightforward to aggregate them manually and intuitively without referring back to the MC procedure. *Marching Cubes,* on the other hand, consists of thousands of units, and while it is still possible to assemble them free-form, it was anticipated that large and complex aggregations would benefit from assembly instructions. Our Physical MC (PMC) algorithm adapts Lorensen and Cline's original procedure in support of this need.

MC was designed to produce polygonal meshes from any scalar field. These meshes delineate the boundaries of a volume within a given range of scalar field values, in the same way that the contours on a topographical map delineate the boundaries of an area within a given range of elevations. This ability made MC extremely popular for graphically rendering incremental scalar contours of non-visible characteristic such as temperature, concentration, or intensity. In the general case, these scalar fields can exhibit value gradients resulting in multiple concentric polygonal boundary meshes, like the layers of an onion.

Producing a single polygonal boundary mesh of the closed outer surface of a single object—analogous to isolating one topographic contour, or one onion layer—is a limited application of MC that corresponds with what we required in order to provide assembly instructions. We developed and optimized our PMC algorithm for this special case. The scalar field is Boolean, in that it has only two possible values: the inside condition (true) and the outside condition

(false) of a sampled voxel octant. Only computing Boolean scalar fields permits PMC to efficiently make use of the MC algorithm's look-up table procedure in support of a user's desire to experiment with different input geometries. A PMC solution is guaranteed, because every MC topological solution has a corresponding *Marching Cubes* unit.

PMC, implemented as a custom Grasshopper routine within the 3D modeling program Rhinoceros, facilitates the construction of *Marching Cubes* assemblies as follows. First, it permits the user to dynamically visualize what an assembly generated from a given virtual reference input—a 3D model or scan—might look like. If this visualization is deemed satisfactory, the routine can then create assembly instructions. The instructions consist of an illustrated manifest that documents the type, location, and orientation of the *Marching Cubes* units required to aggregate a physical approximation of the virtual reference input. For ease of use, the manifest is divided into vertical layers so that the approximation can be built incrementally from bottom to top. (Figure 12).

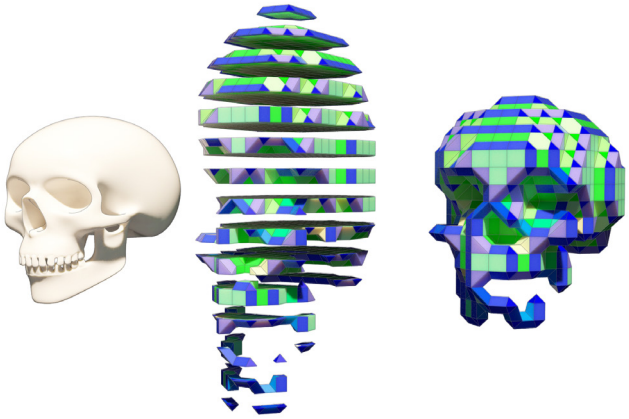

Figure 12: Virtual reference input (left), PMC assembly instruction layers (middle), aggregated PMC approximation (right).

PMC provides user control over the coordinate origin, axial orientation, and unit resolution so that these attributes can be dynamically and iteratively refined to facilitate the selection of an optimal approximation of the reference input. For example, a user can consider how the approximation of a virtual reference input varies with changes to the coordinate grid orientation about any of the three axes (Figure 13). They can also consider the impact of changes to the coordinate system grid size (Figure 14). This key parameter corresponds directly with the resolution of the aggregation.

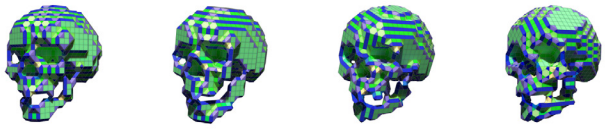

Figure 13: PMC approximation with the coordinate system rotated about the y-axis in 22.5 degree increments left to right

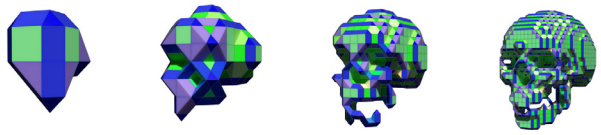

Figure 14: PMC approximation with the coordinate system grid size doubled in each increment left to right

The original MC algorithm suffers from a solution ambiguity in that multiple boundary surfaces can be attributed to a single Boolean condition within a sample voxel. In fact, the boundary surface is computationally arbitrary as long as its perimeter is consistent with its Boolean conditions; PMC optimizes this surface in service of maximizing the viability, utility, and continuity of the *Marching Cubes* units.

Several future improvements are being investigated. The first is the ability to calculate approximations for a reference input where the solution is constrained to use no more than a user-specified number of each particular *Marching Cubes* unit type. This feature would allow users to build complex aggregations with a limited number of units. The second is a fidelity setting, which will compare approximations with different coordinate grid rotations and determine which solution has the least deviation from the reference input. Finally, we are investigating integration of a structural analysis package that would permit users to predict whether a given aggregation is stable.

The Making of Marching Cubes

The desire for playful interactivity motivated the design of a new connection mechanism. The connection rods and couplings used in *Automatic/Revisited* provided the stability necessary to erect architectural-scale assemblies. However, this system is complicated and time-consuming to assemble, uses many small parts, and requires the precise application of a torque wrench. The pins designed for the first 3D printed plastic prototype are a simpler mechanism, but these continue to require precision assembly of small parts and provide nearly no tensile strength. Worse, this mechanism only permits stacked assemblies along one axis at a time due to interference between the pins and the units when they are brought together off-axis.

Several iterations of connection mechanisms using embedded magnets were explored. This approach promised hardware-free self-alignment and tensile strength proportional to the attraction between the magnets. Because each unit has six degrees of freedom, magnets with fixed polarities relative to the units proved impossible, as this prohibited connections between units in opposing orientations. The final design makes use of spherical magnets that rotate within cavities. These magnets and cavities are positioned on the voxel grid surfaces of the units at a position that balances magnetic field interference between adjacent magnets with the proximity of the magnets to the boundary surface.

The magnets are contained by a glued-in-place end cap with a unique color and shape for each of the five different voxel grid surfaces. This coding encourages intuitive

interaction by helping users understand which surfaces are connectible: the one-magnet face is coded with a pink triangle, the two-magnets-on-opposite-corners face with a magenta irregular hexagon, the two-magnets-on-the-same-edge face with a light blue rectangle, the three-magnets face with a purple irregular pentagon, and the four magnets face with a dark blue square. Filleted corners near the voxel grid vertices signal the correct orientation of each face. Put more simply, users are told that "units are correctly connected by matching the colored faces." The colors themselves were selected on an aesthetic basis, heavily constrained by the need to acquire large quantities of inexpensive 3D printer filament in each color.

The decision to 3D print the units was not taken lightly as previous experience suggested that the precision required would be difficult to achieve using this technology. A number of factors conspired to motivate fabrication using consumer-grade fused-deposition 3D printers. First was the realization that injection molding, the most conventional method for creating repeated plastic objects, would prove impracticably expensive due to the cavities required to contain the magnets: the requisite molds would need to incorporate removable slides along two axes. Moreover, the target count for each unit—on the order of fifty to two hundred pieces—did not justify the tooling costs for even simple molds. Second, the opportunity arose to make use of a newly purchased array of 3D printers, which provided a learning opportunity for future projects that might make use of a printer farm.

Ultimately, over a three-year period, forty-two 3D printers from three different manufacturers were operated to produce the components required for over 5000 *Marching Cubes* units. While the trials and tribulations of this process are beyond the scope of this paper, it bears mentioning that this means of production is not recommended. However, the choice to 3D print proved conceptually fortuitous because the actions taken by the user in aggregating the units into assemblies, layer by layer, mimics that of the printer in aggregating each unit from deposited plastic.

The making of *Marching Cubes* was made possible by: thirty-two Printrbot brand 3D printers (for the natural plastic main unit), eight Airwolf brand 3D printers (for the pink, magenta, purple, and dark blue colored plastic end caps). two Dremel brand 3D printers (for the light blue colored plastic end caps), 600kg of PLA filament, 50,000 N42 grade 6.4mm diameter neodymium spherical magnets, at least 50,000 hours of 3D printing and 2500 hours of post-production, and the invaluable help of fifteen studio assistants.

Making Marching Cubes Tangible

The first units fabricated (Figure 15) permitted the beginning of an ongoing sequence of interactive performances and installations designed to publicly demonstrate the tangibility and the expressive potential of *Marching Cubes*. Through the end of 2018 we have explored architectural and anthropomorphic themes, two extremes of the form-making opportunity this project provides.

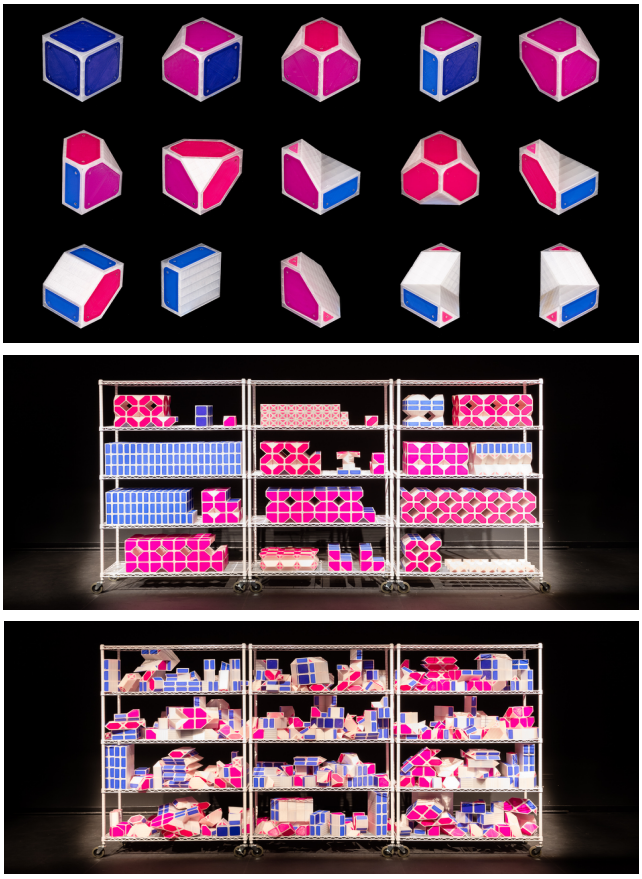

Figure 15: The first Marching Cubes units fabricated (2016)

The First Interactive Performance

The first opportunity to publicly demonstrate *Marching Cubes* took place in the Experimental Media Performance Lab (xMPL) in Irvine, California. The xMPL is a black-box performance space for interdisciplinary, interactive, and experimental media performance projects. This unique venue provided an optimal opportunity to deploy the construction units as part of an interactive performance.

Approximately 1500 units were located in the xMPL for three days. Volunteers were trained to facilitate public interaction with the construction units. The custom modeling software was used to generate instructions for a series of nine sculptural assemblies with architectural characteristics, derived from *Automatic/Revisited* (e.g. Figure 16). Participants were given the opportunity to work with the volunteers as a team, acting out the instructions as if they themselves were 3D printers, locating material in space from bottom to top. We also observed participants take advantage of the opportunity to ignore the instructions and design novel assemblies as they saw fit. This hybrid of expert and inexperienced participants deliberately evoked a historic performance previously reenacted in the xMPL: Yvonne Rainer's Trio A, in which rhythmic movements, structured like tasks, are enacted without pause or climax. [11] In this case, the regular rhythmic movements of the participants echo those of the algorithm's procedural calculations.

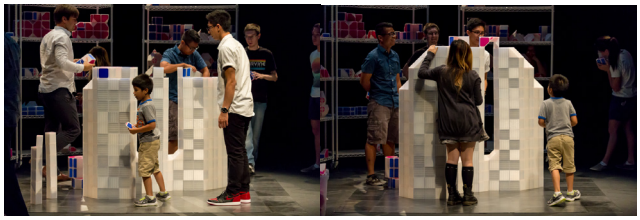

Figure 16: Marching Cubes Assembly #7 (2016)

Time-lapse photography was used to record the performances as well as generate documentary material required for the next phase.

The First Gallery Installation

The second opportunity to publicly demonstrate *Marching Cubes* took place at Pari Nadimi Gallery in Toronto, Canada. A final evolution of the architectonic sculptural assemblies was installed along with a complete set of units and video documentation of the xMPL interactive performances (Figure 17). The documentation was curated to illustrate both the original systematic intentions of the algorithmic procedure and any unanticipated results generated by the participant confusion, communication failure, or (in at least one case) deliberate and aesthetically intriguing subterfuge.

Figure 17: Marching Cubes Assembly #17 (2016)

Further Performances and Installations

Through 2018, one further pure installation and one further pure interactive performance have taken place, at the Arts Brookfield Grace Building in New York City, USA (Figure 18) and at the Patkau Project Space in Vancouver, Canada (Figure 19), respectively. The latter featured the first assemblies derived from 3D scans of a human figure.

Figure 18: Marching Cubes Assembly #19 (2017)

Figure 19: Marching Cubes: Boris (2017)

Three further hybrid performance/installation events have taken place to date, at Platform 28 for Art & Architecture in Tehran, Iran, at Kulturhuset Stadsteatern in Stockholm, Sweden, and at Open Gallery in Toronto, Canada. These opportunities presented logistical and financial constraints that precipitated the design of new assemblies that, when collapsed, could be transported by plane as checked baggage. These venues also featured video documentation of previous *Marching Cubes* performances and installations. Further demonstration opportunities are anticipated through 2020.

Reflection

An algorithm is nothing more than a step-by-step procedure. Conceptual artists have a long-standing engagement with

step-by-step procedures as generators of form: per Sol Lewitt, the "idea becomes a machine that makes the art." [12] In this case the machine is an algorithm appropriated from one of the most transformative cultural forces in history: information technology. By inverting the normal application of this machine—from a procedure for converting form into computer-digestible units, to a procedure for converting computer-digestible units into form—*Marching Cubes* allows the audience to, through tangible interaction, directly experience the algorithm's procedure and the visual language this procedure imposes on the world. Extended interaction begins to reveal the syntax patterns of this language and its representational limitations.

Embodying the algorithm in a construction unit—a traditional vehicle for open-ended play and experimentation—places MC at our fingertips, extracted from its usual background position within the inner workings of screen-based visualization technologies. Enabling the algorithm in this way requires physical movement on the part of the user, which, released from the error-correcting mechanisms present in a virtual instantiation, permits them to exploit the potential of glitches or other unintended consequences. Put another way: while assembly instructions are provided, they need not be followed; per Huizinga, "all play means something." [13]

Conclusion

The algorithm that drives *Marching Cubes* is not new, and its applicability to physical form has been established and explored by our previous work. However, the new materiality and enhanced tangibility of the construction unit variant, enabled by the universally familiar and culturally primal act of play, has rendered the abstract idea of the algorithm accessible. This project provides a way in which one of our foundational computational procedures can be touched and manipulated, generating dialogue about the ways in which information technologies can be used to both literally and metaphorically create the building blocks of contemporary culture. Anything can be digitized: *Marching Cubes* asks us to reflect on what is lost and what is gained in this normally hidden process.

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Authors Biographies

Jesse Colin Jackson is a Canadian artist based in Southern California. His creative practice focuses on object- and image-making as alternative modes of architectural production. He manipulates the forms and ideas found in virtual and built environments through the expressive opportunities provided by digital visualization and fabrication technologies. His interactive *Marching Cubes* installations and performances (2016—present) have been featured in Toronto, Vancouver, New York, Los Angeles, Tehran, and Stockholm. Past solo exhibitions include *Skip Stop* (Pari Nadimi Gallery, 2019), *Radiant City* (Pari Nadimi Gallery, 2014), *Usonia Road* (Larry Wayne Richards Gallery, 2009), and *Automatic* (Larry Wayne Richards Gallery, 2009). Jackson was a 2014-2015 Hellman Fellow at the University of California and a 2008-2010 Howarth-Wright Fellow at the University of Toronto. Jackson is Associate Professor of Electronic Art & Design at the University of California, Irvine. He taught previously at OCAD University and the University of Toronto.

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Stonemaps: A Slow Intentional Network for Collective Sentience

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Abstract

We present a framework to promote the formation of slow intentional networks with characteristics of gifting, dialogue, and collaboration. These networks are formed through the physical gifting of river stones that are hydrographically printed with maps and embedded with an NFC chip. When handed from one person to the next as a gift, a stone (through the scan of its NFC tag) opens a channel to its virtual network and asks the recipient to contribute to the intention of the network. This contribution can be of any type (voice, picture, text) and once gifted, becomes part of the collective knowledge of the network. The recipient is then tasked with gifting the stone to another. By introducing a physical stone as the mechanism for connection, this framework deliberately slows the traditional notion of social media networks and enforces a more considered personal, intentional interaction between the network constituents and their contributions. The intent is to blend the best of physical and virtual interactions towards deeper, more meaningful conversations that can collaboratively create, solve, and investigate – a kind of documented collective sentience, a network that can be deeply and reliably interrogated.

Keywords

Intentional Networks, Slow Media, Gifting, Sharing Economy, Collaboration, Co-Creation, Dialogue, Physical Interfaces, The Commons

Introduction

We began the Stonemaps journey with "what if?" What if we could create an intentional network through the act of gifting a beautiful object like a patterned stone? What motivations would prompt such an act of gifting? What would be the traces of that relational act and how would they accumulate to create value and strengthen existing bonds?

This interrogation originated from a feeling of being awash in information and yet shallow in conversation. The mediated virtual social network – the capacity to link to almost anyone – is not (yet) structured for good conversation, for the distillation of knowledge, for the promotion of a kind of collective sentience. For us, there is a sense that this is missing, that we used to have more depth in conversation than we do now. Perhaps it was not as connected, but it was deeper and less noisy. This decrease of order leads to more unpredictability which is, in effect, less intelligence. Proponents of the "quantified self" claim that offloading the creation of order to networks of algorithms will fill this gap. [1] That is, as long as we continue making data, eventually we will understand ourselves. Indeed, Harari warns of the inflection point when algorithms will know us better than we know ourselves. [2] While we grant that algorithmically-guided decision making will continue to form part of a more ordered future, we also believe that collective wisdom requires the more direct influence of first-hand experience, which is not easily translated to an algorithm but is readily conveyed to others through conversation. A good conversation diverges and converges around a shared state. It creates trust and intimacy. It takes time, practice, and patience. Unfortunately, the structure of current social networks is not designed for these kinds of conversation. Social networks are, rather, optimizing for quantity of content and time spent on a platform. This phenomenon has been articulated in depth by writers and thinkers such as Carr, Alter, Harris, Turkle, and others. [3, 4, 5, 6] What has become apparent is a descent into shallow, provocative, and often uncivil interactions.

Solutions proposed by the major platforms for the restoration of civility online have mostly focused on small changes such as hiding the number of likes on posts or developing smarter algorithms that detect conduct that is against a platform's terms of service. [7] While there seems to be a recognition of the problem and its sources, the big platforms are hampered by a business model that is not aligned with the goal of good conversation. [8] Indeed, the "move fast and break things" mantra of Silicon Valley does not apply to itself.

There are parallel conversations that argue for the slowing of media for a healthier relationship to our digital ecosystems. [9, 10, 11, 12] They propose a redesign that takes as inspiration the Slow Food movement and asks us to mind the means of production and consumption. A related concept is that of The Commons articulated by the P2P Foundation, [13] which advocates for the participatory creation and stewardship of common goods that are universally accessible ("Productive citizens in communities creating shared resources." [14]) Taken together, these ways of structuring media aim to deepen engagement and produce collective sustainable abundance of knowledge. Michel Bauwens of the P2P Foundation argues for "subversive constructionism" to build different kinds of social networks that provide what we

need. Stonemaps is our contribution to the subversion of existing social media networks. It is a provocation based on slow intentional networks of gifting. The values that animate Stonemaps are in line with those of the Slow Media Manifesto and include: intimacy, trust, dynamism, curiosity, generosity, creativity, responsibility, joy, collaboration, preciousness, intentionality, and the gift.

The Stonemaps Network

Figure 1: Stones ©Hanif Janmohamed

We start with the humble stone as the material anchor for the Stonemaps network. A stone takes its time, measured in eons. Over millennia a stone comes into itself and gains its identity. Its beingness is timeless and expressed through its form and its materiality. It has been here for eons before us, and will be here for eons after we are gone. It warms from the heat of our hands as we hold it and has a focused weighty presence – a kind of "thing-power" as described by Bennett. [15] The stone is also a metaphor of our own context – a reminder of the very large stone that we are all standing on and share, and upon which our existence is so thinly spread like a film or a pattern on a stone. Holding the stone is symbolic of stewardship for what is beneath our feet. In that way, the stone has a grounding force that moves through us and quiets our abstraction - at least momentarily. This may be the magic of stones and why humans like to pick them up and hold them - but then we throw them away - and in that, they are symbolic of our personal power as well. We have to decide what to do with them once we have them in hand: throw them away, throw them at someone, skip them on the water, abandon them - give them as a gift.

The Stonemaps stones are smooth river rocks that are modified to contain an NFC tag. They are also visually embellished with a pattern printed on their surface – a map (See Fig. 2). The stones travel as gifts, creating an intentional network as they change hands. Giving a stone to another person is a kind of entrusting of a shared intention, an invitation to join a Commons. The stones are travelers on the waves of gifting, on the generosity of human curiosity. The stone, once given, can be read by a mobile device that then reveals a glimpse of its travels and prompts a contribution to a virtual network. In this way, there are always two layers to each Stonemaps network: the physical material layer of the traveling stone, and the virtual layer of the network of stone recipients that continue to contribute to the network's intention. The momentum of the stone is the energy of the network and regulates its speed.

(a) Printed stone. ©Hanif Janmohamed

(b) NFC chip in stone. ©Hanif Janmohamed

Figure 2: Stonemaps network stone. The maps can be of any desired (real or fictitious) location and scale. The image of the map is fused onto the stone surface using a high-resolution transfer process.

The intention of the network can take many forms. Perhaps the stone wants to arrive at a particular destination, meet a particular person, answer a complex question. Perhaps the intention is driven by an Artificial Intelligence which sets an alien agenda, puzzling to the network initially but eventually becoming clearer as a diverse set of human minds are prompted toward the intention. The intention of the Stonemaps network is satisfied through the input of the members of the network as the stone travels from hand to hand.

The Gift as Slow Media

The Stonemaps mechanism of exchange and growth is quite simple and yet contains within it some powerful principles. The requirement of making a personal connection with another person and entrusting them with the stone as a gift slows down the growth of the network and underlines the responsibility of now holding the stone and its intention. This is aligned with point 2 of the Slow Media Manifesto:

> **Slow media promote Monotasking.** Slow Media cannot be consumed casually, but provoke the full concentration of their users. As with the production of a good meal, which demands the full attention of all senses by the cook and his guests, Slow Media can only be consumed with pleasure in focused alertness. [9]

The gift encounter can engender a feeling of sensuous enchantment that Bennett defines as "that strange combination of delight and disturbance," [16] which, she posits, can prompt a more ethical engagement with the everyday world. Indeed, she takes this idea further in a later publication by taking a critical look at the catalytic effects of non-human bodies in this relation of enchantment. [15] The artist Lee Mingwei has also investigated the feeling of delight and disturbance in his participatory installation *Moving Garden* where visitors are invited to take a flower with the obligation to gift it to a stranger that they encounter while taking a detour from their usual route home. [17] In this way, he introduces strangeness to both the gifter and giftee, inducing what may be a quite

profound experience.

During the Stonemaps gifting encounter, there is a transfer of information about the network and its intention. The gifter communicates the obligation inherent to the gift to the intended recipient. Not only is this transaction slow but the contribution requested from the Stonemaps network also demands focused attention – it is not a throwaway tweet or picture but rather a significant first introduction to the network and a serious engagement with the network's intention. There is likely to be a significant delay between being gifted the stone and gifting it to the next person, as the new recipient considers their first contribution. All of these layers of slowness around the ritual of the gift stress the importance of non-trivial engagement.

The Gift as Obligation

The stone, however precious it may look and feel to the holder, cannot be kept as a possession. Its value is intricately tied to its movement as it catalyzes the growth of the network and the addition of new data to the network. The beauty of the stone is representative of the value of the gift, not as an object but as an invitation into a rich dynamic conversation.

The role of the gift in its various forms within human societies has been well studied and eloquently articulated by Mauss and Hyde. [18, 19, 20] Some gifts are ritualized and form part of cyclical exchange (e.g. the Kula rings of the Trobriand Islands), or serve as symbolic proofs of tribal ties on a macro scale (e.g. ostrich eggshell beads of the African Kalahari Desert), [21] or are a demonstration of communal shared wealth (e.g. Northwest Potlatch). In all cases, gifts carry with them social obligations that strengthen communal bonds. By operating outside of the commodity market, they promote inter-dependency over individualistic freedom. The act of gifting enacted in the Stonemaps network encompasses three obligations:

The Obligation to Give: There are two layers of gifts acting within the Stonemaps network: the gift of movement of the stone to the next recipient (the stone wants to travel), and the gift towards the Stonemaps network intention (the network seeks). The network needs to motivate the current holder of the stone to both contribute towards the intention of the network and to gift the stone to another. This can be achieved through personal persuasion from the previous gifter (see The Obligation to Reciprocate) or through network benefits that only accrue once the stone is gifted. If the holder fails to uphold the obligation to give, the stone will continue prompting the holder to "set it free" (See Fig. 3).

The Obligation to Receive: The acceptance of the stone is both a commitment and a burden. By accepting the stone the recipient implicitly promises to fulfill the contract to reciprocate, to become part of a communal bond. The stone asks for a thoughtful contribution to the network's intention, and an eventual departure toward its next recipient. The intended recipient is free to refuse the gift, however a trace of that refusal remains as a kind of recorded interpersonal loss.

The Obligation to Reciprocate: The obligation to reciprocate is an onus and privilege - a worthy imperative. The gifter imparts the importance of the obligation to the recipient of the gift and hopes that this social tie will be sufficient for the stone to remain in motion. Traditionally, the failure to reciprocate is seen as a "debt bond" that does not expire. [19]

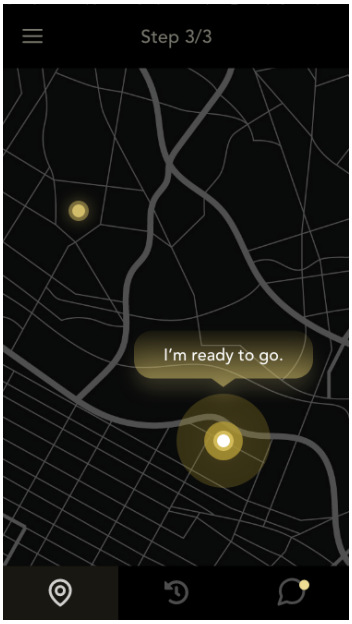

Figure 3: Stonemaps prompts to release. ©authors

If these obligations are fulfilled, the full richness of the gift becomes apparent: a dynamic and intimate group of actors committed to contributing to a varied and deep conversation for the benefit of the network.

> "It is the cardinal difference between gift and commodity exchange that a gift establishes a feeling-bond between two people, while the sale of a commodity leaves no necessary connection. [...] a gift makes a connection." - Lewis Hyde, The Gift. p. 72 [18]

Successive connections between people, bonded through gift exchange, are aggregated in the stone's memory. By acquiring contributions from participants over time, the stone accumulates greater worth and symbolic value. This cumulative accretion transforms the humble stone into a talisman - a fusion of person and thing. In turn, the talisman amplifies and affects subsequent personal connections, enriching the network over time.

The Gift as Strengthening Weak Ties

The stone travels on paths of "weak ties" – connections between diverse groups of strongly interconnected individuals (strong bonds). Weak ties typically represent inter group connection made by individuals, across networks (See Fig. 4). For example, a person may know very well the person they are gifting the stone to and may have chosen them specifically

for the network but (especially over time) the existing members of the stone's network are likely to have a much more distant connection to a new member. The stones travel along

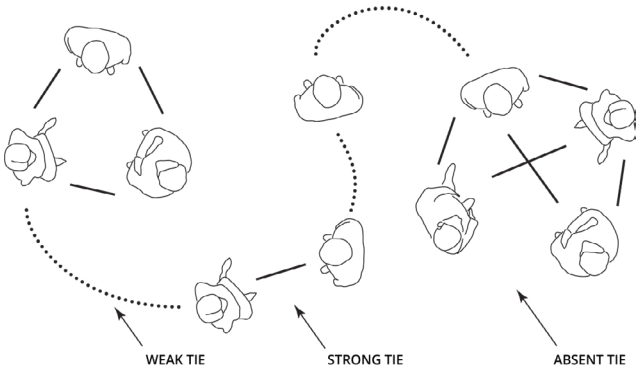

Figure 4: Weak ties vs. Strong ties.

these lines of connection thus acting as bridging devices and encouraging diversity, a wider world view, empathy, novelty, and innovation. Granovetter was the first to show the importance of weak but bridging ties between networks. [22] He showed that strong bonds tend to favour dense clustered networks and that, in the absence of weak bridging ties, information flow was segregated and less novel. Later, the concept of the "bandwidth" of a connection was added by Aral and Van Alstyne [23] to foreground instances where strong bonds do correlate well with novel information simply by virtue of greater frequency of exchange even if the overall proportion of novelty was lower than that of weak ties. From the point of view of the Stonemaps network model, we are looking to maximize reach and diversity while strengthening the overall bandwidth of the network. So, while the initial ties to the Stonemaps network may be weak, they are strengthened over time through a common intention and motivation. The obligation of the gift provides the initial momentum towards stronger ties, which then evolve as the benefits of the network accrue to the group (The Commons).

The Gift as Building Block for a Commons

Once the gift of the stone has been received and reciprocated, the former holder of the stone is now a full-fledged participant in the virtual Stonemaps network. This network functions in many of the same ways as the social media networks we are accustomed to (e.g. account, contributions, and comments), however its function is based on the principles of The Commons. The members of the network are the creators and stewards of the contents of the network. The network is governed by its members and its value accrues to them[1]. The activity and regulation of the Stonemaps network is communally decided and managed. There are many examples of successful physical and virtual Commons such as car sharing co-operatives, the Open Source Software movement and Wikimedia. Elinor Ostrom, awarded the Nobel Prize in economics in 2009, conducted a worldwide study of common-pool resource (CPR) groups. She found that groups are capable of functioning sustainably without requiring top-down regulation if they follow eight core design principles [24]:

1. Clearly defined boundaries;
2. Proportional equivalence between benefits and costs;
3. Collective choice arrangements;
4. Monitoring;
5. Graduated sanctions;
6. Fast and fair conflict resolution;
7. Local autonomy;
8. Appropriate relations with other tiers of rule-making authority (polycentric governance)

It is beyond the scope of this paper to fully describe these design principles but even in their short form they allude to some of the pitfalls that are being averted. The Stonemaps network will be implemented in a way that supports these design principles both technologically and inter-personally.

One common pitfall of social media networks is the presence of bad actors – conflict instigators and trolls. One of the ways in which the Stonemaps network mitigates this pitfall is through the mechanism of the physical gift to grow the virtual network. Every person in the network will have been seen and spoken with by at least one other member of the network. Indeed, the inherent obligation of the gift will preclude many potential bad actors. Beyond this, there will be other mechanisms within the network that select for collaborative actions towards shared goals, and give the group the ability to isolate problematic individuals.

While the movement of the stone through gifting gives form to the network, the intention of the network is the mechanism by which it creates the value that is shared by its constituents. The intention of the network influences how stone recipients are prompted to contribute to the network, and how these contributions are further distilled into knowledge, solutions, creations. Through the framework of The Commons, Stonemaps networks become a support for thinking and creating together – a collective sentience.

Scenarios of Intention

This section presents some possible scenarios of intentional Stonemaps networks. A network is seeded by the purchase of a stone with a chosen visual imprint. The purchaser can be the one to set the Stonemaps' first intention, or can leave it to system chance. In either case, the purchaser must gift the stone to another, thereby starting the Stonemaps chain of events.

In every scenario, when a new recipient accepts the stone, they scan it using their phone and the network passively logs information about the location of the stone (GPS coordinates or what3words). This is the location of the gift exchange and the set of all exchange locations will form one basis for a network visualization.

[1]This is in stark contrast to the large social media networks currently in operation, which accumulate behavioural data from their members for the benefit of third party clients (the prediction futures market). [8]

Scenario 1: Intention as Destination

I want to get somewhere! In this scenario the stone has an intent to travel to a particular geographical location or perhaps to be handed to a particular person. This intent may or may not be explicitly stated and known to the members of the network. In the case where the intent is not explicitly stated, the stone reveals glimpses of its intent through nudges towards its destination ("I want to travel far West of here but still within this country" or "I'm looking for a singer from a punk band"). The current holder of the stone has the responsibility of finding someone who can propel the stone towards its destination and to convince this person of the importance of this mission. As the stone travels from hand to hand, the network is charged with documenting its travels and adventures. It will ask for a contribution from the new recipient in a form that is dependent on the network's intention and the way the stone's travels are to be documented. Perhaps the documentation is a picture of the location of exchange along with a short story of why there is hope it will lead to the stone's desired destination. Perhaps it is strictly a soundscape of the exchange location. Once the contribution is accepted by the network, the stone gives its next prompt and moves along. The existing members of the network have full access to the documentation of the stone's travels and can choose to remix and synthesize the contributions, and give advice toward the next contribution or gift recipient.

Scenario 2: Intention as Question

I want to know something! In this scenario the stone seeks an answer to a question. The question can be initiated by the purchaser of the stone, or by the network. Each new recipient is briefed on the question by the stone gifter and can see the last answer given. They can choose to enhance or counter the previous answer or give a completely new answer. In all cases, they are charged to take as much time as they need. Constraints on the length of the answer, or the format of the answer may be attached to the request. Once the contribution is submitted and approved by the network, the stone prompts the current holder of the stone to find another person who could contribute a valuable point of view on the question at hand. As the stone collects answers to the question, the existing network constituents can deepen the enquiry by conversing on the different contributions, perhaps adding relevant references, and synthesizing a multi-faceted and nuanced document. The network is ultimately responsible for "calling" the question – deeming the enquiry finished and setting a new intention for the stone.

Scenario 3: Intention as Co-Creation

Let's make something! In this scenario the stone is asking for contributions to a collaborative making project. This can be an artwork such as a collage or film, a poem, or narrative. It can also be collaborative design document for a new park, say. Each new recipient of the stone is asked to contribute to a particular aspect of the collaborative creation, or to give towards a "wildcard" direction. They may not have a full view of the creation so far until they are a full-fledged member of the network. As with all previously described scenarios, the contribution is first vetted by the network before prompting the current recipient to give the stone to another. Once the stone is gifted onward, the co-creation is visible to the new member. In this scenario, as with the Question scenario, the network members have a responsibility for managing the assets collected by the stone's travels. The contributions can manually be composited towards a finished product, or be input into a generative artwork that continues to grow as the stone travels.

Scenario 4: Intention as Quest

Let's find the gold! In this scenario, the stone prompts the network towards ludic discovery of a virtual game world. The stone's intent may be set by game mechanics that involve specific geographic locations, similar to geocaching. When the stone reaches specific locations, more of the game map is revealed or assets are collected (health points, tools, etc.) and the network constituents can make a decision about where the next step they would like to take in the game. This slow game is a combination of physical movement of the stone and goal-setting by the virtual network.

Combining and Entangling

These scenarios can also be combined as sub-intentions to a greater intention. For example, if the network wants to start by talking to a sociologist before setting a question, it can set a sub-goal of finding a sociologist and, once found, ask them for an opinion on what aspects the question should target. In this way, the Stonemaps network interface supports both exploration (going deeper with sub-enquiries) and synthesis (resolving pending enquiries).

If two stones cross paths, they have the option of becoming an entangled pair. The exchange is a mutual gift and the networks can choose to merge and share future intentions or to work collaboratively with distinct goals. Or they can choose to merely greet each other, mark the encounter, and continue as before. If they choose to become entangled, the networks continue growing on separate paths but share all information.

After an intention is satisfied or deemed inconclusive, the next intention is agreed upon by the network and the stone's adventure continues. Over time the network builds a kind of expertise, a way of manipulating the stone's movement to create value for the Commons. It attains a collective sentience that can be depended upon.

Discussion

The purpose of describing the Stonemaps project in this context is to enter into the discourse about new models of social engagement that emphasize values of shared generated wisdom – what we have called collective sentience. The tension between individualism/capitalism and The Commons is not new but with new technologies we are seeing opportunities to insert ways of resisting the push towards the enclosure of knowledge and the design of interfaces that promote shallow engagement and invisible manipulation. We are not claiming that Stonemaps networks will be the best or even a successful framework for a new model of engagement. However, it is a mindful collaborative development of what we hope will be

Figure 5: Stone with abstract map. ©Hanif Janmohamed

an enchanting new way of being in blended physical and virtual networks, one that will inform future efforts in this area and attract like-minded individuals.

Implementation

The stones of the Stonemaps network have been constructed and tested with various phones. The first visual designs for the stones are maps, both real and fictional, to indicate the stone's impulse towards movement. Future designs may include more abstract representation, maybe tied to a particular network's intended expertise such as a gaming stone (See Fig. 5).

The implementation of the application layer that supports the intentional network is in development. Because we want to create an environment that operates outside of the surveillance capitalism frame, we are looking to software tools which not only safeguard user privacy but are in line with The Commons ideals of putting the users in control of any data accumulated on the platform. The Stonemaps network can only be successful if the constituents know they control the interface with others outside the network – they cannot feel they are being watched or manipulated in any way. We are currently looking at an Open Source solution from Oasis Labs that is designed to support private and secure decentralized applications, using blockchain technologies for data integrity. [25] Other open source third-party tools such as those developed by Inrupt (a company founded by Sir Tim Berners-Lee) are also being investigated as a way to store and control access to personal information.

The application will be multi-platform and support social media functions such as user accounts and profiles, and mechanisms for adding content to the network (posts, conversations), synthesizing new content from existing content (co-creation), archiving, and management of resources. We will develop the application in stages and test different scenarios to inform the next steps and requirements.

One important aspect of the User Interface is that it support the gifting process without excessive technological or cognitive overhead. There should be some immediate visibility of the Stonemaps network aggregate identity and intention without any barriers beyond scanning the stone's NFC tag (See Fig. 6).

After a member's initial encounter with the application, the

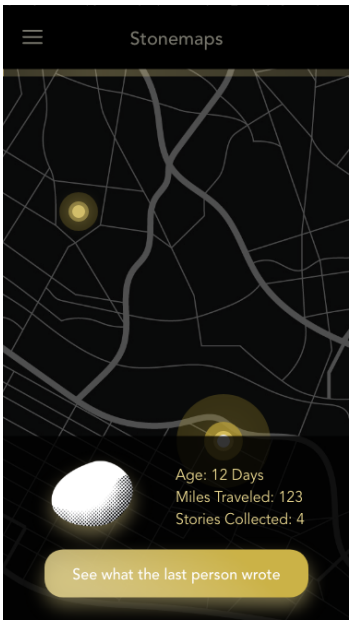

Figure 6: Mockup of Stonemaps application opening screen showing the stone's aggregate statistics. ©authors

design should support the principles of The Commons by providing tools and interfaces for:

- conversations and consensus building;
- content creation;
- management and distribution of resources towards a sustainable network;
- documentation and archiving;
- management of network intention and membership;
- conflict resolution.

At the core of the implementation and the user interface are the values of the Stonemaps network, first outlined in the introduction: intimacy, trust, dynamism, curiosity, generosity, creativity, responsibility, joy, collaboration, preciousness, intentionality, and the gift.

Testing

For the first stage of testing we are designing a barebones application to collect data on some example scenarios such as the ones outlined above. We will release 5 sets of 5 stones, each set being assigned a scenario with slightly different parameters of engagement. This phase will also include a short survey suggested to the participant once they open an account with the network, and periodically throughout the testing period. They can refuse to fill out the survey without any effect on their ability to continue in the Stonemaps network. We will monitor the stone's movements for a set period of time to study the effectiveness of the different scenarios on the stone's momentum. This monitoring will be strictly limited to the stone's range and frequency of movements. Any additional monitoring and feedback will be voluntarily contributed by the network constituents.

Sustainability

There are two aspects of sustainability that are pertinent to the Stonemaps network: its ability to keep the stone in movement and the members engaged in conversation; and its ability to generate revenue to support the maintenance of the platform and the network's greater goals if these require resources.

We have discussed some motivational elements to keep the stone in motion in previous sections and we expect to further refine these as we receive the results of the first test scenarios. Some of the motivation will come from the way in which the constituents of the network arrange themselves but successful strategies will also have to be supported by an apt interface.

Financial sustainability is likely to be achieved through many different means. Initial project development funding is envisioned through project development grants, investment, and crowdfunding. Seed revenues originate from the direct sale of stones. Subscription models would further sustain the basic operation of the platform, and stone networks would be able to attract donations from its growing membership. Other revenue sources could come from the provision of services especially as the networks gains some proficiency and documented knowledge. For example, a network could be valued for its diversity across different demographics, and could make a point of maintaining this as a basic component of all its intentions. This diversity, in turn, could make it valuable to those who need information from a diverse group. In this situation, the network could offer a polling service, or a set of user-derived prediction data. In a more general case, the expertise of a network can be advertised and instrumentalized to generate revenue. The selling of users' demographic, geo-location and behavioural data has been amply proven as a lucrative business model. Typically, this value generation has bypassed the data generators themselves. We are interested in exploring ways to evolve this practice, to preserve the sovereignty of user data, provide transparency and consent regarding data usage, and reward users directly and commensurately through support of network projects and initiatives.

If the network generates a surplus of revenue, the members can choose to direct the funds towards external projects that they find valuable, or fund new projects spearheaded by its members. We envision Stonemaps acting as a philanthropic venture, supported by a variety of sources and enabled by distributed ledger functions.

Conclusion

Stonemaps are slow media. They traverse personal connections to create thoughtful, real-world networks built along invisible currents of affinity. Stonemaps is both a social experiment and a distributed art project – online social media that is deeply connected to the physical world through hand-to-hand connections. Stonemaps are emergent networks – creating new ripples of rich connection, shared experience, meaning, and value as the project unfolds.

We have presented the foundational elements for the design of Stonemaps. Many of these elements, though based on careful research on gifting and social networks, are still at the speculative stage. An iterative design process will continue to respond to the emerging dynamics of the launched stones. Initial prototypes show the potential of delightful engagements reminiscent of the first hopeful dips into social media. It is our hope that Stonemaps and their intentions contribute to the design of a more democratic social media space.

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Author Biographies

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Maria Lantin is the Director of the Basically Good Media Lab at Emily Carr University of Art + Design. She has a deep interest in space and movement both physical and metaphorical, and this is woven through her work in immersive media and interaction. She takes pleasure in scanning the technological horizon for trends in human fascination – what is grabbing our attention and why. Formative experiences include a BSc and PhD in Computing Science (Dalhousie University and Simon Fraser University), a wonderful stint at Mainframe Entertainment working on the first ever stereoscopic animation for the IMAX screen (it never made it to the screen but it was amazing), three fantastic years at the ground-breaking Banff New Media Institute's Advanced Art and Technology (A.R.T) labs, and now heading into thirteen years at Emily Carr University.

Alex Hass is a multi-disciplinary artist, designer and instructor. Her creative practice investigates and adopts slow approaches to working with technology and communication. Core to her practice is expressing and experiencing the richness of nature. Her projects fold nature into a conversation with technology and lead to uncovering aspects of our changing humanness. Her design practice encompasses art direction, brand + book design as well as image creation. Alex studied illustration and art direction at the Alberta College of Art and Design, received her bachelor's degree in visual communication from Nova Scotia College of Art and Design University and her Masters in Applied Art, Media stream from Emily Carr University. She has taught various aspects of design at ECU, SFU and BCIT for the last twenty years.

Renrong Guo is a visual designer and artist, pursuing a master's degree in design at Emily Carr University of Art + Design. Their current design practice investigates the communication of moments and feelings through still and motion graphics. They studied user-centered design and received their bachelor's degree from the EPII program at the School of Design, Jiangnan University.

NEO//QAB: Creating a World Through Speculative Play

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Abstract

We present a design case study of NEO//QAB, an augmented reality speculative design experience that provides a provocative take on religious tolerance, empowering individuals to deal with those who resist cultural assimilation by replacing them visually. NEO//QAB is a two person experience, involving a wearer of a full-body garment, and a controller who controls the appearance of the garment. NEO//QAB falls within the intersection of speculative design and game design; this is a design space we refer to as *speculative play*, where digital playful interaction is leveraged to prompt speculation on alternative presents and futures. Across four iterations of NEO//QAB, we have observed how different prototypes and their materials have brought to life related, but different, instantiations of the NEO//QAB world. In this paper we expose the design trajectory that has led us to the current instantiation of NEO//QAB, and identify four design strategies for speculative play that focus on successful worlding.

Keywords

Speculative design, critical design, playful design, interactivity, augmented reality, prototyping.

Introduction

Speculative design takes many shapes. It can concern highly polished 3D renders of non-existent objects. It can be a video prototype. It can take the form of one-off functional objects. Our interest in speculative design concerns a form that we refer to as *speculative play*, which communicates and reveals its worlding through digital playful interaction. Core to our interest is in making it possible for these designs to be experienced and engaged with. Also key to this focus is that our designs are destined for a wider audience than speculative design's typical audience of designers, artists, and scholars.

As speculative play is but one subfield of speculative design, in our research we seek to experiment with what constitutes speculative play as a design space and explore the design strategies that support it. Playfulness and interactivity are associated with their own specific qualities and affordances, and thus change the dynamic of undertaking speculative design. As our major mode of knowledge production for this work concerns research through design, we find ourselves needing to deeply engage with design process and be cognisant of the material and experiential consequences of our prototypes.

In this paper, we present a design case of NEO//QAB, an augmented reality speculative play experience that provides a technological "solution" for religious tolerance, and empowers individuals to visually deal with people who resist cultural assimilation. NEO//QAB is a dark critique of moves that have been made in various Western countries to ban *niqab*, the full or partial face cover that some Muslim women wear, as well as curtail freedom regarding choice over appropriate dress in public day-to-day life. Through NEO//QAB, we seek to give materiality to a debate that has as yet failed to address or support what clothing restrictions entail for those affected at a human level. We provide rich detail of the four iterations that have led to NEO//QAB in its current form. Drawing on our design research, we then identify four design strategies for speculative play that focus on successful worlding.

Background

Being a Visibly Muslim Woman in Quebec

In many Western countries, including Canada, niqab has received outsized attention on the political stage and in public discourse. In October 2017, Quebec passed Bill 62, which requires residents giving and receiving public services to do so with their faces uncovered, potentially banning Muslim women from wearing niqab in public as it means they are not allowed to make use of services like public transport or libraries [8]. In June 2019, Quebec passed Bill 21, which bans people working in the public sphere from wearing religious symbols [7]. While religious symbols are worn by people of various faiths, many Muslim women wear hijab – the headscarf which allows for the visibility of the face. Unlike small symbols such as crosses, hijabs are difficult to conceal and thus Bill 21 disproportionately affects many working Muslim women.

While we are agnostic regarding niqab as researchers and designers, we are uncomfortable with the targeted curtailing of Muslim women's choices regarding their self-representation. Through an AR speculative play experience, we wanted people to materially and physically engage with two questions that shape this debate: (1) Should anyone have the right to govern and control women's appearance and

dress? (2) Is dictating that women not wear particular clothing morally different from dictating that they do wear such clothing?

AR for Ethics and Politics

In recent years, augmented reality (AR) has joined VR in being studied as a potential driver of positive social change. An almost unending stream of press releases and academic articles have touted AR as everything from a social 'cushion' for children belonging to the autism spectrum [9, 34], to a mindfulness aid [2], to a scaffold of instructional support for cognitively impaired workers [13]. Comparing such projects with VR, it seems clear where such excitement arises. AR is thoroughly worlded: it is already operative in the concrete social world and not in the contrived 'scenaria' demanded by the hardware and design limitations of VR. This alone raises a number of new ethical and political concerns that go far beyond those of VR, ranging from privacy and face recognition [1] to property rights [21]. Yet in many cases, AR inherits from VR the notion of *empathy* as a guiding concept (see [14] for a discussion of VR's position as the ultimate empathy machine).

Empathy becomes a key term for AR, acting as a lodestar for a number of projects with self-avowedly ethical and political ends (e.g. [6, 15]). While discussions of ethics and politics in VR also surround the notion of empathy, AR's worlded status comes to be understood as a means of forging truly embodied affective connections between AR users and others at a (figurative or literal) distance: Syrian refugees [16], Muslim travelers to the US [35], undocumented travelers to the southern US border [12], survivors of human trafficking [32], etc. Such a stance finds an articulation in a generalized form in the AR/VR for Peace Project, which claims boldly to bring together "two people who hate each other" [33].

Despite such optimism surrounding AR and VR as tools for developing the ethical and political capacities of individuals, there is a great need to be cautious in this domain. Many scholars have argued that technology is not value-neutral: it bears the seen or unseen marks of the powers which give rise to it and broadcasts many of the biases built into the ideologies upheld by said powers [4, 21, 28, 31, 37]. With respect to AR, one of the potential values embedded therein is the technolibertarian notion of user empowerment, which here means augmentation of the rights of individuals operating in public to alter and control that public through their (presumed to be innocuous) 'individual preferences.' We may ask, for example, if increasingly available and sophisticated AR technologies (such as Microsoft's Hololens) will combine with the ideologies of individualism to create a kind of *options menu* for the real world – one that might include a toggle to 'turn off' certain ethnicities or genders (as was, by certain accounts, under consideration for the game *Mordhau* [24]).

Speculative and Critical Design

Actualising the aforementioned question for the purpose of catalysing debate would be to engage in speculative or critical design (SCD hereafter). SCD as proposed by Dunne & Raby [11] points to the role of design as a mode of interrogating the socio-political imagination or even as a 'worst case scenario' unveiling of possible dystopias [36]. SCD has been positioned in contrast to affirmative design; if the latter concerns problem solving, reflecting how the world is, the former concerns itself with problem finding, reflecting how the world could be [11]. Pragmatically, it involves designing and evoking objects and experiences that allow individuals to critically approach technology and its futures anew [5]. This is of special import in situations where true debate is difficult to come by – a statement certainly true of the issue of reasonable accommodation in Quebec [19, 20]. But as Auger points out, the likelihood of SCDs succeeding in triggering critical thought depends in part on how we interpret them with regards to familiarity. They should feel familiar enough that we deem them relevant, but unfamiliar enough that we bother to pay attention [3].

Despite SCD's commitments towards servicing society, it has itself has come under fire in recent years for its naivety towards its own privilege. The eurocentrism involved in positing dystopias that are already occurring to people who are not white academics in Western countries becomes, by way of framing them as speculative possibilities, one more way to silence rather than foster debate, as well as to reinstitute techno-utopic solutions [17, 23, 25, 26, 30]. Acknowledging that our own work could be criticized along these lines, an uncomfortable reality of Bills 62 and 21 is that they exist in part because they have significant support from the public [19, 20]. Shifting public opinion, which SCDs possess the capacity to do, is one path towards overturning these bills, but public opinion only shifts if a public beyond the university in engaged with.

NEO//QAB

Design Intention and Fiction

The design intention underlying NEO//QAB is to engage people in an experience that provides a provocative "solution" to the problem of cultural and religious tolerance. In the world of NEO//QAB, individuals are equipped with technology that empowers them to deal with niqab-wearing women by replacing them visually, if the sight of these women is more than the viewer can tolerate. For instance, such a viewer may choose to see a person matching their own ethnicity or, perhaps, no one at all. Or maybe they prefer to see no one at all. Core to the intended experience is that NEO//QAB enables total control over appearance, mirroring the control Quebec has over what Muslim women can wear in the public sphere. NEO//QAB is a design experience to be deployed in a variety of settings including

those beyond academia, such as malls and other shared public spaces.

Initial Concept

Our initial concept revolved around the following: a NEO//QAB would be a type of all covering garment, not unlike the combination of a niqab worn with an *abaya* (a long-sleeved, floor-length outer garment). But unlike garments we are already familiar with, the external appearance of NEO//QABs would be under the control of people looking at their wearers through an AR application. As such, we proceeded with the objective of bringing NEO//QAB to life as a two-person experience, one involving a wearer of a full-body garment, and a controller who controls their physical appearance. Worth pointing out here is that it was not important to us to *actually* develop NEO//QAB technology, but rather to evoke the experience enough that reflection and debate could be initiated.

Prototyping Speculative Worlds

A universally acknowledged best practice for interaction design of all forms is that it should be developed iteratively [10]. It has become evident to us across multiple iterations of NEO//QAB that speculative design has a special relationship to the iterative process for the following reason: Speculative design is about evoking realities and worlds that draw from, yet diverge from, our present realities [3, 11]. Iterative prototypes are themselves a form of invoking realities — each prototype is about bringing to life a curated assemblage of potential [18].

Each of our stages of speculative play prototyping have then been about worlding, both "world building" — how do I bring a *particular* world to life? — but simultaneously also about "world interrogation" — is the evoked world the *right* world? Here we examine how the worlding and rhetoric of NEO//QAB has evolved across four iterations.

Prototype 1

Our first prototype involved live chromakey via webcam using an unstructured piece of green fabric that was worn like a shawl. Over two sessions, we overlaid both photos and videos onto the fabric, experimenting with mapping clothes, bodies, textures from nature, and video feeds of the room in which we were conducting the experiments. From these sessions, we took away the following observations.

Identity control was compelling The base concept of NEO//QAB — that of identity control — had traction. The mapping communicated a dystopian world in which people's appearances were not only malleable but under the control of others. People's outwardly expressed identity became a destabilized element, as we had hoped.

Chromakey was too limiting It was clear that chromakey would not be tenable as a long-term technical solution. To make any mapped photos and videos meaningful, i.e. to express "identity replacement" and not simply ugly digital fabric, chromakey required carefully choreographed movement from the wearer and tight control over the background. Furthermore, the worn garment alone did not constitute a large enough canvas – we needed a way for the mapped imagery to exist outside of the contours of an actual garment-clad body.

Prototype 2

For the second iteration of prototyping, we opted for a simpler and more forgiving prototype: we projected imagery of clothes and bodies onto a wearer clad in an abaya and head scarf. As we were working with projection, it occurred to us that visual layers were an affordance we could leverage. We developed a simple JavaScript tool that enabled a controller to choose a background image or video, and a foreground outfit or body; both of which were then applied to a wearer. Figure 1 shows the prototype in action.

Figure 1. Prototype 2 in use.

After running three internal playlists with members of the development team, a number of considerations surfaced.

Context significantly impacted interpretation The background played a notable difference in how the resulting image "read". A person in an abaya on a busy street evoked quite a different response to the same person in an abaya on a crowded beach. The background therefore became an important consideration for worlding, and for raising the question of where we expect certain bodies to exist, or even where they are legally *allowed* to exist. We turned to stock photography databases for sourcing these backgrounds.

Bodies were more evocative of identity control than clothes Niqab-wearers conceal their faces. In countries that have banned niqab, social and moral requirements to see everyone's faces have frequently been expressed. NEO//QAB was about ascribing identity independently of the desires (and potentially knowledge) of the wearer; hence we decided to forego standalone items of clothing (e.g. a red dress) and to have controllers choose clothed bodies — of people — to map onto the wearer (e.g. a millennial aged Hispanic woman in hospital scrubs). But in opting to focus on people, another question emerged: *which* people?

Motion was key to conveying everyday existence Our simple projection set-up meant the wearer had to either remain stationary, or the person in charge of the imagery had to be exceptionally good at moving the media to fit with the wearer's motion. As with prototype 1, this was much too

restrictive for conveying the intended wearer-controller dynamic. It seemed key that the wearer should be able to be in motion, as NEO//QAB was about evoking control over people who exist around us in day-to-day life. We needed some way to automate motion tracking.

Prototype 3

For the third iteration of prototyping, we made use of an Xbox Kinect to perform body tracking in tandem with a Processing sketch and a Node.js web app to superimpose images chosen by controllers (hereafter referred to as *superbodies*).

For prototype 2, we had already turned to stock photography for background images. It therefore made sense to look to the same databases for foreground superbodies. What we soon discovered as we browsed the options on offer is that stock photography serves as one particular interpretation of a normative Western society, albeit one flavoured with capitalism, as a significant portion of the stock photography customer base is composed of businesses seeking imagery that will appeal to and/or reflect their consumers. Certain categories had many high-resolution options: *young white business man friendly*, *young white man sporty*, *middle aged man casual*. Other categories had very few options. In these cases, the image resolution was also often comparatively poor: *Hispanic older woman in a wheelchair*. Noting that we could easily become derailed in attempting to understand the biases inherent in stock photography databases, we decided instead that we would work with the lack of representation of certain bodies, as it was an aspect of our present reality that our speculated world could meaningfully mirror.

The stock photography searches also brought to light another element of NEO//QAB that we would need to contend with: how to articulate diversity, particularly with regards to the controller's user experience. We wanted to convey a technolibertarian, Silicon Valley sensibility of the illusion of fairness, where user empowerment reigns supreme and individual technological solutions can patch all facets of life. One of the contradictions of contemporary experience design is that personal customisation is available to all users, yet the range of options made available is often less about providing democratic and inclusive coverage and more about customer markets: not all users can find their preferences reflected in customisation options.

In designing the user experience of the controller app, we set out to convey a flawed personal customisation system, replete with over-representations of some types of individuals and under-representation of others. To help determine a way of narrowing down identity in a way that would feel familiar to many users, we turned to Canadian census questionnaires for inspiration, noting in particular the age brackets, ways of characterising ethnicity, and language surrounding occupation. Our census-based categorisation required the user to make a series of five decisions regarding the following: gender, age, ethnicity, occupation, and other features (which included physical disability). Based on these categories, we then went back to a stock photography bank and sought out images to populate each category, noting that some combinations were either very thinly populated or completely absent. To counter the experience of thin representation across certain combinations, alongside an occupation flavoured search, we added a "context" flavoured search, which required the user to make four decisions: age, gender, ethnicity, context (casual or formal), and other features. Controller selections led to the app outputting choices into a JSON file. See figure 2 for a screenshot of the Prototype 3 controller app.

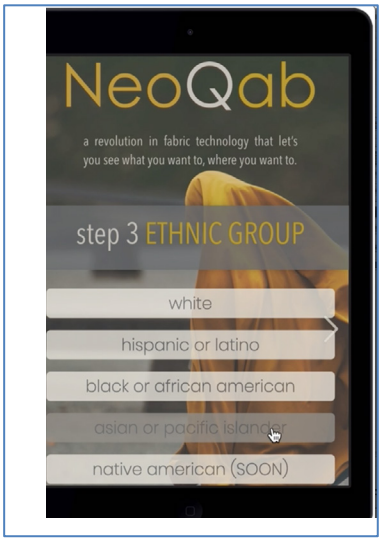

Figure 2. Prototype 3 controller

Interfacing between the controller app and the Kinect was a Processing sketch that made use of the KinectPV2 library. The sketch read the JSON file to retrieve the most recent superbody match. This superbody was then superimposed over whichever body the Kinect could see. Once our software setup felt stable enough to test, and our body database had sufficiently many superbodies loaded into it, we invited people to playtest NEO//QAB.

We recruited six participants for the playtest from the Technoculture, Art, and Games (TAG) Research Centre and from our department. We set up the playtest in our department's "black box" room; an enclosed, windowless, furniture-less room that was empty save for floor to ceiling black curtains. We positioned the projector such that it faced one wall, with the Kinect facing the projector. Each participant was supplied with an information sheet that gave a broad overview of the NEO//QAB research project, and then signed a consent form regarding their participation. We matched up our participants into controller and wearer pairs. Wearers were dressed in a long flowing garment and faced a large projection screen that showed output of the Processing sketch, while controllers were given an iPad from which to drive the controller app for making superbody selections. Figure 3 shows the playtest in process.

After we let each pair play both roles (which lasted about 15 minutes), we ran small focus group discussions featuring open ended questions about the nature of the experience. Below we present the core findings from that playtest.

NEO//QAB did not do enough diegetic worlding When the play testing was about to begin, one core aspect of the

NEO//QAB experience became apparent: NEO//QAB requires an amount of exposition before it can do its speculative "work". We found ourselves having to give an impromptu and hurried explanation of the type of world NEO//QAB conveys and exists in, as well as our own political stance towards niqab and hijab. Verbally explaining the world and our position felt uncomfortably didactic, and simultaneously in tension with the point of speculative play — to act rather than to tell.

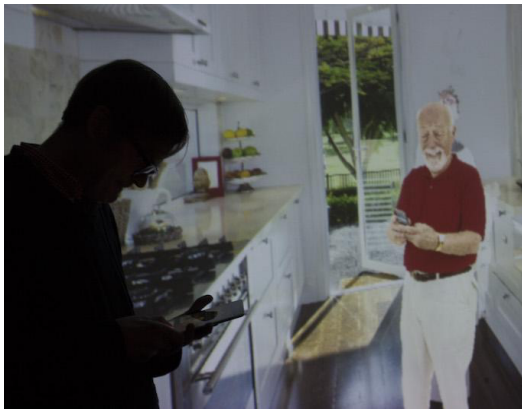

Figure 3. Prototype 3 playtest.

Census-based filtering did not feel gratifyingly interactive For pragmatic and speculative crafting reasons, the app experience was too slow. Basing the selections on census questions, while rooted in a familiar experience, was at odds with people's expectations of an iPad as an interaction device. Our users spent a lot of time staring down at the app, and explained that they placed importance on every decision they made. This sense of responsibility, as well as the comparatively large amount of time invested by interaction design standards, did not match the payoff they felt of seeing the superbody appear on the big screen — especially when they encountered a "zero matches" search result.

The stock photography critique was too opaque Unsurprisingly in retrospect, the critique of stock photography's limitations in representing diversity, which we had found intellectually compelling, failed to come through. No one was able to connect the bodies that were available for selection with the idea of image banks and stock photography. As such, the "zero matches" message was interpreted exactly as it sounded: at face value, and representative of an incomplete tool.

Different individuals had very different processes for selecting bodies It was notable that our participants strove to find many different types of bodies to assign as superbodies. Two participants explained that they tried their best simply to assign a body that most closely resembled the appearance of their wearers. Another participant explained that once he realized he was dealing with a system (and a system of categorizing and representing bodies), he wished to explore and test the "limits" of the system, as he might when playing a game, and hence focused on the system itself as opposed to the human wearer standing nearby. Yet another person tried to hand the wearer of the garment the device, opening up the possibility of the wearer controlling her own appearance, with the wearer responding, "isn't the whole point that I don't have control?" The same individual, when in the role of controller, said she was nervous the entire time that a naked body would appear as an option. This participant, along with others, explained that they felt a sense of vulnerability on behalf of their wearers, and a responsibility to treat them with dignity.

Presenting differently abled bodies felt problematic All of the participants expressed that they felt uncomfortable about selecting an individual in a wheelchair as a superbody. One participant stated that he felt especially uneasy about it given the wording we used for the corresponding section: *other features*. Our participants expressed that selecting the individual in the wheelchair would have felt like a step towards making fun of differently abled individuals. This was certainly not the effect we had intended — our wish was simply to make a wide range of different bodies available (apart from those that overtly appeared to be Muslim women) — so it was clear something was going wrong in the tone and presentation of how this choice was being made available.

The role for wearers was not structured enough Both from observations of wearers and based on what they told us afterwards, it was clear that the role for wearers was under-articulated, with some feeling uncomfortable about being the object of attention. Whereas the controllers had an active task (change the appearance of the wearer) the wearers had a very passive task (stand in place wearing a garment). How we had arranged our projector and Kinect in relation to the projection wall also meant that the wearer was directly facing their projection, and therefore in a position to see themselves with different bodies being applied, i.e. as a large dress up doll. Indeed, in the initial concept for NEO//QAB, the wearer was not even supposed to know *if* a superbody was being applied to them, let alone *which* body.

Bugs weakened the speculation Our participants encountered a few bugs lurking in our software, including the backgrounds changing too quickly, the superbody resizing algorithm sometimes acting unexpectedly, and the web app occasionally freezing at the very last stage before a selection was made. Bugs are fairly common occurrences in prototypes, but in the case of a speculative design, they potentially played a fairly significant role in gnawing away at the plausibility of the world that our prototype was meant to evoke.

Controlling someone else's body was still discomforting For all the unforeseen issues we encountered, we did confirm the main hypothesis underlying the rhetoric of NEO//QAB as a design piece: having direct control over the appearance of flesh-and-blood, embodied others made people feel uneasy.

Prototype 4

For the fourth iteration of prototyping, our major objective was to address the issues and limitations of the previous prototype. We chose to continue working with the Kinect for body tracking, but decided to undertake redesigns on other elements of the NEO//QAB system.

The census-inspired controller app experience had not resonated with our users as we had hoped. We went back to

the drawing board with regards to brainstorming ways to sort and categorise identity. Because the app would always be used on a tablet or mobile device, we decided to lean more on traditional mobile app design tropes. It occurred to us that applications such as Tinder were essentially about sorting and categorising identity and so we looked specifically to the Tinder's central interaction of swiping for inspiration.

The default selection pool for superbody matches now presents the entire set of bodies to the controller, one at a time. To cycle through possible superbodies, the user swipes left. To select a superbody, the user swipes right. Buttons along the bottom filter the superbody pool according to gender, age, and ethnic group. We decided to eliminate the categories of occupation and other features, instead using the images directly to convey their own messaging regarding these qualities. The redesigned app was developed in Node.js, and we retained the previous solution of outputting controller-made choices into a JSON file to be read into the Processing sketch. Figure 4 shows a screenshot from the Prototype 4 controller app.

Shifting to the model of cutting down a pool of identities, as opposed to building up the criteria to specify a certain type of individual improved the responsiveness of the app and the pace of the overall NEO//QAB experience. This solution also reduced the degree to which we needed to assign labels (such as "differently abled" or "other features"). Instead it shifts this often highly subjective exercise onto users, letting them bring their own interpretations.

Figure 4. The Prototype 4 controller app.

While we still view NEO//QAB as being, in part, a critique of stock photography images, we have detuned our expectations of NEO//QAB participants perceiving this. Just as standard product design frequently involves distinguishing between "must have" and "nice to have" features, we propose that speculative design involves distinguishing between "must know" and "nice to know" aspects of the projected speculative world. The stock photography critique falls within the latter category.

The other major redesign we have made concerns the role of the wearer, which had been revealed to be under-articulated. In reflecting on the wearer role, we realized we had drifted from the initial concept we had for NEO//QAB, which centralised controllers acting on wearers without their consent. To address these issues, we decided that any activity undertaken by wearers should be intentionally unrelated to the activity being undertaken by controllers: wearers would act out moments from an ordinary day. Wearers would thus *not* face the projection screen and therefore would not be able to see which superbodies were being applied to them. Controllers would be positioned so that they had a clear view both of the wearer and the projection screen.

To direct the wearer, we developed a branching Twine-based interactive fiction that they could read on their own device. The Twine story conveys moments from a day, and asks the wearer to perform specific, mundane physical actions at certain points for short durations of time, as in figure 5.

Figure 5. The Prototype 4 Twine for wearers.

While the Twine has most obviously given wearers a more clearly defined role and point of focus, it has also given us a means of engaging in worlding. The first screen begins by unfolding a fiction in which the wearer has been specially selected to participate in a closed beta of a system which is about improving everyday life. In *Black Mirror*-esque style, it is never revealed whose life is being improved.

Discussion

Across four iterations of design and prototyping, we have developed a much better understanding of what we would like people to understand about NEO//QAB, what is key to its interaction, and how to use interaction design and playfulness to get people interacting with one another in ways that perform the "work" of NEO//QAB. Here we generalise some of that design knowledge to the context of playfully interactive SCD, or speculative play, with a focus on achieving appropriate worlding.

Leverage existing, contextually-appropriate interactions unless there is a rhetorical reason not to SCDs by their nature require people experiencing them to grapple with novel, unusual, or difficult subject matter: they imply a

degree of interpretive complexity. Novel or nonstandard interaction mechanics likewise introduce complexity, though of a different type. Accepted wisdom in interaction design proposes that user-interfaces (UIs) should be as minimal as possible, and that designers should endeavour to make them transparent, i.e. harmonious with what a user would expect [10]. We propose SCD designers likewise rely on minimal UIs or well-known UI design tropes unless the interaction mechanic directly explains the subject matter. In contrast, including unnecessary complexity in an SCD introduces noise into what people are able to interpret.

Endeavour to have the SCD perform its own exposition diegetically SCDs imply worlds that are like our own, but with notable differences. Interactive systems and devices usually require a degree of explanation regarding their workings, with contemporary interaction design typically streamlining tutorials into early stage interaction. We propose doing the same for SCD exposition where possible: it increases the immersiveness of the experience, mirrors interaction design experiences we are accustomed to, and removes with the need for a more didactic interlude from the design/research team.

Do not expect that a complex SCD world will be perceived on a first experience By the time an SCD is taking form, most likely a significant amount of background research has been invested into it. Individuals who experience an SCD for the first time will hopefully pick up on a broad understanding of the implied surrounding world, but are unlikely to discern more subtle and complex details. We remind designers that the same holds true of much other media. As long as the most important rhetoric and questions are communicated, the SCD has achieved its purpose.

Run the SCD past individuals external to the design team frequently Game design best practice demands that game designers playtest their games early and often. We suggest SCDs should also be tested early and often. Members internal to the design team become deeply familiar with the intended message of an SCD, and over time may no longer be good judges of whether that message is being conveyed, or even what the conveyed message is. As SCDs live and die by their messaging, running playtest-style evaluations of SCDs with newcomers enables designers to see their own work through eyes that are still *unworlded*.

Conclusion

NEO//QAB is an AR speculative play experience that arose in response to recently proposed legislation in Quebec that disproportionately affects visibly Muslim women. NEO//QAB is a two-person experience, involving a wearer of a full-body garment, and a controller who controls the appearance of the garment. In this paper, we detailed the design trajectory of NEO//QAB over four iterations, exposing and reflecting on how different prototypes and their materials have mediated the NEO//QAB world. From this design research, we have isolated four strategies for speculative play concerning complexity, interactivity, but most of all, worlding.

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Beneath the Surface and into the Planetary: Listening to/for Coexistence in Contemporary Sound Installations

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Abstract

Satellite images of the earth present the planet as a whole and seemingly unified object. However, as Jennifer Gabrys argues, the planetary is not a uniform fixed set of conditions, and more distributed monitoring environmental sensors can point to the ways in which the earth might be seen not as one, but as many. This paper considers how contemporary artists use sound to hint towards the planetary by closely engaging with Leah Barclay's *WIRA* (2015), a geolocated audio walk along the Noosa River, and Calder Harben's *Bodies of Water* (2017), a low-frequency audio installation that engages with the violence of ocean noise pollution. Drawing on Brandon LaBelle's theories on listening, it argues that these sound installations, by engaging viewers in acts of deep listening, amplify various forms of coexistence among humans and more-than-humans that challenge the satellite view. These bring us to ask: How do we listen to what we have not been trained to acknowledge, understand, or interpret? Can listening to what we cannot understand still be productive? Ultimately, listening is elaborated as a productive sentient engagement with marine worlds that makes apparent our entanglement with soundscapes we do not inhabit and bodies that are not our own.

Keywords

Contemporary art, listening, sound installation, marine soundscapes, planetary, coexistence

In 1972, the image of the "Blue Marble" introduced a unifying and seemingly complete view of the whole earth. [1] This all-encompassing view has since come to be seen as insufficient and problematically universalizing, giving rise to new representational challenges. Jennifer Gabrys is among those who have argued that we must move away from imagining the earth as a totality, as an entity that can seemingly be captured and managed. She posits that the planetary is in fact that which cannot be fixed or settled. It requires "a mode of inhabiting with what escapes translation or 'acceptance;'" and it consequently "resists representation." [2] Gabrys' conception of the planetary will be a central consideration in this essay, which investigates listening as a form of sentient engagement with coexistence in contemporary sound installations. More precisely, this essay examines how her concept of the planetary might be mobilized by Leah Barclay's *WIRA* (2015), a geolocated audio walk along the Noosa River; and Calder Harben's *Bodies of Water* (2017), a low-frequency audio installation that engages with the violence of ocean noise pollution. I ask: how might these artworks hint towards the planetary? In other words, how do they attend to the incommensurable, the unjust, and the yet to be recognized? I contend that these installations, by engaging viewers in acts of deep listening, move away from the satellite view to attend to multiple forms of coexistence.

Following a brief consideration of what listening as a practice can entail, I discuss how the sound recordings from Barclay's *WIRA* engage with polyphonic and non-translatable voices of the Noosa River. I then consider how Harben's *Bodies of Water* explores the limits of human perceptibility in order to rethink coexistence beyond human centrism. Finally, I end this essay by examining patterns that emerge in both Barclay and Harben's installations, namely the bridging of intimacy and distance in sound recordings that can only ever reveal a partial view.

Potentials of Listening to/for Coexistence

It is worth dwelling right away on how listening is understood in the context of this essay.

Scholars engaging with the politics of listening highlight its importance, as opposed to speaking, for effective democracy. In *Democracy of Nature: Speaking and Listening* (2010), Andrew Dobson explains that speech has been one of the key characteristics with which humans have distinguished themselves from other beings, and this has in turn resulted in a general lack of political consideration of more-than-humans. However, echoing Bruno Latour, Dobson proposes that humans are not the only ones who speak, discuss, and argue. He contends that listening as a capacity merits further scholarly attention because, like speech, it requires cultivation, especially in the context of human and more-than-human relations. To think about listening in terms of "receptivity," which evokes a broader notion of responsiveness that is perhaps more attuned to more-than-human "voices," is where Dobson proposes we begin. To further elucidate this claim, he writes that "[i]f we had been better listeners, we might have heard the drip-drip of the melting glaciers as a 'proposition' to be considered." [3]

Leah Bassel would suggest that in order to take dripping glaciers as a serious proposition, norms of intelligibility must first be broken. In *The Politics of Listening* (2017), she explores how the "barriers that partition the sensible and the audible," and therefore create norms of intelligibility, can be refigured. [4] Like Dobson, Bassel thoroughly considers the political potential of listening as an act that can begin to pluralize public space, but notes that the *how* of listening matters as much as the *why*. While there is value in cultivating such a skill, viewers that enter a gallery space bring with them various understandings of what is "audible" or "sensible," or of how to engage with (un)intelligibility. How do we listen to what we have not been trained to acknowledge, understand, or interpret? Or more importantly, how can listening to what can never fully be grasped or comprehended still be productive?

Brandon LaBelle discusses listening as an act of recognizing as it is experienced within sound installations. Theories of listening are typically grounded in the notion of diffused subjectivity. He explains that through listening, individuals are extended beyond the boundaries of singularity, and toward a necessarily multiple space since the act of paying attention blurs the borders between things. [5] It is a form of sentient engagement with coexistence and a way in which beings co-become in the sense that "[l]istening breaks apart the shell of the subject, eases the borders of identity, and initiates an interdependence whereby one is constituted by the whole environmental horizon." [6] LaBelle then proposes that in the context of sound installations, viewers are positioned inside an ecology of acoustical events. He writes that "[t]o listen attentively then is to become a part of things and to lessen the human agency of will, for listening is about receiving through an intense passivity all that is surrounding." [7] It is not about refiguring norms of intelligibility or decoding more-than-human sounds to then necessarily incorporate them into political or legal discourses, but about recognizing how even the unintelligible can affect the listener. With both LaBelle's understanding of listening and Gabrys' "being planetary as praxis" [8] in mind, the following examines how experiences of listening unfold in two contemporary sound installations that invite viewers to attend to the soundscapes of marine environments.

Leah Barclay: Polyphonic and Untranslated Voices

Leah Barclay is an Australian sound artist, composer and researcher working at the intersection of art, science and technology. In her practice, she experiments with mobile technologies as tools for ecological connection and explores the value of acoustic ecology as a socially engaged, accessible, and interdisciplinary field that can inspire people to listen to the environment. Her deep listening practice is centered on sound, listening and tuning into normally inaudible or unrecognized aspects of the "natural world." [9]

Barclay's *WIRA* installation from 2015 is part of a larger project titled *River Listening*, which is an interdisciplinary collaboration that more broadly explores the creative possibilities of aquatic bioacoustics and the potential for new approaches in the conservation of global river systems. The artist developed this project in collaboration with the Australian Rivers Institute in Queensland, Australia in 2014. It promotes immersive community engagement through interactive listening labs, field recordings, sounds maps, performances and installations that creatively experiment with digital technologies to better understand river health and aquatic biodiversity. [10]

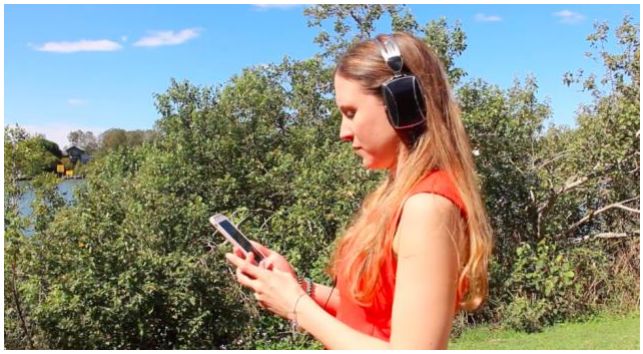

Figure 1. Leah Barclay, *WIRA* (woman listening to sound recordings through mobile device and earphones), 2015.

WIRA was the first major creative outcome of this project, though other iterations of this installation were presented along the Thames River, and later at the Seine River during ArtCOP21. It is an interactive sound installation located along the Noosa River that launched in the context of *Floating Land* 2015, an Australian bi-annual environmental art festival. It opened on August 27, 2015 and has since become a permanent installation for local communities. This artwork can be experienced by walking along the river, listening to sound recordings with a mobile device and earphones (figure 1). Each recording is geotagged in relation to a relevant part of the river bank. For instance, a recording of snapping shrimp becomes louder as one approaches the jetty, and so closer to where the shrimp are indeed located. Community voices and chants similarly become louder as one approaches certain landmarks. These geotagged recordings can be heard at irregular intervals between the Noosa Regional Gallery and the mouth of the river (figure 2). The entire installation takes roughly an hour to experience, though listeners can experience it in sections, or circle back to different areas of the river at any time. [11]

Figure 2. Leah Barclay, *WIRA* (map of geo-located sounds), 2015.

At the heart of Barclay's *WIRA* are the experiences of sounds themselves, which is why I now attend to the content of the recordings as well as the ways in which they were framed in the context of the installation. In an essay published in *Soundscape*, the artist explains that the work's audio includes both "biological" and "cultural" soundscapes that were recorded over the course of a decade. [12] Hydrophones were used to record and stream that which makes up the acoustic ecologies of the Noosa River. These devices amplified the sounds emitted by waves, bell birds, shrimp, mud crabs, and dolphins among others. Barclay equally recorded the voices of artists, activists, conservationists and local Indigenous leaders who are variously tied to the Noosa River. For instance, excerpts from conversations had with Lyndon Davis who spoke about the Indigenous history of the Noosa Biosphere Reserve, and introduced Gubbi Gubbi words are incorporated into the installation's sound compositions. One of the words he introduced was in fact "Wira," the title of the artwork, which means "moving water." [13] The voices of members from the Lewton Cultural Group, and the Vanuatu Women's Water Music group – which is comprised of artists working towards preserving their cultural knowledge as their islands continue to experience the ramifications of climate change [14] – are also

embedded into the river's composed soundscapes.

I propose that these sound recordings allow us to see life in and around the Noosa River otherwise, and within the thick of planetary inhabitations. Barclay lifts submerged ways of being and knowing and juxtaposes them with the viewer's own perceptions of the river. By inviting viewers to listen to these soundscapes, the artist resists "high modernist, and totalizing visions of differentiated planetary life" that silence rivers. [15] Instead, she allows for the rushing sound of the river and its normally inaudible or unrecognized voices to emerge.

Gabrys contends that being planetary as praxis moves away from a satellite view – with its transparent logic that leaves no place undiscovered – and towards more entangled environs. [16] Barclay uses two main strategies for framing the submerged sounds of the Noosa River that contrast this transparent logic. The first consists of layering and interweaving sounds into polyphonic compositions, at times making individual sounds intangible. In some of the recorded and composed soundscapes, Barclay overlays "biological" and "cultural" voices. Human and more-than-human voices, recorded independently or together, are layered to create some of the work's most textured audio compositions. Live streams are also layered onto constructed clips, complicating the work's temporal scales. Some of the compositions are made up of binaural recordings, meaning they were recorded using two microphones. Such recordings are used to hallucinatory effect, blurring the distinction between live and prerecorded realities, and giving the listener the impression that sounds are coming from multiple directions. [17]

In a particular sound clip, titled "Mud Crabs,"[1] Lyndon Davis is initially heard talking about the Noosa River, though his voice is rapidly obscured by the noise of mud crabs that become increasingly loud. Familiar words continue to be heard, but they become difficult to decipher and piece together. Barclay's use of layering tends to the range of overlapping worlds that Timothy Morton discusses in *Humankind* (2017). He argues that "[t]here are a bewildering variety of scales, temporal and spatial," and that "the human ones are only a very narrow region of a much larger and necessarily inconsistent and varied scalar possibility space." [18] In a sense, such audio compositions reference these overlapping worlds, the undecipherable symbiotic interconnectedness of the river and its inhabitants.

The second compositional strategy employed by Barclay in *WIRA* involves framing more-than-human voices without offering, if it were even possible, any translation. In some recordings – namely "Snapping Shrimp" and "Dolphins" – the artist seemingly isolates the voices of river organisms, bringing listeners to attend to underwater animals that cannot be heard on land. The act of listening to snapping shrimp or a pod of dolphins through hydrophone recordings raises some of the questions posed earlier: How do we listen to what we have not been trained to acknowledge, understand, or interpret? Can listening to what can never fully be grasped or comprehended still be productive?

I argue that Barclay's incorporation of the untranslated (or the untranslatable) is generative for thinking about what it might mean to become planetary, and thus also challenge the transparent logic of the satellite view. Gabrys proposes that "[t]he planetary demands a mode of inhabiting with what escapes translation or 'acceptance.'" [19] It then appears to require what Morton refers to as "ecognosis," and perhaps "solidarity." He writes that ecognosis "is something like coexisting. It is like becoming accustomed to something strange, yet it is also becoming accustomed to strangeness that doesn't become less strange through acclimation." [20] To listen to Barclay's recordings of snapping shrimp then offers the opportunity to encounter those with whom we coexist, and cohabite from a

1 The sound recordings are available on the artist's website. Leah Barclay, "WIRA," 2015, https://leahbarclay.com/portfolio_page/wira/

distance, as something weird that can never be fully known. Translating in this case could be likened to making knowable, and thus, according to Gabrys, manageable within a universal science or perspective. To know the planet, she explains, it to fix or settle it, and to rid it of its alterity. [21]

WIRA rather embraces the polyphonic nature of the Noosa River's soundscape and asks viewers to confront its strange untranslatable inhabitants, and by doing so, privileges the multiplicity and alterity of the river's worlds. In *Program Earth* (2016), Gabrys explains that the satellite view has been largely narrated as a project of making a global observation system and seeing the earth as a whole object, while more distributed monitoring environmental sensors point to the ways in which the earth might be seen not as one, but as many. [22] The layering of recorded sounds and the diffusion of intangible voices in Barclay's *WIRA* are made possible through various and multiple distributed sensors – from hydrophones to river organisms – that represent and perform an overlapping of worlds. In what follows, I further consider how such distributed environmental sensors can complicate the notion of coexistence through Calder Harben's sound installation, *Bodies of Water*.

Calder Harben: Beyond Human-Centric Perceptibility

Calder Harben is a Toronto-born artist currently working in Copenhagen, Denmark. They primarily use sound and installation to explore the thresholds of human perceptibility. The artist is concerned with the idea of knowing a body of water for so long without being able to hear its stories. Their practice raises questions such as: "What is the experience of sound in the oceans? What does an image of ocean noise look like? How can it be tracked? Recorded? Translated? Transmitted?" [23] Their 2017 installation, *Bodies of Water*, is a low-frequency audio installation largely concerned with marine noise pollution.

Before delving into the work itself, it is worth briefly dwelling on the context of noise pollution as it is how Harben attends to unjust modes of coexistence. The level of noise pollution in the ocean is increasing, which means that anthropogenic sounds are disrupting the acoustic ecologies of the world's bodies of water beyond any previous rate. The authors of *Ecoacoustics: The Ecological Role of Sound* (2017) stress the importance of sound as it is, to varying degrees, how many beings relate to their environment. Aquatic animals are especially dependent on the auditory system, more than any other sensorial modality, because they use acoustic signals to enact a wide range of activities that ensure their survival; from communicating, to protecting themselves, locating food, navigating space and understanding their environments. [24]

Francesco Filiciotto and Giuseppa Buscaino note two types of anthropogenic noise pollution, one of them being low-frequency continuous noise, generally produced by ships and vessels used for extractive activities, shipping commercial goods, or even recreational purposes. This noise can create significant changes in marine habitats and organisms by causing hearing damage or by disrupting communication systems. [25] Boat engines and related vibrating machinery mostly emit low-frequency noises, occupying the space needed for communication among organisms. Whales are especially vulnerable to this during the signing season when boats violently camouflage their communication signals. [26]

Despite the harm anthropogenic low-frequency noise can cause to marine organisms, it remains mostly inaudible to humans. In fact, low-frequency sounds are often studied as ambient waves, as the unheard vibrations of infrasound, or even as "sound-like." [27] In *Low End Theory* (2016), Paul C. Jasen notes that low frequency sounds demand more theoretical attention as they are too often associated with "a buzzing confusion of sensation and therefore the enemy of clear auditory perception and, by implication, clear thought." [28] Like Barclay's *WIRA*,

Harben's *Bodies of Water* embraces ambiguity and unclear auditory perception.

Before entering the room housing the installation at Xpace Cultural Centre in Toronto, viewers were provided with earplugs and a second layer of over-ear protection. Harben claims that this ear protection was offered as an assistive device to help viewers "turn off the ears," rather than as any real form of safety guard. While the two layers of ear protection do not isolate all sounds, they "allow a quicker transition into sensing with the body." [29] The space itself contained a bench, and was bathed in a dark blue hue that limited visual distractions, concealing them in the darkness of the room (figure 3). In a more recent presentation of *Bodies of Water* at the Vermilion Sands gallery in Copenhagen, a similar blue hue filled the room. The space was equipped with several inflatable chairs (figure 4) instead of a bench. Harben suggests that these chairs provided the viewers something more comfortable to sit on, feasibly encouraging them to stay longer and thus extending the experience of listening. Filled with air, these chairs also more intensely carried, rather than impeded, the vibrations and frequencies of the installation's audio. [30]

Figure 3. Calder Harben, *Bodies of Water*, 2017, Xpace Cultural Centre, Toronto © Yuula Benivolski.

The audio is comprised of hydrophone recordings from different underwater locations – from the Mediterranean Sea to the Gulf of Bothnia and Lake Ontario – that document the auditive consequences of industry and traffic on marine environments. [31] The artist amplifies these low frequency recordings to the very threshold of human hearing, and plays them through a subwoofer, a speaker typically used to augment low frequency sounds. In a text accompanying the work, Shannon Webb-Campbell, a poet and member of Qalipu Mi'kmaq First Nation, writes that *Bodies of Water* requires deep listening as a means of communing with the sonic depths of bodies of water, even though these low-frequency sounds are almost inaudible to humans. [32] The installation's audio asks listeners to metaphorically enter the ocean, to embody and to pay witness to those who encounter and sense anthropogenic noise.

Figure 4. Calder Harben, *Bodies of Water,* 2017, Vermilion Sands, Copenhagen © Kevin Malcolm.

Bodies of Water expands the question of how we might listen to what we have not been trained to acknowledge, understand, or interpret. We must add: how do we listen to what we cannot audibly perceive? How can we relate to bodies that perceive differently? Together, the barely audible audio and the ear protection in Harben's installation pushes viewers to perceive and to feel vibrations otherwise. According to the artist, the longer a listener is in the space, the more their body might become sensitized to low-frequency sounds. In a review of the artwork as it was displayed in the 2019 exhibition *Bubble Metropolis*, Kristian Vistrup Madsen writes that

"[l]istening inflicts a certain pain, as the soundscape becomes indistinguishable from your own heartbeat and the thudding of the hearing protection against your temples." Madsen explains that the vibrations in the space created a "slow, sickening rumble" [33] that we might imagine could be felt in the depths of the bodies of water in which the audio was recorded.

While Harben employs certain aesthetic strategies – the low-frequency audio, the ear protection, the dark room – that test the limits of human perceptibility and ask people to tune into perhaps under/unexplored modes of sensing, I am certainly not suggesting that *Bodies of Water* brings its viewers to fully know the experience of marine organisms who sense similar sound. In Thomas Nagel's *What Is It Like to Be a Bat?* (1974), he argued that we are sensorially unequipped to think about the subjective character of experience without relying on the imagination. [34] However, more-than-human sensing modalities are referenced in this work, even if they never become fully accessible, as listeners become aware of the auditive reach and impact that anthropogenic industrial and leisurely activities taking place on the water's surface might have on underwater worlds.

To think about how Harben's *Bodies of Water* challenges the limits of human perceptibility can also bring us to think about forms of coexistence beyond human-centered experiences within the gallery itself. In what follows, I explore how the installation contains a multiplicity of more-than-human perceptions that enable what Gabrys refers to as a collaborative mode of sensing, and I add collaborative listening. In *Program Earth*, she explains that sensing is often focused on a human subject and considered through theories of phenomenological or prosthetic engagement. However, she works to develop new understandings of sensing that are not grounded on a pre-established human-centric subject or mediated subject-object relationship. [35]

Sensing is not exclusively about human modes of perception for Gabrys, but rather about distributed formations and conjunctions of experience across human and more-than-human subjects. She writes that "[t]he experiences provided by and through more-than-human processes, as well as the processes that unfold within sense data, in-form a more environmental approach to what might constitute 'collaborative' modes of sensing." [36] Similarly, Micheal Gallagher argues that technology is not a passive surface for inscription of meaning, but a material assemblage that partakes in machinic ecologies that operate differently to human perception and language. [37] In *Bodies of Water*, the viewer does not listen directly to marine soundscapes polluted by anthropogenic noise. Rather, the viewer listens to recordings of marine soundscapes as they were sensed and recorded by hydrophones. Embedded in these soundscapes may very well be the low-frequency sounds emitted by whales and other marine organisms sensing and reacting to their environment. The viewer listens to a machine listening to animals listening to anthropogenic noise pollution, and so on. This form of co-listening is also present in Barclay's *WIRA* in which similar technological dynamics are at play.

Coexistence is then not simply uncovered or represented in these sound installations, but performed. Gallagher argues that "[u]nlike landscape photographs or paintings, which appear as immediately present for seeing, field recordings have to be enacted to be heard, taking time to unfold." [38] Both the recording process and the transmission of sound is then shaped through a performance involving multiple human and more-than-human actants: "the vibrations in the environment being recorded; its acoustic qualities of reflection and absorption; the recording apparatus of microphones, cables, preamplifiers, electrical currents, memory cards, batteries, and headphones; and the recordist's ears, hands, and eyes." [39] Listening in *WIRA* and *Bodies of Water* then becomes not only about recognizing how we coexist with soundscapes we do not inhabit and bodies that are not our own, but also about coexisting in the present with more-than-humans actants.

Intimacy and Distance: Towards Partial Planetary Views

Gabrys notes that the invocation of the planetary – "the rolling out of behemoth systems that hold the planet and all of its entities in a space of complete capture" – suggests total dominion. [40] She proposes that planetary relations are not easily fixed or figured, but in their incommensurability, can signal toward other ways of being planetary as praxis. [41] In this final section of the essay, I attend to a pattern that has started to emerge through my examination of Barclay's *WIRA* and Harben's *Bodies of Water*, some of the aesthetic strategies that they employ, as well as the relations that they uncover and enable. Both sound installations bridge experiences of intimacy (connection) and distance (disconnection), therefore disclosing a certain incompleteness, and I argue that this how they attend to the planetary without totalizing and universalizing it.

There are some more evident ways in which the artists stage connection through disconnection. For instance, in Barclay's *WIRA*, the listener can only encounter the recorded voices of the Noosa River by isolating themselves from other aspects of the environment with a mobile device and earphones. The experience of listening in Harben's *Bodies of Water* is equally dependent on the partial isolation of one's senses; the viewer listens to low-frequency noises that elucidate a multiplicity of relations only by wearing ear protection in a dark space contained within the walls of the gallery. There are also other ways in which these installations disclose their partiality through simultaneous distance and intimacy, particularly through the inherent dynamics of sound recordings and playback.

As I have previously established, listeners immersed in the artworks listen not to marine soundscapes as such, but to their recordings. LaBelle elaborates this by elucidating how sound's relational condition can be traced through modes of spatiality. He historically situates acoustic ecology in relation to the development of Land Art in the early 1970s, outlining Robert Smithson's distinction between the site and non-site; the gallery functioning as the non-site that houses the site of the actual artistic work. LaBelle ultimately contends that in sound installations, "place paradoxically comes to life by being somewhat alien, other, and separate, removed and dislocated, rather than being mimetically real." [42] The sound recordings in *WIRA* and *Bodies of Water* then necessarily spatially, but also temporally, distance listeners from the underwater worlds that they reference. LaBelle contends that to bring such places into proximity with listeners, one has to contend with the interferences of its very representation, and ultimate dislocation, as well as that of its human and more-than-human inhabitants. [43] Listening in these installations would then be "a time for space to become alien, dislocated, foreign, so as to become present, renewed, and alive." [44] Distance then becomes key in experiences of proximity.

A last observation I wish to make before concluding is that the sound installations seem to be comprised of present absences, of spectral traces of spaces and beings. According to LaBelle, practices of acoustic ecology and soundscape composition often overlook, or underhear their own ghosts; "the distant, the foreign, the strange, the spooky, the haunting, and the mysterious" [45] that emerge through the distancing acts of recording and performances of playback. If we consider Morton's claims that "[t]he spectral beings that comprise the symbiotic real are disclosed as partial objects," [46] perhaps we can see that by engaging with sound, and thus inherently with the spectral, Barclay and Harben's installation unveil a certain incompleteness, or a partial view, through which they ultimately hint towards the planetary.

Conclusion

What makes the planetary representationally challenging is that it is not a uniform fixed set of conditions. Instead, it signals both conditions of difference and collective possibility (or solidarity). [47] This essay has argued that by

moving away from the satellite view, towards the submerged and the entangled, Barlcay's *WIRA* and Harben's *Bodies of Water* attend to multiple forms of coexistence as they are represented and performed within the context of the installations. Through the multiple and untranslated voices of the Noosa River, and the collaborative experience of listening to low-frequency sounds, viewers are confronted with multi-temporal and multi-spatial scales of experiences; they encounter the strange, the haunted and the unknowable humans and more-than-humans with which we coexist. While it could be argued that such relations are not made possible *because* of these installations, Barclay and Harben's staging of these modes of coexistence provide listeners the opportunity to engage with the always-already present. The artists do not – and cannot – make entirely accessible the submerged, but by asking the listener to sentiently engage with some of its undecipherable and/or spectral traces, they bring the viewer into a place of alienation that is perhaps not disheartening, but productive in processes of becoming planetary and ultimately of building more ethical relationships with our waters.

Acknowledgments

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Enchanting Materialities: e-textiles installations for an ecosophic world

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Abstract

Jane Bennett's concept of enchantment materialism argues for aesthetics' role in calling for an attentiveness to the ecologies of things. In turn, such experiences of appreciation and care have the capacity to instigate an ethics of generosity (2001). In *Vibrant Matter* (2010), Bennett enacts this ethics by including all entities, living and non-living, in what she calls an 'onto-story' – a counter tale to the anthropocentric stories of a disenchanted world.

This paper outlines how we told onto-stories through e-textiles installations, central to which are the transformative material encounters with non-human bodies. We begin with an account of working with a conglomerate of natural and electronic materials to attend to disappearing plant species in the site installation *Twilight States and the Edges of Darkness* (2016) for Bundanon's Siteworks. We follow with a discussion on our collaboration with unfamiliar materials to explore coral polyps as bio-archives in the multi-sensory installation *Spinning World* (2018) for Sydney's Powerhouse Museum. These accounts are framed within Bennett's theory of political ecology to show how material assemblages open up spaces of wonder for encountering non-human and non-living entities. The paper concludes by addressing how sentience can participate in an environmental politics for an ecosophic world.

Keywords

E-textiles, installation art, enchantment, sentience, vital materialism, environmental politics

Introduction

This paper is written at the site of our first collaboration: Bundanon Trust's Riversdale residence on the Southeastern coast of Australia. We are: a visual artist with expertise in textiles, installation, and storytelling, and a media artist whose practice is guided by the transformative relationship between art, science, and technology. As researchers, we collaborate with artists and scientists from a range of fields to bring technologies, materials, and knowledges together to create immersive experiences of an ecosophic world.

Our first collaboration responded to the mid-winter Riversdale landscape by the Shoalhaven River. We placed discreet crocheted forms sewn with tiny but exceptionally bright LEDs onto the trunks of eucalyptus. These pieces twinkled unpredictably as the fabric was animated by the wind. At dusk, the winking LEDs beckoned to the viewers. The points of luminescence merged with car head-lamps across the river, and echoed the meeting of Jupiter and Venus in the night sky. This experiment showed how aesthetic interventions call attention to the preternatural liveliness and enchantment latent in our lived environment.

Jane Bennett's enchantment materialism argues for aesthetics' role in engendering an attentiveness to the ecologies of things that make up our world.[1] Becoming aware, she claims, has the capacity to lead to an ethics of generosity. In *Vibrant Matter*, Bennett's vital materialism enact this ethics to tell an "onto-story" of living and non-living things.[2] Responding to Bennett's call, this paper asks: how can sentience participate in an environmental politics? We address this question by reflecting on how we transform materials into aesthetic experiences in two art installations.

In what follows, we relate how *Twilight States and the Edges of Darkness* (2016) emerged from a meshwork of materials (silk organza, bamboo hoops, cotton thread, LEDs, sensors, and solar cells) to attend to site; and recount our encounter with familiar and emerging materials (graphene, climate data, silk, cotton, ink, rice paper, coral, metallic threads, and kimono) in creating *Spinning World* (2018). These accounts are framed within Bennett's theory of political ecology and our analyses focus on how material assemblages open up empathetic spaces. We conclude with a discussion on how cooperating with ecologies of materials can give rise to a sentience dimension necessary for an environmental politics.

Twilight States and the Edges of Darkness

Twilight States and the Edges of Darkness (*Twilight States*) was an interactive site-specific installation staged as part of Siteworks 2016 at the Bundanon. Bundanon is situated on the land of the Wodi Wodi people, of the Yuin nation, and of the Dharawal country on the Southeastern coast of Australia. The Bundanon homestead and the Riversdale site are connected by the Shoalhaven River. Both were bequeathed to the Australian people by artists Arthur and Yvonne Boyd in 1993.[3] The Bundanon Trust invites artists, scientists, scholars, researchers, and communities to participate in dialogues at its annual Spring festival: Siteworks.

In 2016, the theme "Ghostings" marked the 150th anniversary of the Bundanon homestead. The organizers elaborate: "Ghosts surround us. Everything that has happened

leaves traces. Buried pasts, half-remembered stories, hidden life and cryptic clues – Siteworks lifted the veil to uncover what lies within." [4] *Twilight States* was a response to the interstitial status of human and non-human migration, emplacement, and traversal through a changing land(scape). We asked: what may a ghostly landscape inhabited by different lives feel like?

"Ghostings" was a one-day event that ran from noon into late night. As guests walked pass Boyd's studio, through the courtyard and beyond the sandstone walls, the garden opened up to an expanse of a lightly wooded grassed slope beside a dam. Amongst the trees, visitor's attention was directed towards circular shapes that seemingly hovered just above eye-level. The interconnected circles were almost transparent apart from the frames that gave them form (fig.1). On closer inspection, grey lines became visible. These traced the outlines of plants, while thinner tracks connected opaque circles to tiny points of lights. Once a conglomerate was discerned, more similar shapes floating around trees came into view.

Figure 1. *Twilight States and the Edges of Darkness*, cotton thread and micro-electronics embroidered on silk organza framed in bamboo embroidery hoops, installed view. Courtesy of the artists.

Twilight States was created for this particular site – a sparsely vegetated foreshore populated by introduced plant species. The work consisted of seventeen sets of interconnected pale pink mixed with yellows and greys silk fabric works mounted onto bamboo embroidery hoops of differing sizes. Each set had an image of a single endangered flora species of New South Wales embroidered onto the fabric with cotton grey thread. The decision to use silk organza was influenced by our previous experiments in creating floating drawings of living and mythical creatures. Silk organza is a biodegradable, sheer and light yet resilient material. It provides an unexpected support for embroidered images for outdoor works. The images magically superimpose onto a landscape as if they are drawn onto air. Circular micro-controller boards and electronic components were sewn onto the silk with steel fibre threads. The rambling circuits, reminiscent of insect trails connected sensors and actuators to lithium-polymer batteries charged by circular solar photovoltaic panels. The use of electronics in an outdoor setting called for an ecocentric approach to installation art with the use of solar panels to power a wireless radio network that allowed discrete pieces to communicate. During the day when the viewers engaged with the embroidered images on silk, the solar panels charged. When the light sensors on the fabric detected a fall in light level (overcast sky or at dusk), the micro-controller switched on the LEDs, which blinked to pre-programmed patterns (fig. 2).

Figure 2. *Twilight States and the Edges of Darkness*, cotton thread and micro-electronics embroidered on silk organza framed in bamboo embroidery hoops, installed view. Courtesy of the artists.

Within Bennett's vital materialist ontology, *Twilight States* was an assemblage of diverse materials that acted on each other, shifting and responding to changes in the local environment. Unlike exhibiting in gallery spaces (with controlled lighting, sounds, and air), outdoor installations must contend with the elements: weather, wind, smell, temperature, and light. In the light of day, *Twilight States* played to both the sense of touch and sight. Visitors reached out to feel the tactility of the hand embroidered images and the trees. The gentle breeze swayed the silk forms and compelled the picnickers to look up to make sense of the connections between the landscape and the ghostly orbs. Daylight provided a well-defined view of the installation where the viewers could touch and be touched in return. In this light, *Twilight States* offered the audience a zone for feeling their presentness in a place and the presence of nonhuman entities and forces inhabiting that place. Bennett refers to such sentient spaces as sites of enchantment where encounters of genuine wonder with the natural environment can motivate ethical ecological thinking.

At twilight – between sunset and dusk, a magical half-light glows. Andreas Huyssen notes, "Twilight is that moment of the day that foreshadows the night of forgetting, but that seems to slow time itself, an in-between state in which the last light of the day may still play out ultimate marvels. It is memory's privileged time." [5] In this temporal in-

betweenness of wonder, *Twilight States* shifted in hue and intensity of form. The work pushed and pulled between appearance and disappearance, the familiar and the uncanny, to enable a fleeting experience for recalling connections and feelings deeply rooted in time before they are forgotten.

As vision faded, the translucent circles of silk gave way to points of luminescence amongst the trees. After night fall, the frogs began to croak and their rhythmic chorus convinced some viewers that the artworks' pre-programmed light patterns were intentionally synchronized with the local amphibian symphony. Other viewers became sentient of non-human presences in the nocturnal landscape. For them, the pins of lights evoked animal eyes, stars, or bioluminescent insects. In "'Landscapism' at the *Speed of Light*: darkness and illumination in motion", Tim Edensor and Hayden Lorimer explore the embodied experience of darkness and illumination within landscapes in participatory performative events.[6] They explain that "levels of dark and light provoke affective and emotional responses, cajoling bodies into movement, activating passions, charging the imagination, instigating sensual pleasures and discomforts." [7] The darkness erases the spatial boundaries and allows somatic sensing to expand outwards. Senses, other than sight, respond to the nocturnal landscape that enveloped the body. The enchantment of the winking LEDs in the darkness of the night drew the visitors deep into the terrain to come into contact with non-human entities. Later, a storm ended the evening's events for the human participants but the assemblage continued. Wind and rain all entered into material interactions that produced *Twilight States*. This is an example of how an enchantment can be located when handmade textiles, electronics, natural forms, and forces are brought together as an art installation. For the human visitors, the encounter intimated the felt connections that speak to how they share a world with non-human entities.

Bennett's call for a "micromaterialism of sensibility" to be enacted through aesthetics echoes Edensor and Lorimer use of the term "landscapism" to describe "the *transporting* and *enchanting* affects that result from estranging the encounter with topography, terrain and atmosphere." [8] Art has the capacity to draw out the liveliness of things within spaces of enchantment imbued with the uncanny. *Twilight States* dramatized the site with artworks made from diverse materials that responded to environmental conditions, giving rise to the affective, emotional and multi-sensory dimensions of Bundanon homestead. Such experiences enable the human visitor to become a participant-observer – a sentient being – who simultaneously witnesses and feels, the interconnected entities that constitute place (fig 3).

How, then, does sentience help build an active environmental politics? In *Vibrant Matter*, Bennett proposes a materialist theory of democracy that de-anthropocentralizes Jacques Ranciere's political theory to include non-human agencies. Bennett speculates that by conceiving ourselves as a conglomerate of living and nonliving entities, the self-interest that guides our actions may become more encompassing. In her view, this re-framing allows for the "emergence of more ecological and more materially sustainable modes of production and consumption."[9] To imagine how this materialist ecology performs political work, it is useful to acknowledge that agency does not necessitate intentionality. Bennett writes of how Bruno Latour conceives of a materialist politics:

> Latour frames political action not as the enactment of choices, but as the call-and-response between "propositions." A proposition has no decisionistic power but is a lending of weight, an incentive toward, a pressure in the direction of one trajectory of action rather than another. Any given response to a problem is less the result of "deliberation" than of "fermentation" of the various propositions and energies of the affected bodies.[10]

Central to the making of *Twilight States* was this "call-and-response between 'propositions'" that responded to the theme "Ghosting", to the materials at hand, to the physical and invisible features of the site. Our account shows that the combination of materials, textiles, electronics, trees, animals, daylight, twilight and night fall, as well as natural forces such as wind and rain, did not so much intentionally create a sentient experience, as it lent weight to its emergence.

Figure 3. Visitors to *Siteworks 2016* encountering *Twilight States* at Bundanon homestead. Courtesy of the artists.

In recognizing capacity of affect in non-human and non-living bodies, Bennett's vital materialism exposes the inadequacies of the nature–culture binary. She argues that by transforming "the divide between speaking-subjects and mute objects into a set of differential tendencies and variable capacities" we can advance towards a more democratized way of thinking that is inclusive of ecologies of entities. [11] Manual Delanda's Deleuzian materialism also illustrates how this mode of thinking intervenes in how humans conceive of a material reality. [12] By replacing abstract generalities (such as the Environment) with assemblages of individuals, new materialisms offer alternative ways of

conceiving how human, non-human, non-living entities push and pull to coalesce into material existence. These conceptions, in turn, transform how we act, react, respond, and make in an ecosophic world.

For artists, the "call-and-response between propositions" provoked by the capacities and tendencies of materials, is the modus operandi. In *Twilight States*, the layered meanings and value of elements encountered in an outdoor setting together with textiles and electronics opened up an enchanted contact zone where the presentness of ghostings and the disappearing non-human bodies of endangered plant species can be felt. The experience invites humans, non-humans, and the non-living to enter into an active assemblage of environmental politics.

Spinning World

We extended the material explorations of *Twilight States* in our Visiting Research Fellowship at the Museum of Applied Arts & Sciences Australia. Our study aimed to connect the eco-politics of slow textiles methods with sustainable materials, processes and technologies to propose environmental responses via making. Specifically, the fellowship examined how traditional metallic thread embroidery techniques in the Museum's Asian textiles collection, may direct us to new ways of creating e-textiles. Broadly, this research explored how environmentally sustainable practices can influence what we make and how we make them.

We invited a materials scientist and a climate scientist to join our collaboration to further investigate how we can combine natural and smart materials to make artworks using ecologically sustainable processes with reduced environmental footprints. Together with the research gained from our fellowship, this art-science collaboration posited other "onto-stories" of our changing climate that can inspire meaningful environmental action. The projects gave rise to a mixed and multi-media installation entitled *Spinning World*, at Sydney's Powerhouse Museum, which received over 27,000 visitors.

Spinning World consisted of three e-textile works. A large hand-stenciled wall hanging (9.2m x 3.3m) depicted a fantastical scene filled with coral with hand-embroidered speakers that played an underwater sound recording of the Great Barrier Reef, made by XL Catlin Seaview Survey, when triggered by viewers' presence. [13] A second wall hanging (1.2m x 3m) featured a flock of fluttering white birds. It was a direct response to the late nineteenth century hand-sewn green silk kimono from the Museum's collection, which accompanied the exhibition (fig. 4). A third component presented two fabric lengths of touch-sensitive graphene screen-prints of enlarged microscope images of coral polyps. When visitors touched these images, LEDs lit up with patterns.

In studying the green silk kimono, we observed how the design depicted "a world within a world" that was energized by entities acting, reacting, and interacting. Reminiscent of Japanese anime characters, the birds embroidered in white silk swooped over a moss green seascape, embellished by gold thread. We adapted this idea of "a world within a world" to construct an animated sentient space that inspires wonder and appreciation towards non-human ecosystems.

Figure 4. Kimono, tomesode style, silk / lamé, made in Japan, [late 19th century, held at the Museum of Applied Arts and Sciences, Australia.

To tell this onto-story, a fabric length hand-stenciled with shades of bright green colour was animated with a flock of fluttering birds, made out of white rice paper, and hand-fashioned electromagnets made with copper wire and neodymium magnets (fig. 5). In relation to enchantment materialism, Bennett writes that "animation can disturb as well as delight [as] dead things [come] alive, or objects [reveal] a secret capacity for self-propulsion." [14] By setting the flock of birds in motion, the e-textile work enlivened and invoked the spirits of non-human entities latent within the cultural and material stories of a museum object.

Figure 5. (Right) *After Japanese Kimono in green silk figured, gold embroidery, small birds in silver coloured silk*, 2018, ink, silver wire, copper wire, paper, magnets, and microcontrollers on cotton canvas. Installed view. Courtesy of the artists.

The large-scale wall hanging depicting a panoramic coral scene positioned on the central gallery wall beckoned viewers into the space. It was the paleoclimatologist's research of deriving long-range climate datasets from studying coral substrates that catalyzed the concept for this work. That is: corals as bio-archivists. The kimono's "world within a world" provided the basis for the artwork to draw attention to the significant role corals and their communities play in providing climate data beyond human records. These bio-archivists systematically collect and record the variations of

ocean temperatures in their calcium carbonate bones up to four hundred years.

A depiction of a fantastical world in which colonies of coral polyps thrive responded to Bennett's call for aesthetic experience to engender an attentiveness towards the ecologies of human, non-human, and non-living things. Multisensory elements such as, scale, colour, sound, ecologically sustainable materials, and making processes were brought together to set the scene for this onto-story of the interrelationship between humans and coral communities. The green hues of the wall hanging invoked the vitality of environmental politics. The main protagonist – a coral – was reimagined as a gigantic entity occupying a seascape in this story. The entire scene was created by hand-printing with manually-cut stencils and inks onto recycled cotton canvas (fig. 6). This slow making method enacted an ecocentric approach that invokes a sense of care and attentiveness that tends to these creatures and their communities.

Figure 6. *Spinning World*, 2018, ink, silver wire, magnets, proximity sensor, and microcontrollers on cotton canvas. Installed view. Courtesy of the artists.

Spinning World activated a sentient space for the viewers occurred through the auditory and tactile senses in addition to sight. As visitors entered the space, their presence triggered a proximity sensor, which signalled to the circuit to play an underwater sound recording of the Great Barrier Reef though eighteen hand-made speakers. These devices were made by couching silver wire coil (and neodymium magnets) onto fabric then sewn onto the wall-hanging (fig. 7). The soundscape emerged quietly from the textiles, enlivening the museum space, calling for the visitor's attention. The noise, reminiscent of a sizzling frying pan, moved the audience closer to the artwork, lending an ear to the conversations and voices of the aquatic communities living in a healthy coral reef.

The third component of *Spinning World* consisted of two e-textile lengths with graphene screen-prints depicting enlarged microscopic images of coral polyps (*Porites spp*) and capacitive touch circuits stitched onto the fabric. When the prints were touched, electric currents flowed from the soft-circuit into the human body, depleting the electric charge stored in the graphene, and triggered animated light patterns of bioluminescent plankton (fig. 8).

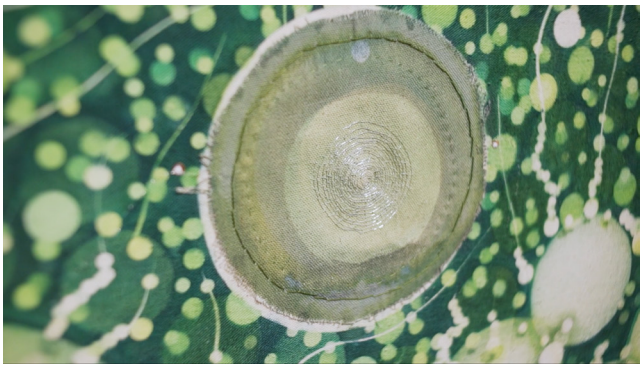

Figure 7. Speakers made with silver wire and neodymium magnets hand-stitched onto cotton canvas. Courtesy of artists.

Importantly, an eco-friendly formula for conductive graphene ink was developed for this project. The cycle of trials involved in synthesizing this material was guided by the "call-and-response between propositions" that must negotiate between the use of environmentally sustainable solvents and optimization of the material's conductive properties. The application of this ecologically sustainable material in the artwork gave rise to an enchanting experience that mediated connections between human and nonhuman bodies. *Spinning World* materialized rather than visualized climate science research into onto-stories by offering a space for experiencing material reality differently.

Figure 8. Visitor's hand activating capacitive touch circuit by touching the graphene screen-print. This change in electrical charge triggered LED light patterns. Courtesy of artists.

Conclusion

So, how can sentience participate in an environmental politics to activate an ecosophic world? Both *Twilight States* and *Spinning World* took on the form of sentient installations – emergent spaces that are "aware". On one level this awareness is programmable: proximity sensors registered human and non-human presence, capacitive sensing acknowledged touch, and light sensors measured the varying levels of natural light. This sensing responded to these forces with light patterns and sounds.

On another level, in the unfolding of onto-stories of sentient coral polyps (collectors of information), and plant species (entities under threat) through these responses generated a space and time to become aware.

Artworks as assemblages intensify human awareness of materials' vital "propositions." Telling of onto-stories draw the audience into a material constellation with other non-human and non-living bodies, suspending the habitual anthropocentric thinking. The experience opens up a sentient dimension that is beyond the nature-culture divide.

Onto-story-telling here is an aesthetic intervention that moves the body to listen, to touch, to feel, to pay attention, and to take notice. In so doing, the body is moved physically, emotionally and psychically. The telling of onto-stories in *Twilight States* and *Spinning World,* responded to the call of actants by transforming eco-sustainable materials into spaces and experiences. The alternative ecologically sustainable processes in graphene synthesis, the response to recycled cotton, silk organza, silver wire, and electronics, the adoption of slow textile making methods, and openness to other non-human beings like the frogs-choir by the dam to join in, give rise ecological thinking and making. By opening up to the sentience of matter, artists witness and participate in the emergence of sentience spaces.

Bennett describes the "desire to make it possible to discern a kind of life irreducible to the activities of humans or Gods" as a "material vitality [that] is me, it predates me, it exceeds me, it postdates me." [15] *Twilight States* and *Spinning World* reimagined enchanted worlds that are us, but they also exceed us, predate us, and postdate our material existence. This form of sentience questions human sovereignty over non-human and non-living bodies.

Artworks have the capacity to enable encounters that unleash the "more-than-human natural force that draws bodies together" – a force that is capable of compelling a movement from ethical code into ethical action. [16] To conclude, we borrow Bennett's statement on Walter Whitman's *sympathy* to claim that: art, too, can "help us discern more actively this tendency towards tending, and to articulate a trans-individual model of receptivity, affectivity, and sociality." [17] By appealing to sentience, we aim to activate a deep hope through art that can compel meaningful actions in sympathy with all bodies in an ecosophic world.

Acknowledgements

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Sensory and Spatial Koans

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Abstract

Taking as a departure point Lygia Clark's koan-like use of paradox and material juxtaposition this paper asks how her methods might be deployed in the context of contemporary technologies, like embedded electronics and algorithms, and what we might make if we take the spatial or sensory koan as a strategy when building with these materials. It will introduce the spatial koan as a lens through which to view Clark's work, discuss her use of sensory juxtaposition in the object based therapeutic treatment she devised called Structuring the Self, and introduce *The Relational Objects Project,* currently in production, as an example of how this framework might be applied in the context of contemporary materials. This work developed through research in Clark's archives and conversation with Lula Wanderley and Gina Ferreira, two psychotherapists trained by Clark in her Structuring the Self practice.

Keywords

Sensory Engagement, Gestural Interaction, Physical Computing, Lygia Clark, Spatial Koans, Embedded Electronics, Contemporary Sculpture

Introduction

koan (n.) a paradoxical anecdote or a riddle that has no solution; used in Zen Buddhism to show the inadequacy of logical reasoning. [1]

The Koan is a provocative form to consider when working digitally. We often use binary and electromagnetic materials to make a task easier, faster, or more profitable. In these cases the framework of optimization guides design and the binary nature of these materials complements the logic of their formation and use. What might we find by juxtaposing binary materials with methods that ask us to look beyond logic? Might we achieve radically different outcomes by using logical materials in ways that 'show the inadequacy of logical reasoning'? The koan, with its use of juxtaposition and paradox, offers an alternative design methodology. One that is promising for discovering new ways in which digital and electromagnetic materials can affect sentience, possibly even leading to new types of sensations. Lygia Clark was an artist whose objects used koan like juxtapositions to create experiences of overwhelming sensation. Her works suggest that the koan framework is a rich strategy for designing objects that prompt transformative experiences between people.

In the late 1970's Brazilian artist Lygia Clark developed a therapeutic object based practice called *Structuring the Self.* This practice relied on her *Relational Objects* and the types of interactions they enabled her to develop with clients. These objects stimulated sensory engagement and employed a koan-like use of paradox and material juxtaposition. This paper provides an overview of Clark's *Relational Objects* and *Structuring the Self* practice. It describes her methodology in making these objects as sensory and spatial koans and it speculates on how this idea might be useful in framing a sensory focused object making practice in conjunction with contemporary materials, like embedded electronics and physical computing. It discusses *The Relational Objects Project,* a set of interactive sculptures focused on the qualia of gestural interaction, as an example of how materials operating on the electromagnetic spectrum can be used to create focused sensory experiences that explore the framework of the sensory koan.

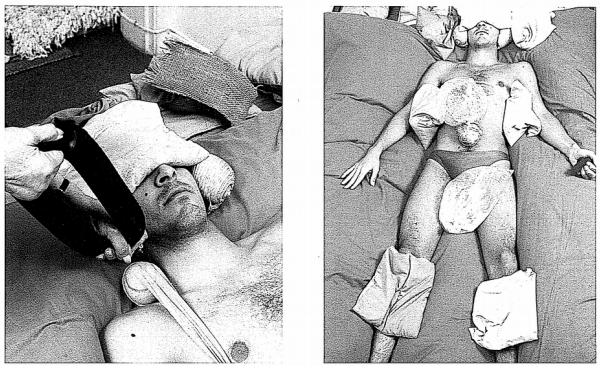

Figure 1. A client with *Relational Objects* during a *Structuring the Self* session.

Lygia Clark's *Relational Objects* and *Structuring the Self*

Clark was a Brazilian artist who developed an object based practice centered on sensory engagement. She created interactive objects that re-framed familiar experiences and the mindset with which audiences approach those experiences. From the late 1960's through the 1970's she made works focused on interactions that redirected the viewer's attention to sensorial experience. These objects privileged senses like smell and touch and hinged on the active participation of the viewer. Through their forms, they created uncomfortable, transgressive, explorative arrangements of bodies. What grew from this was a series of works, made from 1976 to 1988, that turned away from the

form of the object to the gestures of the participants. These artworks involved objects that acted as focal points around which ritualized gestural performances were enacted. They specifically required gestures to animate them. These works transcended the object and centered on the active participation of the viewer. She called these sculptures *Relational Objects.*

With the *Relational Objects*, Clark became focused on one-on-one experiences that centered on touch. These sculpture were made from mundane materials- a shoe, a mattress, a piece of cloth- that Clark used in gestural and sensorial ways. In this period Clark begins to achieve a minimalism of the object that focuses on the possibility of the object as relational device. She built these sculptures with materials that highlighted themes of passage, exchange, and relationality. With these objects, Clark developed a therapeutic process she called *Structuring the Self.* Clients visited the artist for one-on-one sessions conducted in her home, where she applied the *Relational Objects* to herself and the client's body. Many of her earlier works were re-purposed in service of these therapeutic engagements.

Figure 2. The *Relational Object, Respira Comigo* in use.

The film, *Memória do Corpo*, depicts the *Structuring the Self* process. [2] In the film, Lygia Clark gets down on her knees next to Paulo Sergio Duarte. He lies prone, on a bed, and she takes her *Relational Object*, *Respira Comigo,* and puts it to his ear. The object is a small length of industrial rubber tube with tapered ends for making fitted connections. She puts one end of the tube to her mouth and the other to Duarte's ear and begins to suck, cluck, and whistle. She makes more clucking noises followed by small hums. She ends with a few clucks and takes the *Relational Object* away from his ear. Duarte was undergoing a *Structuring the Self* session. As part of the process Clark had already stroked his face like a person pets a cat, played with his hair, and put plastic bags filled with water and air over his crotch and rolled them across his torso, arms, and between his legs. Suely Rolnik further describes the process in her 2007 article, *The Body's Contagious Memory*:

> The artist received each person individually for one-hour sessions, one to three times a week, over a period of months, and, in certain cases, for more than one year. Her relationship with the receiver, mediated by the objects, had become indispensable for the realization of the artwork: it was on the basis of her sensations of the living presence of the other in her own "resonant body," in the course of each session, that the artist progressively defined the singular use of the Relational Objects. This very quality of opening to the other is what she was able to provoke in those who participated in her work. [3]

As Rolnik characterizes it, the *Relational Objects* focus attention on the sensory and through this attention open a disruptive and ultimately transformative space for the client, one where they could conceive of new possibilities in how they relate to the world. Her practice was never fully accepted by either the art world or the medical community. Rolnik characterizes it as transcending both. Certainly, clients of Clark's felt transformed by their participation in this process. However, when asked to talk about outcomes few could articulate what exactly happened or the mechanism by which it worked. Most talked, as Lygia wrote, about an opening to the possible. [4]

The Spatial and Sensory Koan Framework

I present here the koan as lens through which one can understand both the effect and mechanics of Clark's work. Much like a koan, Clark provided experiences of such overwhelming sensory engagement that there was no one logical or linguistic pathway to arrive at understanding. Clark's material choices also created koan like juxtapositions. She used materials, like burlap sacks and transparent bags, in ways that highlighted the paradoxical qualities of the skin as a relational zone. She juxtaposed sensations like the taste of honey and the warmth of a lamp or the lightness of air and the heaviness of stone. In her article, *The Spheres of Insurrection: Suggestions for Combating the Pimping of Life,* Suely Rolnik analyzes the tension created by paradox in the political sphere. [5] She speaks of the disruptive strength in paradoxical recombination, and this analysis describes how a process like Clark's, that relied on material and sensorial paradoxes, might evoke the transformative opening to the possible that Clark and her clients so often describe.

Figure 3. *Pedra e Ar*, a *Relational Object* that the client creates by filling the plastic bag with their breath

Lygia Clark's koan-like use of paradox and material juxtaposition was a crucial element of how her *Relational Objects* worked. In these objects, made from deceptively

quotidian components, she paired materials that evoked inverse sensations like heavy and light, or malleable and rigid. In *Pedra e Ar*, Clark used a plastic bag filled with air juxtaposed with a small stone. In this object inert material mimics the epiphenomena of life. Clients would blow up the bag with their own breath and use the air filled bag to move the stone in a way that evoked respiration. The light material moves the heavy object and the heavy inert stone, often a metaphor for a death like state, is the thing that, through its movement, mimics life. In regards to juxtaposition Clark said, 'I felt that life is always existent because of the polarities that give mutual value to one another.'[6] Like koans Clark's object paired contrasting and paradoxical sensations. These spatial and sensory koans animated her *Relational Objects* and gave rise to tensions that spurred her clients self described transformative experiences.

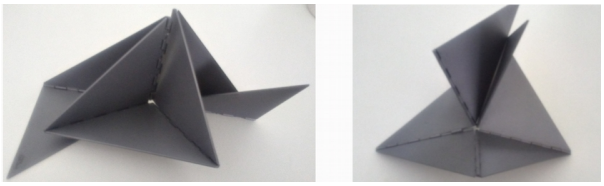

Figure 4. A replica of a *Bicho* in two positions

Lygia Clark coined several phrases that capture the way her objects sensorialized paradoxical concepts. One phrase in particular, the empty/full, embodies a koan-like relationship to space. She often referenced this concept but the *Bichos* are the first of her objects that embody it. When one plays with the *Bichos*, geometric sculptures made participatory and kinetic through hinge connections, the object's planes are both inside and outside while its forms create containers that are simultaneously cavities. As Lula Wanderley says of them, one must make oneself complicit with the object while also dealing with its autonomy because the hinges both invite movement and impede it. [7]

Joan Sutherland's description of how koans work also describes Clark's use of *Relational Objects* in *Structuring the Self*. She say, **"...**the koan is a way of getting us out of our constricted sense of self, not by denying or cutting off that self but by expanding it so infinitely that it ceases to have the limited meaning it once had."[8] Clark spatialized this idea of the koan. Her objects used juxtaposed sensations, like stretching and compression, to expand the self beyond prior conceptions.

Structuring the Self used juxtaposed sensations to make explicit the koan like role of the skin as both a border, that defines inside from outside, and a site of exchange, where the inside interacts with and takes in the outside. Her therapy involved touching the client's body with her hands and the *Relational Objects* creating an awareness of the skin as relational zone. Her objects, through their material qualities like transparency and holiness, referenced the permeable barrier- a surface where the inside might encounter the outside. The application of Clark's *Relational Objects* to the body made the in-flux, porous nature of this relational zone explicit. Her process was a demonstration of the skin as site of exchange, even though we often conceptualize it as boundary that contours definitions of the self. By contrasting these simultaneous functions *Structuring the Self* suggested that one's conception of experiences was relational, rather than a definition by which one was bounded,. By making explicit the ways in which the skin functions as a relational zone she was able to foreground the possibility inherent to exchange.

This koan like making explicit of skin as porous barrier and relational definition was an outcome of a particular facet of Clark's work, namely the way her objects activated a reflexive sort of sensory engagement to access narrative consciousness. *Structuring the Self*'s overwhelming sensations drew attention to the process of creating conceptions of self in relation to the world. By intensifying the experience of receiving sensorial inputs she was able magnify the mechanics of how sensory experiences structure understanding. Her process gave her clients an analyzable experience of how the body's sensations trigger memories that become the ground on which we build a conceptual model of our environment. Inherent to this process is the idea that restructuring our interpretation of sensations demonstrates the possibility of restructuring our understanding of complex narrative concepts. Clark called the process *Structuring the Self* because it opened one to the infinite possibilities of reinterpreting one's conceptions of the world.

The *Relational Objects* and the gestures they elicited mimicked the patterns and rhythms of the natural world. For example, Clark amplified the rhythms of breathing with objects like *Respira Comigo* and *Pedra e Ar.* She evoked those rhythms with sound by placing conch shells on her clients ears during sessions. Clark used these intensification to create an awareness of the qualia of living in ones body. As she put it in the film *O Mundo de Lygia Clark*, "You take things with your body, which you do not remember with your head – you can not remember because you have no memory at the time, but you record these things in your body. You record when you sway, when you fall sharply, when you are hungry, when you are wet, when you are dry – in short, the body registers everything and is going to structure itself with it." [9] By presenting the ways that qualia undergirds our experience she implicitly reveals the possibility of taking an active role in applying qualia to building a narrative understanding of ourselves in relation to the world. Hubert Godard says of Clark's work:

> ....she actually made two types of perceptual revolutions. The first is at the level of how it works within each feeling: taking the eye as an example, the question here is how it goes from an "objective" gaze to a "subjective" gaze. It is not new to say so, but today there is a lot of research in neurophysiology that

> supports her ideas and explains well these two ways of looking, since there are two analyzers in the brain. We could qualify the first gaze as subcortical. It is a gaze through which the person merges into the context, there is no longer a subject and an object, but a participation in the general context. So this look is not interpreted, it is not loaded with meaning. If a fly comes in the corner of my eye, my eye blinks and closes, before I realize the fly is coming. Therefore, there is sensoriality that circulates without being necessarily conscious and interpreted. This is possible because there is actually a gaze that is beyond the objective gaze. A geographical or spatial gaze. A gaze that is not linked to time or, in any case, that is not linked to a memory, which is not linked to a return to the subject's history. And then, if we go to the other sense of the gaze, it would be the objective, cortical, associative look, the objective gaze, which is associated with language, etc. So it's really crazy, because it's not about Lygia Clark being content with that gaze. Lygia actually makes a revolution in the sense that she works on what might be called a subjective gaze. [10]

Clark's process used a koan like application of sensory experience to access the space in which qualia shades subject-hood. Her objects used an intensified sensory engagement to make strange familiar sensory experiences. This tension, grounded in embodied consciousness, lead to an awareness of the ways in which qualia moves from providing feedback to structuring our interpretation of the world. Her *Relational Objects* suggest that sensation is a way to modify the armature of narrative consciousness and thus to access the always present possibility of 'structuring the self'.

Suely Rolnik provides a further assessment of how Clark's objects open the user to a transformative position. She analyzes the way in which paradox creates productive tension that moves one to act. Combined with Clark's focus on sensation as armature of consciousness her use of juxtaposition and paradox allowed the client a new openness to desire, to the position of the subject, and the subject's ability to act. Rolnik, in analyzing the discordant pressures of contemporary political life, explains how paradox might give rise to these positions:

> Destabilized by the paradoxical experience of strange-familiar, subjectivity experiences a tension between two movements. On the one hand, the movement that presses it toward the conservation of life in its essence as the power for germination, in order to be embodied in new modes of existence. On the other, the movement that presses it toward the conservation of existing modes in which life is temporarily embodied and subjectivity can recognize itself in its experience as a subject.
>
> The malaise caused by the tension between the strange and the familiar, as well as between the two movements triggered by this paradoxical experience, functions as an alarm that summons desire to take action in order to recover a vital, emotional, and existential balance, a balance shaken by the emergence of a new world and the dissolution of the existing worlds. [11]

As she puts it the tension of the paradox calls on us to recognize desire and act on our recognition in order to feel vital.

It is in this same spirit of opening to the possibility of the vital that I look to Clark's work for strategies of making with algorithms and electronics. Much like Clark stands in implicit if not explicit counter to socio-cultural strictures and hierarchies this work also seeks to open a space where it is possible to re-imagine oneself in a new relationship to these entities. Considering her works as spatial and sensory koans provides a point of departure for thinking about how we might use her strategies when building with contemporary materials.

The *Relational Objects Project*

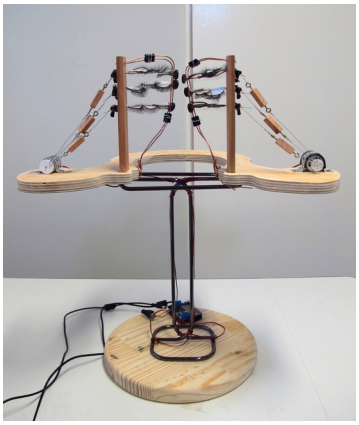

Figure 5. *Beijos de Borboleta (Butterfly Kisses)*, from the *Relational Object Project*

. In the *Relational Object Project* I appropriate Clark's strategies of gestural engagement and juxtaposition in conjunction with physical computing. I use embedded electronics and algorithms as materials in relational sculptures that explore 'techno-qualia,' a new repertoire of senses created by our experiences with technologies that let us dwell in the material world while simultaneously experiencing a more abstract conceptual space. [12] By focusing and intensifying embodied sensations I suggest new relational encounters and create new sensations. These strategies,

tools, and materials produced focused sensory experiences that trigger cross-scale interactions between rhythmic, haptic, and reflexive ways of knowing.

The sculptures in the *Relational Object Project* engage the qualia of gestural interaction. They appropriate and reinvest Clark's strategy of material and sensory juxtaposition. They begin with quotidian sensations, like the feeling of eyelashes brushing one's skin, but use embedded electronics to create sensory juxtapositions. These objects amplify the paradoxical nature of gestural communication and simultaneously focus attention on the embodied aspects of its interactions.

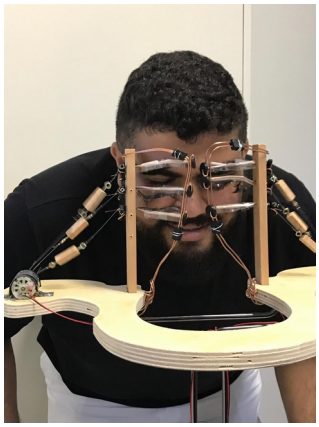

Figure 6. *Beijos de Borboleta (Butterfly Kisses)* in use.

Beijos de Borboleta, the first sculpture in the series, is a machine that can kiss. Reimaging the intimacy of the butterfly kiss as a technological encounter, it amplifies and intensifies the intimate gesture of brushing one's eyelashes against anther's skin. It is a 22 inch high sculpture whose scale references table top vanity mirrors. It has a fitted wooden base and chromed, decorative, metal stand. The stand supports a wooden platform, the design of which references the shape of eyelash curler handles. This platform supports two motors and the mechanics that move three tiers of false, extra-long, carnival eyelashes. The viewer is invited to put their face up to the flitting eyelashes to receive the sensation of several butterfly kisses at once. The frequency of the motors and the sound of the mechanics mimic the sound of medical devices. For many people, its sound evokes a heart rate monitoring machine. This juxtaposition, of medical support sound with intimate sensation, is one of the sensory koans that animate this object. The paradoxical qualities of the butterfly kiss as intimate and localized gesture given with high frequency and over the whole face creates overwhelming sensations that call on the viewers embodied memories. When people use this machine, these sensations remind them of their past experiences involving similar intimate gestures. Their narrative consciousness is called forth through the qualia of the sensory experience.

Figure 7. *Respiração (Breath)* a Relational Object for two or more people.

The second sculpture in the series, *Respiração,* translates the rhythm and force of one's breath into haptic experiences that others can feel on their skin. It is a five foot tall structure with a blue hexagonal base. Three bars extend from the base. One supports a small and sensitive microphone, the other two support open hexagonal structures whose insides are ringed with orange, five inch long cilias. One person breathes in front of the microphone and the orange cilias vibrate mimicking the force and rhythm of that person's breath. Others are invited to interact with the hexagonal transducing forms as they choose. All the hinges on the structure are adjustable, allowing people to move the object to suit their stance. Users can arrange the microphone and the transducing cilia so that they can lay down, or have one hexagonal cilia form ringing their leg and another their head. The machine creates a unique experience that focuses attention on the awareness of another's breathing patterns. It re-frames what is often an intimate gesture of attention between two people as a site for engagement and reflection. It evokes the juxtaposition of intimacy and distance and it allows for the receiving users to develop new forms of engagement with what is usually a passive experience of attention and perception.

Figure 8. *Respiração (Breath) in use.*

Both of these sculptures reflect my engagement with Clark's strategies of sensory engagement as amplified by electromagnetic materials. The viewer's participation is actively invoked by sensory attunement and the attendant association of personal embodied memory. By provoking new associations, the sculptures arouse the possible mutability of the viewers narrative consciousness. My work, however, diverges here from the influence of Clark. The sculptures that comprise the *Relational Objects Project* amplify epiphenomena of the viewers' body in a different way. Sensors and those algorithms which interpret their data allow for a sustained immersion in the embodied experience of intimate communication. The viewer's engagement is more autonomic, they need not maintain conscious or directed focus on the sensory. Instead, they are able to remain immersed in sensation, cycling through embodied engagements, visceral interactions, and memories of intimate encounters.

The use of computing as material then attempts to open the viewer to novel variations in sensory language, prompting them to devise new engagements with its syntax. Embedded electronics and algorithms then enable dynamic interactions with viewers. A critical aspect of this work is the possibility of expediting an embodied response to stimuli that is usually passively processed. Through amplification and sustained interaction these sculptures experiment with a collaborative process of play and exploration which facilitates ways of knowing that are beyond logic. They call on our embodied knowledge and temporal sensibilities in a new process which builds on the suggestion in Clark's work that relational objects can be transformative and therapeutic. Like Clark's *Structuring the Self* process they activate sensory experience to loosen a productive potential, an opening of oneself into other possible worlds.

The innovative legacy of Lygia Clark's *Structuring the Self* practice offers fertile strategies to explore how embodied engagement may be able to restructure our narrative consciousness. From focused engagement with documentation of her work and process, I borrow and re-invent the following strategies as my own: 1) novel approaches to material and conceptual juxtaposition, 2) ways to access and explore relational border zones, and 3) intensified sensory engagement as a method to accessing a speculative narrative structure of the self in the world as it is given and as it may become possible.

The *Relational Objects Project* is, foremost, a body of sculptures to reimagine a breadth of possible worlds. These sculptures use technology and sensory engagement as their materials. This project lead to further questions: What worlds become possible if we take seriously these strategies of sensory engagement as guides when building with new technologies? What types of sensations might I and others discover, as sculptors, by thinking of algorithms and computational hardware as both material and relational? What possible worlds might we discover and proliferate if we invent new forms – new sensations to structure the self – that challenge the popular inevitability of techno-deterministic dystopia?

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Author Biography

Liz Lessner is a sculptor whose work combines traditional fabrication techniques and emerging technologies to create novel sensory experiences. These often interactive objects stage encounters that reframe common occurrences and routine happenings. She was a 2019 Fulbright Scholar affiliated with the University of Fortaleza in Ceará, Brazil. Lessner has had solo shows at Honfleur Gallery in Washington, D.C.; Big Orbit, a Center for Exploratory and Perceptual Arts Project Space in Buffalo, NY; and an upcoming show at VisArts in Rockville, MD. She has exhibited her work nationally and internationally including the Guapamacátaro Center for Art and Ecology in Michoacán, Mexico, A.I.R. gallery in Brooklyn, NY, and Everard Read's Circa Gallery in Cape Town, South Africa. Her research into embedded electronics' ability to create novel sensory experiences has been supported by grants like the Mark Diamond Research Fund, fellowships like the Eyeo Artists Fellowship, and awards like a Fulbright Research Award.

Taxonomy for the Contiguous Spectrum: Corporeal Computing Futures and the Performance of Signal Transmission

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Abstract

This paper evaluates the emergent networking paradigm of cognitive radio and its connection to Body Area Networks (BAN) through the lens of performance, in order to explore the potential of these assemblies for creative expression. Through a taxonomy of entangled signals, we hope to address the potential of emerging material futures and the algorithmic complexity of signal processing for creative practice. The transdisciplinary space of feminist science and technology studies, alternative computer networking culture and artistic research reveals nascent eccentricities in emergent technologies' relationship to somatic agency. As emergent technologies arise as key actors in our public sphere— especially through ubiquitous personal computing and mobile digital culture —we expand and speculate upon performance and its relationship to both computer culture and critical communication theory by presenting a new model for entangled, corporeal signals that can inform the design of networked experiences. Wireless networking is contemplated through a somatic framework, in order to consider how corporeal and computing signals are entwined; to assist us in developing enriching ways to act with emerging technologic entities and deploy performance research as a mode of inquiry into future scenarios of use.

Keywords

Internet folklore, Visceral Systems, Interiority, Embodied Cognition, Holistic Computing, Future Performance, Feminist Theory, Hybrid Materials, Body Area Networks, Extra-Terrestrial Radio.

Introduction

"...we blink on and off over infinite existences…the invisible breath of consciousness emanates from your now-point in both future and past...Intensities build just beneath the range of physical matter. They possess their own inclinations. They accumulate organise and grow. They appear in several places at once and without going through space…you are being farmed, back away, your work here is to make a song and dance about nothing, your nothing, your amounted nothing…They crack and widen for the streams to run them through. Streams of sentient thought forms pull and compel. You think the thoughts are yours. Ha ha, you are the infected carrier. Nothing more…"[1]

Welcoming the future of holistic computing requires us to embrace a burgeoning field of socio-cultural relations between materials, body and environment and therefore seeks a transdisciplinary analysis. This paper evaluates the emergent technology of cognitive radio in microscale devices through the lens of performance in order to contemplate the possibilities of designing for these networks across human and non-human agencies. The model outlined in the Taxonomy for Contiguous Spectrum (fig.1) seeks to present the artificially intelligent (AI) automated systems that direct signal transmission, as a new kind of species that exists alongside us, and within which we propose our corporeal signature entwines. This idea is developed within the context of Barad's (2007) agential realism; viewing "intra-action" as an embodied, performative process that produces the phenomenon of reality through the ongoing material exchange of human and non-human actors. We speculate what the implications of this material exchange could be in the face of ubiquitous signal transmission directed by machine learning and taking place within and through our corporeal human bodies.

The distinguishing character of both wireless networks and visceral systems lies in their interconnectivity, which we advocate is enabled by modes of enactment that initiate, participate and interact. Butler (2015) insists '[t]he politics of performativity is also a way of enunciating and enacting value in the midst of a biopolitical scheme that threatens… Bodies cannot be understood at all without the environments, the machines, and the social organization of interdependency upon which they rely, all of which form the conditions of their persistence and flourishing.'[2] For the user as consumer to critically engage with the networked assemblage, they must comprehend their own biopolitical performativity. This raises pertinent questions for the experiential relationship between actors that are human and nonhuman, especially in the context of a wireless world of internet things.[3]

Too often people assume they are separate, autonomous beings in singular command of thoughts, perceptions, intentions and action. The world acts on us as much as we do on it, especially in the age of The Internet of Things (IOT). Our embodied perception is tangible yet illusory, fluid yet fraught; in much the same way as a signal is

before it reaches its target. The signal is not a message per se; it could be seen as an embodied cognition between sender and receiver, always subject to interpretation and influence. And conversely, what of this invisible signal impact to our embodiment - this can hardly be a neutral implementation?

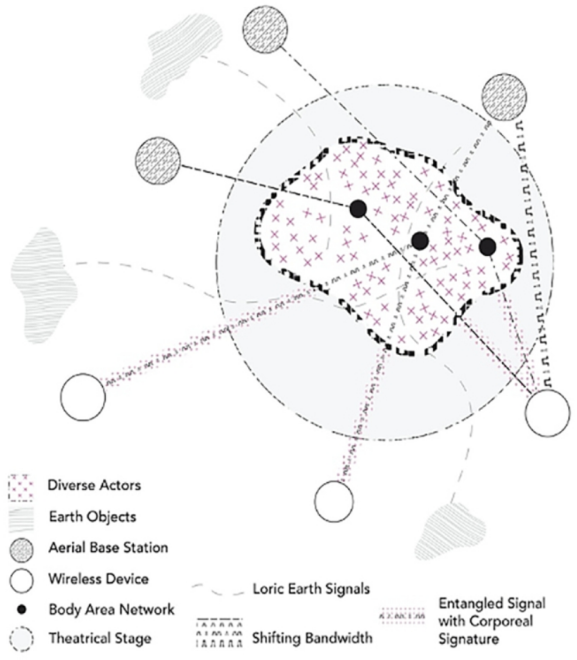

Figure 1. Taxonomy for Contiguous Spectrum. Agency of corporeal field is displaced by signal performance; performance of signal becomes entwined with corporeal signature. Image: Authors.

Entangled Techno-Cultures

The desire for accelerated bandwidth pushes through the tangle of always-on devices, which ravenously consume digital culture. Resultantly, our world is increasingly designed to support ubiquitous computing across a spectrum of digitally-augmented interactions in 'Smart Cities'. Cognitive radio and body area networks are proposed technologies that seek to better facilitate our expanding internet of things; key sites of autopoietic signal performance that are entangled in corporate, governmental and cultural politics for better or worse. The deep learning of these systems use algorithms trained 'from samples of transmitted and received signals...(and) it is possible to train a detector without any knowledge of the underlying system model.'[4] However, the cultural implications for our embodied world in relation to this remain largely unexamined.[5] This reveals an interesting opportunity to explore a new critical language to frame creative research into these networks; one that might explore the cultural performance of agency.[6]

Figure 1 proposes a model for conceptualising the entangled nature of the signals that emanate from humans and non-humans. It is intended for artists and designers as a conceptual underpinning as to how they might coexist with non-human actants. This radical subjectivity comprises multiple signals, voices, modes, and inflections; proposing that unstable and emergent identities could exist as embodied signals within an entangled human/non-human milieu. This nuanced lexicon could enable us to discuss the development of anticipated in-body applications that utilise our sensory motor system, fluids and organs as signal carriers. The model intends to offer creative practitioners a way to consider the performance of the cognitive networked signal within and through the body; and draws in part from Karen Barad's framework of posthumanist performativity.[7]

Barad enables us to examine machine learning actants as a new kind of species that exist within and around us. Her thinking allows us to consider the agency of non-humans by turning to the discursive and agential nature of matter itself, which can comprise bodies of stuff, elements of culture, snippets of code or sensations of affect. This enables an "intra-action" of machine, code, human and space where reality is produced through an ongoing entanglement. This has important implications for an algorithmic-material future, as autonomous decision making infrastructures sense patterns from our data and modulate or filter content accordingly. This makes space for the "algorithm" to be "agential"; able to cut reality at distinct moments allowing some productions to occur and others not.

Internet Folklore & the Small Cell Revolution

Far-reaching infrastructure is needed for the performative futures of the IOT. [8-15] In the search for Body Area Networks (fig.2) it is speculated our visceral fluids will be harvested for the small cell revolution, where signals will perform on and through us. Advances in energy-efficient infrastructure such as Body Area Networks allow wireless networks to be powered by small cell batteries that energy-harvest power and signal over-the-air via Aerial Base Stations.[8-15] Adjunct to this, new communication systems based on biology and chemistry work to encode bits through molecules, enabling signal transfer in a wide range of new micro and macroscale applications.[8-15] Nascent research into Body Area Networks looking at how soft materials can allow signal movement without external consumer electronics, fundamental shift the relationship between the body and wireless networks.[8-15] When integrated with cognitive radio through distributed antennas and self-healing mesh networks, the body becomes the site for wireless transceivers that intelligently adapt to the bandwidth needs

of both network and user.[8-15]] This also presents new problems to solve and implications to consider: in terms of infrastructure, critical theory and contemporary society, including Internet culture.

To envision the potential of the small cell revolution (fig.2) Farsad and Goldsmith have been testing sensor nodes that chemically send their measurements to each other or to other devices under/on the skin via the internet. [16] This occurs alongside current research into cognitive radio that aims to apply multi user detection techniques for autonomous real time signal control through the assembly of omnipresent Aerial Base Stations. This translates to hundreds of antennas on our horizons, otherwise known Massive MiMo (multiple-input multiple-output mmWave antennae) to enable electromagnetic harvesting of power and signal.

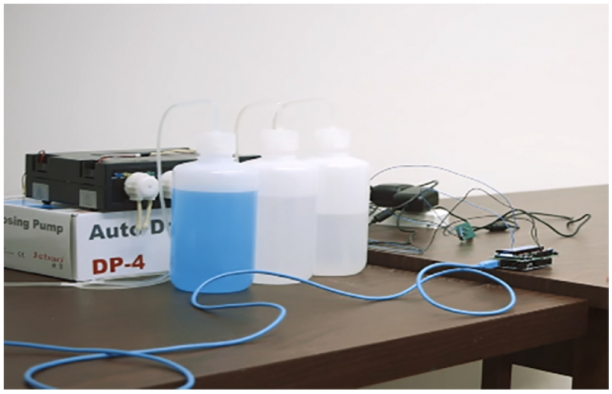

Figure 2. Stanford Wireless Lab conduct research on chemical and molecular signals for in-body communication. Image: Screengrab YouTube

Meanwhile, Internet culture is an ever-evolving conspiratorial seeding ground for networked lore. This 'digital folklore' is a complex phenomenon, existing at the crossroads of anthropology and folkloristics, media and cultural studies, aesthetics and design, art history and communication studies.[17] One can unequivocally acknowledge Internet life and lore to be speculative and mischievous, and embraced for its ephemeral nature. It lies in disrupting the instrumental relationship as an automatic circuit of abstracted interaction. It is not that internet folklore lacks cultural value; it is rather that its value is determined loric and contiguous as demonstrated in the diversity of agents included in the model Taxonomy for Contiguous Spectrum (fig.1.). Internet and digital folklore encompasses gifs, memes and contemporary home computing practices, described as 'online amateur culture, DIY electronics, dirtstyle, typo-nihilism, memes and chatbots.'[18] Discloses of fictitious sagas are visible for all to see but do not detract from their meaning and significance.

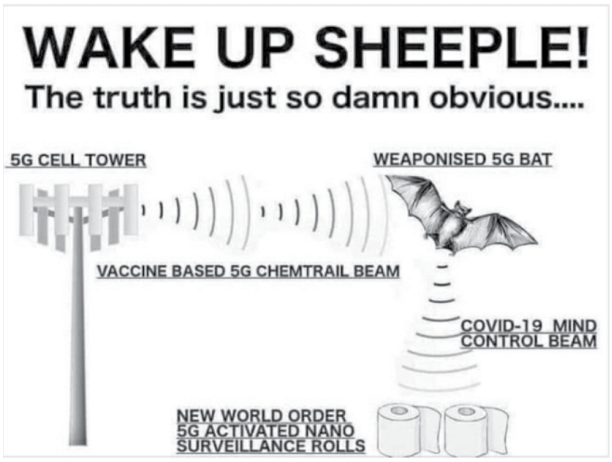

Figure 3. COVID-19 Inspired Internet Folklore Meme/Taxonomy. Image: Screengrab April 10 2020

At the onset of the COVID-19 pandemic conspiracy theories thrived through the networks, and in the street 5G towers were burnt, being blamed for the viral pandemic. On ever-encroaching fringes, human and non-human actants were seen as interrelated; part of the 'new world order' as humorously depicted in fig.3. Other memes speculated that the video conferencing Zoom malware was behind the pandemic; others that the electromagnetic waves emitted by the towers were causing the public to become more vulnerable to the virus. Loric signals were said to be the downright cause of transmission and that a Body Area Network would be implemented viscerally, as seen in fig. 4.

Figure 4. COVID-19 Inspired Internet Meme. Image: Screengrab April 10 2020

Such examples foreground conflicts around somatic literacy and in digital knowledge production (fig. 3 - 4) and

are pertinent examples of how social concerns manifest allegorically within the network itself. Through networked anxieties, emergent technologies already arise as key actors in our public sphere. With sophisticated graphics and open transmission, there is sometimes a fine line between conspiratorial opinion and official advice. In a post-truth world where the landscape of news has been subsumed into a flat and continuous plane of content 'bait', opinion is presented alongside fact. Like fairytales, the story is what travels between us, entangled at each telling with the memory of the teller. Gabriel de Seta (2019) suggests that as an analytical category, theorists should no longer use the word culture, but 'folklore'; as the ubiquity of networks and the cultural field is both literal and figurative.[17]

Internet folklore challenges official modes of knowledge production and dissemination. It can be irreverent, but also a conduit through which metaphor and allegory can be utilized to give agency to opinions that are not otherwise tolerated. Very often memes hold the capacity to engage those marginalised by current affairs in a light-hearted manner and therefore have become a channel to informally address and critique happenings in the political arena, which would not have been possible to write in a formal article or news post. Especially for regimes which are acquiescent to topdown prescriptive approaches.

In light of this, we offer our model (figure 1) to re-conceive the folklore of the signal. Perhaps we need to engage the performative, narrative nature of folklore to allow broad engagement with technological concepts. Our model intends for creative reasoning about the signal exchanges between humans and non-humans. It does not intend to sensationalise this signalling; to limit or catastrophise the agency of the signal. Instead it hopes to open neutral space to consider that one way humans and non humans entangle is through their signals; for better or worse depending on how they may be performatively staged.

The Performance of the Signal

In the context of Body Area Networks, we may see vast scale continuous monitoring through mobile, somatic networks. This suggests future performances of cognitive radio systems that allow for a small cellular networked dance of wireless signals. Disarticulating this from the potential significant health uses and issues (which are beyond the scope of this paper), our model enables us to wonder: how does signal creation and signal labour destabilise human agency in favour of technological agency? If information can be sent by molecules in the body, how might signal performance change the territories upon which and through which it acts? Will our embodied somatic schemata integrate with the signal, creating symbiotic loci of perception between the immaterial and material environments, network and human?

Outlining a typology of interfaces, Florian Cramer and Matthew Fuller discuss how computer user interfaces are often mistaken in software studies for "interface" as a whole. They point out that the term interface has been borrowed from chemistry, where it describes a surface forming a common boundary of bodies, spaces and phases. [19] With the advent of chemical signalling we have come full circle with 'molecular communication, which relies on chemical signals to interconnect tiny devices with sub-millimeter dimensions in environments such as inside the human body.'[4]

This necessitates a reconsideration of how we share, assess, and archive our phenomena. What methods and standards exist for such signal performativity; and for testing and critically assessing the potentialities of widespread, cognitive wireless enabled through in body applications? Confirming that there is a lot we do not know about how these nonhuman signals move through our bodies, the Stanford Wireless lab reveals 'our approach is different from prior works since we assume that the mathematical models for the communication channel are completely unknown'.[20] Tracing these technologies in full, beyond the laboratory and into the field where scientists cede access and control is not just an epistemically important task but also an ethical one. In order to gain agency over our (neo)materiality and suggest entangled purposes, perhaps we must move beyond deterministic design based on expedience. The practice of performing, communicating, reading, divining and healing with viscera, stones and minerals to channel particular modes of energy into our body has transpired for eons in many cultures, with cited physical and emotional healing effects.[21]

So what role will the signal play as these myths and practices are reworked and renegotiated? How will these assemblages, lores and the internet of things collaborate and perform together with body area networks, and will that experience be pleasurable, or will we feel we are in a predetermined yoke? Can we think '[b]eyond the mere design of interfaces' towards an 'imagination of future algorithm functionality' to 'reveal' a 'desiderata of systems outside the boundaries of existing systems'[22]. Culture, material and myth are idiosyncratically entangled. As such a signal can be read as easily or ambiguously as the lines on our hand; necessitating inquiry that demonstrates textured, situated, and grounded engagement. The next generation of networks will harness the ability to learn from interactions in the wild without knowing the dynamics of their environment or relying on previously collected data.

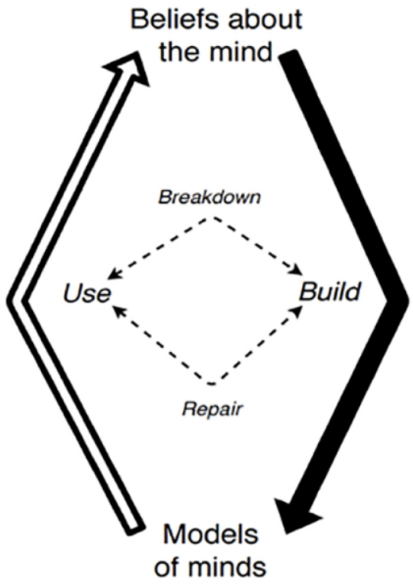

Figure 6. Diagram 'Models of Minds: Reading the Mind Beyond the Brain' Image: Merrill and Chuang.

Our ability to embody, receive and transmit signals as sentient humans is uneven and characterised by diversity. How then can machine learning compare or respond to the complexity of human cognition, if the way machines learn is completely unlike the way humans sensorially experience and thus develop their understanding of the world. Questions remain as to: how will the performance of signal in our current epoch of efficient transmission renegotiate somatic agency? As such, we may no longer just be senders and recipients of signal but carriers of signal - we embody the locus of transmission rather than direct it. We move from auteurs to agents. The signal becomes intrinsic to us, our bodies implicated in not only its reception, but in its transmission. If the input and output characteristics are unknown, what is the cumulative effect of signals performing on and transforming through us?

In their discussion Merrill and Chuang discuss 'Models of Minds' where machines learn and constitute understandings of our state of mind, and then respond to this interpretation.[23] The diagram 'Models of Minds: Reading the Mind Beyond the Brain' (fig. 6) describes how our behaviours inform machine learning which in turn responds to behaviours which then might reinforce them and shape the data we emit. It is not uncommon that we create parallels or perceive reflections of our imaginary, contained deterministic world by reifying the autonomous actions that feed signal functions, thus driving processes that demand to be brought into life. Depending on life's predilection, humans have the ability to empathise and extrapolate the inner realities of an external experience. If this is the nub - that machinic ubiquity contends to superficially mirror our experience in response to the traces of data we generate - how might our behaviours shift when reinforced or misconstrued by long term small cellular visceral sensing?

This entanglement of experience is based on the routing, tunnelling and reception of signals. How do these chemical and molecular signals from networking, microscale and nanoscale in-body communication devices affect our cell fluid movement? Can they slow down our nervous system's ability to provoke or control the release of hormones or diminish nerve impulses? Simondon notes "[t]his process of psychic individuation is only truly accomplished to the extent that it is inscribed in a process of collective or social individuation."[24] This notion can be extended to a signal that adjusts as it probes, detects and enacts in its environment towards various states of perturbation. Critical theoretical reflection requires engaging, and even building, epistemological references and frames for understanding human and non-human performance of the signal.

In the wake of the Shannon Limit

A well-known model of communication developed in 1948 by mathematicians and information technologists Claude Shannon and Warren Weaver was concerned with the transmission of information. In this schema (fig.7) information is a physical concept, an expression of ordering that emerges from thermodynamics. Shannon, a key figure in the invention of digital computation, verified how an immaterial system of Boolean algebra can be represented in the material communication of binary transistors. Breaking the process of interaction up into discrete aspects, in directional streams, he theorised that the dynamic systemic relations between noise and signal is an abstraction of humanity's ability to both send, receive and relay messages to negotiate meaning. The capacity and coverage of terrestrial cellular systems is bound to the concept of bandwidth, which gives us some measure of how much information can be transmitted over a channel. Goldsmith discusses how cognitive radio brings in its wake the 'Shannon Limit' suggesting communication inquiry can contribute to theorizing this space of mutual constitution. [20]

Computing elements coaxed from the earth and embedded in the corporeal are richly entangled with telluric currents which could reveal possibilities for emergent technologies that further the resilience and flourishing of our species. If one views communication as an open system, embodied perception could be identified as a leading part of that system. In this way, the model (fig.1) developed in this present study is designed in a functional and a symbolic manner; it has both descriptive abilities and predictive components. Put forth as a profoundly nascent way of discerning the contiguous levels of perceived and conceived corporeal signatures, relays and non-human signal processes are represented as

building upon the deeper implications of the Shannon model (fig. 7). The challenging textures o signal semiotics in fig.1 acknowledges the gamut o signals that transmit and operate within a human/non-human milieu. Functional, as it attempts to identify the direction, volatility and relationships of the energetic forces involved in embodied cognitive process and signal transmission while attempting to represent the situated forces of the living world.

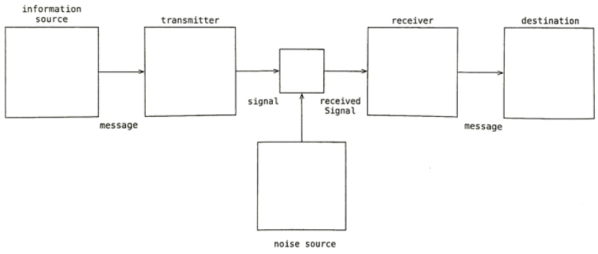

Figure 7. Claude Shannon's schematic diagram of a general communications system (1948) Image: Bell Labs.

The ability to consider our dependency upon our habitat as an ecology is essential in the process of embodied cognition and an experiential being-in-the world through valuing somatic and cultural literacy as state-of-the-art methods to formulate future wireless networks. As a schematic representation of what occurs within a living individual, the model outlined Taxonomy for Contiguous Spectrum (fig.1) can be said to possess both morphostatic (signal) and morphogenetic (visceral) qualities of the corporeal signature. The model (fig.1) depicts inputs as being obtained from emergence in the environment; media ecology actants of which a person may or may not be aware. It posits embodied cognition and its relationship to sensory perception as an element of great significance. The phenomenology of sublime signals through our senses displaces the everyday. Working in a complementary fashion, our various visceral systems utilise embodied sensory motor perception to extract and process the environmental elements required for our continuation. This is an open system media ecological model of embodied communication that is maintained by a continuous exchange and flow of component materials (fig.1). The important concept is the interrelationship and the recognition that alteration to one part of the system affects other parts of the system. Holistic computing could also be understood as interconnected, tensegrity in design - both as principle and metaphor – and is put forth to illustrate the interconnectivity of the subject-object relation, contrary to the prevalent treatment of machines as instrumental inert matter and external objects to satisfy human needs.

The implications of the conceptual model we propose (fig.1) rests in its testability, and as such it is a methodological recommendation open for refinements and speculation by other authors and ourselves in practice. What kind of displacement occurs when signals perform through us? How does this affect our nervous system, our thinking? Does it provide a framework within which the conceptualisation of an embodied cognitive signal process can be located? Can it stand up as a guide for ethical creative art and design? Further research through creative practice into his aspect of verification is intended.

Conclusion

To begin developing and evaluating ubiquitous wireless computational applications, it seems fundamental to discuss and produce performance experiences with critical epistemological lenses. The emphasis in the Taxonomy for Contiguous Spectrum (fig.1) is upon the interrelationship of signal – it is always performing through its entanglement with bodies, technologies and systems.

There is a narrative logic to the entwined signals of loric elements across multiple ecologies. Fiction and folklore is therefore a potent component to the interpretation of communication that could also seed the ground for a holistic approach to planetary computing and the future performances that lay ahead.

In a world where there is no regard for circadian rhythms, the nervous system is always on standby, stimulated, foregrounded; it is proposed that we tune into a contested and unsettled base of knowledge. One that is productive in grappling with theories of embodiment and creative practice, to continually draw attention to the automated apparatus. If users, audiences and citizens are enabled to behold and perceive network systems as constructing and enacting signal performance – then an encompassing awareness of the form, context and content of the embodied signal transmission has providence.

There is no doubt that signal has become a performative vehicle in regard to both material and immaterial processes. The difficulty of grappling with the intention of the performance of the signal lies in the individual differences within the system of the sender and intended receiver, and the narratable modulation of experiential knowing through which transmission takes place. Places of cultural knowledge production are often ambiguous, black box smoky corridors of unknowing, never quite here nor there at the point where meaning is concrete and tangible. By exploring the potential to influence our future infrastructures in a performative manner, we can reinterpret and bind these marvels and conundrums that dare us to solve them.

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Translating disciplinary practices for *trans-sentient* collaboration

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Abstract- Summary

This paper is an inquiry about how the field of translation studies and translation-related issues could provide good practices for enabling successful transdisciplinary collaborations. The focus is on transdisciplinary practice and research, which bridge experts in very different disciplines that do not share success criteria, exact methodologies or dissemination methods. We argue that either disciplinary translators or collaborators with disciplinary translation skills will support better transdisciplinary outcomes. After reviewing literature and reflecting on diverse translation concepts and experiences, we developed 10 preliminary heuristics that collaborators from art and sciences can use to improve teamwork with transdisciplinary-outcome goals. This paper is also an experiment in language and transdisciplinary translation and collaboration. The background of the authors includes design, astrophysics, education, and art.

Keywords

Transdisciplinary collaboration, translation studies, knowledge translation, disciplinary translation, heuristics, art-science.

Introduction

The word 'universe' has the same root as the word 'university' in the western world, which is derived from Latin. Even though university discipline branches are apparently independent, they are connected by the same *roots* - assist humans to manage knowledge for perceiving themselves and the environment, as well as for exploring the validity of concepts about the world. Disciplines have their own methods, terminology, thought patterns and academic cultures. When practitioners from different disciplines collaborate, they realize the need to communicate and agree on the methods, terminology, concepts, processes, and practices. Multiform collaboration among disciplines such as cross-, multi-, inter-, and transdisciplinary collaboration are increasingly playing decisive roles in the process of both knowledge production and problems solution. Strengthen the connection, interaction, and sentient communication are prerequisites for transdisciplinary collaboration. The aim of this paper is to identify what we can learn from fields of translation to improve the power of perception of others' work and suggest heuristics as good practices for transdisciplinary collaboration. We address the concept of translation broadly and include cultural, cognitive, technological, and emotional issues of language and literary translation, knowledge translation, transmodal translation (or translation through sentience), and disciplines of disciplinary translation.

Nowadays, higher education is having more cooperation among disciplines, and disciplinary boundaries are getting more blurred (O'Reilly, 2004, p. 724). This phenomenon is mainly triggered by increasingly complex and inter-related problems in the real world. Those complex problems cannot be solved by any one discipline alone and require multiple disciplines with a shared theoretical understanding and an agreed interpretation of knowledge (Gibbons, 1994, p. 28). Therefore, more communication, interaction, and collaboration across borders of disciplines are needed. It is a trend that disciplinary boundaries are positioned in an iterative process, and are broken then restructured. Breaking down silo mentality among disciplines should be a key - sometimes even the first- step for transdisciplinary collaboration, which requires collaborators to be equipped with a un-disciplinary mindset. The different thought patterns and cognition are influenced by multiple factors, while language is a significant element. What often happens is that they take place simultaneously and build upon each other. Collaborators in practice or research should be encouraged to move beyond the comfort zone, which could help to reveal more subtle internal relations between facts. We argue that the more languages and 'disciplines' we speak, use or translate, the more we are able to work with others and address broader challenges of society.

A translation operation is not just about translating words or sentences but translating meaning, acknowledging intent, and recognizing contexts. Within the translation professions this is often thought of as interpretation rather than translation, which has been a debate in the translation studies tradition for centuries, from Schleiermacher in the Romantic period (Venuti, p. 103-104), to Walter Benjamin (1927) at the start of the 20th century, to Bachmann-Medick's (2013) idea of a "translational turn", just to name a few. In fact, as Bachmann-Medick (2013) explains, *translation* beyond the context of literature shouldn't be "diluted into mere metaphor" but rather considered as "an analytical category with a new emphasis on the often challenging shifts between different (cultural) levels and contexts, whether in intercultural transfers or in interdisciplinary activities" (pp. 188-187).

The same framework applies when translating among disciplines, particularly when false cognates are used. Language translation practices require specific skills that go

beyond basic knowledge of grammar and vocabulary. Translators need to have a deep understanding of conceptual frames, cultural differences to translate meanings rather than words for making communications possible and effective. When collaborating, communication between people from different disciplines or backgrounds also requires continuous translation of meanings. It is insufficient to share only terminology or methods. Therefore, is there a need for disciplinary translators? What is the nature of disciplinary translation? Should collaborators develop translation skills? Where and how can such training be acquired? In the following sections, we will discuss concepts of translation studies and experiences of language translation. Then, we suggest potential heuristics that can be used to enhance transdisciplinary collaboration.

Translation and culture

The practice of translation depends on a deep understanding of the cultures of the source and/or receiving contexts. For example, if a literary work of an English writer is translated into Chinese, the source context may be the United States and the receiving context may be China. Bassnett (2007) explained that, in the last two decades of the twentieth century, translation studies shifted from drawing on literary and linguistic approaches to using the tools of cultural studies (pp. 13-14). She presented some implications of this cultural turn and some of them can be transferred to heuristics that support transdisciplinary collaboration. These selected implications include power relations, the historical situation, and text grids, which are discussed below.

First, power relations are implicit when there is an exchange between two cultures. The cultural turn in translation has unveiled the relevance of equity issues such as gender and racial hybridization (Bassnett, 2007, p. 15). Further, some may see literary translation as an aggressive act of colonization (p. 20). Disciplinary interactions also involve differential power relationships, which implies that disciplinary translators or collaborators with translation skills are more equipped to deal with dominance and equity issues of teamwork. In other words, disciplines that may be considered weaker or developing, or disciplines that have gendered associations could be empowered by translation skills to have a fair voice in collaboration. Ideally, the translated text (or transdisciplinary outcome) can also be seen as a third relational entity different from the source and receiving cultures (Simon, 2011).

In terms of the historical situation, Bassnett (2007) argued that a translated work might or might not influence the receiving context depending on the position of the context (p. 17). For example, China has had a recent boom of works translated from English as part of its modernization process, which was different in the past because China was not as open to exchanges. For transdisciplinary collaboration, this issue could be interpreted as the preparation that some collaborators may need to receive, use, or embed insights from other disciplines. A collaborator should be situated in a position, where there is more likely to be permeated by other collaborators. In some cases, collaborators from a particular discipline and particular approaches to the discipline might need preparation activities to get ready for disciplinary exchanges. For example, design professionals that have a traditional form, expression, and craft-oriented practice may be resistant to collaborate with business professionals that are more interested in the profitability of design. Although business professionals have become interested in the concept of design thinking, not all designers are aligned with the meaning of this concept in business and not all business professionals are familiar with the concept of design thinking in its detailed and various methodologies.

The last relevant implication is text grids. Bassnett (2007) explained that text grids are "patterns of expectations that have been interiorized by members of a given culture" (p. 19). Some cultures share more grids (e.g. Spanish and French) than others (e.g. English and Chinese). These grids have methodological and political implications for translation practices. Similarly, some disciplines share some concepts, methods, and philosophies (e.g. sculpture and dance - dance is seen as a flowing sculpture, and sculpture is seen as a solid dance) more than others (music and chemistry). Therefore, particular transdisciplinary collaborations will require different methods, sensible precautions, or *cultural exposure*. For example, marketing professionals could be asked to sketch and visualize concepts or campaigns before they work with graphic designers in creating visual merchandising strategies. Likewise, graphic designers could be asked to work at a point of sales before they collaborate with marketing professionals. These activities of cultural exposure could help foreign collaborators.

An exemplar of this approach is the research of Tina Qin, an IT professional at a major banking institution. She is also a Ph.D. candidate at the University of Texas at Dallas. The focus of her thesis is the application of metaphor theory to data visualization. As articulated above simple devices like 'grids' or 'tree structures' are 'patterns of expectations' and implicit biases which often take the forms of 'metaphors"; e.g. the branches of a tree do not reconnect, but the roots do. Modeling using grids can be a way of imposing power relations. Simple examples include tree of knowledge versus a network of knowledge metaphors. Conceptual Metaphor Theory (CMT) provides a broad foundation for structuring visual communication. Research has been done such as image-schemas, frames, prototypes, conceptual metaphors and metonymies to mental spaces. Conceptual Blending Theory (BT) elaborates on the integration of the elements to form complex ideas. The metaphoric mappings and connections revealed by these theories provide an integration of network structure for visual technology. Big Data visualizations that use a variety of framing conceptual metaphors could provide new approaches. Every visualization integrates implicit biases that are often difficult to make explicit,

Based on this category of translation and culture, we developed the following preliminary heuristics for transdisciplinary collaboration:

- [Power relations] *Reduce power dominance between disciplines by equipping collaborators with translation skills and tools.* Specifically, collaborators with less "disciplinary power" need abilities to translate their disciplinary languages to make their discourses accessible to others.

- [Historical situation] *Prepare collaborators to receive insights from other languages and determine the potential disciplinary state or maturity of participants to source or receive discourses*. For example, collaborators can negotiate the goals of the transdisciplinary work and realize the approach needed. Then, everyone is a position of interest for translating disciplinary discourses.
- [Text grids] *Understand the approaches, methods and political implications of every discipline to identify similarities and distinctions in cultures of work*. The awareness of similarities/distinctions in the way every collaborator works will help to understand each other.

Language and cognition

Echoing Wittgenstein's dictum that "the limits of my language mean the limits of my world"(Wittgenstein, 2014, sec. 5.6), the study of language has historically explored how language influences worldviews, particularly in terms of the Sapir-Whorf hypothesis that has been a contentious topic among linguists and cognitive scientists for decades (Krippendorff, 2006, pp. 63-64). Translation, however, tends to challenge any notion of "universal language" when revealing the subtle cognitive influences/biases inherent to languages and the cultures they inhabit; for example, the Eskimo have a plethora of names for the color white (Ortega y Gasset, 2012), the Hopi structure grammar devoid of time/tense, or Spanish build direction and gender into its syntax and grammar. Likewise, disciplinary worldviews, which include the technical languages of the respective domains (as Ortega y Gasset also pointed out in the 1930s), develop biases and blind-spots too about reality that need to be understood and translated when sharing knowledge (Risku, 2013).

Bilingualism has proven to have cognitive effects that benefit such speakers, ranging from enhanced executive control (Bialystok, 2011), improved creative processes (Hommel et al., 2011), better memory, and delayed neuronal aging (Bak et al., 2014). The benefits, in theory, would also positively affect transdisciplinary capabilities and inclinations, which could explain why most transdisciplinary practitioners belong to hybrid communities (Simon, 2011, p. 51). For example, we notice that Leonardo journal authors are often bilingual or polyglots, similarly to how artistic avocations influence scientific discovery and polymathy (Root-Bernstein et al., 2008).

In more anecdotal instances, we reflected on our own cultural experiences with language and the cognitive features of language and translation. We are four co-authors that speak four languages total: English (all), Spanish (Mejía and García Topete), French (Malina), and Chinese (Xie). First, bilingual individuals with life experiences in two contexts are often weak formal translators; however, the acculturation process of their past experiences positions them to understand complex meanings in two languages. Therefore, successful transdisciplinary collaborations may require the participants to be willing to undergo 'disciplinary acculturation,' which often takes time for a process of adaptation. One of the authors is bilingual French/English (Malina): he was born in France, he acquired English at home from his parents but French at school and playing on the street with childhood friends; as a result, he easily articulates certain concepts in French, but not as well in English; and vice versa. Yet, he can serve as a mediator to enhance communication and collaboration between collaborators that speak English and French.

Based on this category of *language and cognition*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Bilingual cognition] *Increase language skills of other disciplines in the collaborators to allow them to produce hybrid outcomes*. As individuals become bilingual in the language of two disciplines they are better prepared to understand meaning differences, bridge connections, and facilitate work with larger teams.

Translation and technology

The study of language and translation itself has been a transdisciplinary endeavor for decades, involving linguistics, anthropology, cognitive science, sociology, forensics, and classical humanities (Palmer and Neumann, 2002; Porter, 2009). More recently, the use of technology in translation has developed, which has active participation from the general public. For instance, tracking and documenting slang usually requires crowdsourcing to get the meanings and uses "right" (or as close to real-world uses as possible), which is done thanks to thousands of active amateurs, Internet databases, and tech-savvy scholars in what amounts to a combination of "citizen science" and digital humanities (Davidson and Goldenberg, 2004). More recently Cris Kubli at the University of Texas at Dallas has been developing methods to make AI software 'culturally sensitive' which brings 'AI beings' into translation studies.

The surge of digital humanities provides some of the best examples of how technology can influence and has influenced the task of translation in recent years. First, the Internet with its social media platforms and interlinked databases, along with millions of digitized archival documents from hundreds of languages, have provided the richest and broadest data-set ever for the study of language and translation, spanning not only across dozens of countries but through centuries of cultural artifacts (Bowker and Star, 2000, pp. 292-306; Bowker, 2002; Dash, 2005). Digital humanities scholars are still figuring out how best to explore and extract knowledge from such vast sources, having first to develop the computing power and tools to handle the amount of data alone.

Second, artificial intelligence and machine learning (AIML) have become the de-facto tools to process big data sets, and the translation is not different in that regard (Quah 2006). Tech giants such as Google and Microsoft, and education companies such as Rosetta Stone, Pearson, Duolingo, Babbel, have all been developing AIML-enabled translation engines and similar tools for at least the past decade, with the goal of reaching 'automatic instant translation' as a sort of "holy grail" and utopian ideal not only for real-world tourism and commerce but also for universal, open science for which language is no longer a

barrier. However, there's much debate about the pros and cons of offloading to machines the cognitive skills of language and translation, particularly between those who favor automatic instant translation and those who still favor language learning and all the benefits it brings.

Technology and AIML have also caused advances and controversy in other areas related to language lately. For instance, emojis are hotly contested in the legal world right now as a formal part of speech to be assessed in court (Goldman 2018) – does a winky face emoji constitute sexual harassment in workplace communication or is it just a friendly demeanor? Case law is yet to be settled. Likewise, AIML-enabled facial recognition has facilitated image search analysis for surveillance, cybersecurity, and art-history purposes alike, while proving to have racial biases encoded in the processes and technology, whether by routinely misidentifying black subjects in matters of surveillance, or simply being unable to handle non-white users to the point of locking them out of their own devices because of their skin color (Yapo and Weiss 2018; Introna 2005). Such issues with AIML-enabled facial recognition have prompted researcher Cris Kubli at the University of Texas at Dallas to develop the Emblem project as a complementary feature when AIML translates and interprets speech and movements. This will allow AI facial recognition software to also recognize hand gestures. Hand gestures, widely used to accompany human speech, are notorious "false cognates" because the same body or hand gesture in one culture may have a very different (and potentially offensive) translation in another.

Similarly to written and oral languages, technology has the potential of facilitating translation of disciplinary languages. However, there is no technology for disciplinary language translation. Based on this situation of *translation and technology*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Technologies for translation] Use tech*nology carefully to avoid augmenting misunderstanding caused by systems and algorithms*. Technology can support many areas of collaborative work such as asynchronous communication or documentation; however, there is no technology available that can reliably translate disciplinary languages.

Translation and discomfort

When people experience a context with a different language or discipline, the discomfort becomes a common state. Lukes (2019) argued that our intent to understand a foreign language causes frustration in some situations; however, embracing this emotion can help individuals to make sense and find meanings (pp. 3-4). She uses the metaphor of art interpretation where spectators may be frustrated, but their discomfort helps them make sense of artworks. This also implies they could gain more empathy after embracing discomfort. And empathy is a significant element for collaboration. In transdisciplinary collaboration, individuals can be primed or trained to embrace discomfort to find new meanings and catalyze creativity.

Usually, artists are reluctant to use scientists' methods, engineers rarely aware of creative thinking or methods of designers, biologists could hardly use the tools of marketing. This silo-oriented thinking could be explained by barriers of knowledge translation between disciplines. If they use methods of foreign disciplines or collaborate with others embracing diverse methods new meanings and greater outcomes could be achieved. For example, when business professionals in collaborations are asked to sketch ideas they are afraid and claim that they are not good at drawing. However, if they are persuaded to embrace the discomfort, and realize that the goal is not to produce a beautiful drawing but to express the ideas, their contributions can enhance transdisciplinary outcomes.

Based on this category of *translation and discomfort*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Discomfort] *Persuade collaborators to embrace discomfort and be willing to use methods and tools of other disciplines*. This exchange will enhance transdisciplinary outcomes and creativity.

Knowledge translation

Nowadays, *knowledge translation (KT)* has become one of the most popular concepts in the health field (Davison, 2009, p.77); for example, it is used for diabetes research and treatment (World Health Organization, 2006). KT originated from the linguistic and communication field based on the process of recomposing source material to be intelligible for target audiences (Davison, 2009, p.76). Translation has been conceptualized as an art of bridging the gap between research knowledge and its application in professional practice (World Health Organization, 2006). KT differs from the normal understanding of language translation, which often includes monodirectional processes. Davison (2009) explained that the logic model of KT is a circular or an iterative loop with a multidirectional process among various knowledge translation practitioners (knowledge producers/sources and users/receivers). KT can take place at multiple stages along with translation activities in the knowledge cycle (p.82). Davison also stated that successful knowledge translation depends on the two principles: the level of engagement and interaction of target audiences/stakeholders, and the employment of knowledge to inform decisions that have a positive influence on outcomes. For transdisciplinary collaboration, this indicates collaborators should actively engage and interact more with others in an iterative process and environment, which ultimately helps to generate positive collaboration outcomes.

Further, Liyanage and colleagues (2009) specifically discussed mechanisms of *knowledge transfer* using theories of translation and communication within the general area of *knowledge management*. They explained that the nature of knowledge could be understood mostly in two ways - "tacit and explicit". Polanyi stated tacit knowledge was intuitive and indescribable knowledge (1962). On the other side, explicit knowledge can be present in formal language and transfer within individuals (Koulopoulos and Frappaolo, 1999). And the inseparable connection between tacit and explicit knowledge implicates that only individuals with a requisite level of both - shared knowledge - can truly

exchange knowledge (Liyanage et al, 2009, p.120). In another way, according to Alavi and Leidner (2001), knowledge can be understood from a point of view such as "a state of mind, an object, a process, a condition of having access to information, or a capability". Thus, knowledge management is the ability to manipulate knowledge stored in the brain of individuals to use it, create new knowledge, and help with decision-making in the organizations.

According to Alavi and Leidner (2001), different perspectives of knowledge can lead to different approaches and views of knowledge management. So it is not practical for collaborators to find common grounds for knowledge transferring without figuring out their mutual knowledge perspectives. Further, there is no primary theory of knowledge management. It is hard to have a golden standard for knowledge management because people often understand knowledge in their own way based on their individual experience and background. Good collaboration needs knowledge exchange so it could not happen without connection or understanding of the thoughts, information, goals and process among collaborators. As a general principle there are no 'best' methods but many good ones. Therefore, *connection before and during collaboration* is significant for collaborators.

Liyanage and colleagues (2009) understood knowledge transfer in several ways. First, it is an act of communication, which explains the behavioral side of knowledge transfer, i.e. the activity of collaboration between the source and the receiver (p.125). Second, like Davison (2009) stated, knowledge transfer also could be considered as an act of translation, which enlightened how to effectively transform knowledge into a practicable mode. Liyanage and colleagues emphasized that senders of knowledge (source) should transfer knowledge with contextualizing thinking for receivers (users/ stakeholders) (p.124). They considered successful knowledge transfer implies that transfer leads to the target audience to accumulate or absorb new knowledge (p.122). However, they did not discuss what are the factors of successful knowledge transfer. Chauvel and colleagues (2003) suggested that transparency and openness to communicate knowledge and the readiness to learn and absorb it are the main two strategies for organizational knowledge transfer (p.99).

Based on this category of *knowledge translation*, we developed the following preliminary heuristics for transdisciplinary collaboration:

- [Knowledge management] *Engage iteratively in knowledge sharing to use it, create new knowledge, and make decisions.* Collaborators share knowledge continuously during teamwork.
- [Knowledge transfer] *Be transparent to communicate knowledge and be ready to absorb new knowledge.* As transdisciplinarity is expected to produce new outcomes via integrating (not to simply collect) practices, knowledge management should focus on transparency and learning ability to empower teams in creating innovative results.

Transmodal translation and interpretation

An emerging area of translation is between 'modes' of human communication such as elaborated by Rainer Schulte and Frank Dufour. They argue in their article "Translation in the Digital Age" (2013) that "We can create objects that contain verbal, visual, musical and sound components that will allow a person to approach the object from various perspectives to create multiple sensory experiences;" for instance the Team Lab speaks of "Within the digital domain, art is able to transcend physical and conceptual boundaries. Digital technology allows art to break free from the frame and go beyond the boundaries that separate one work from another (https://www.teamlab.art/). This can be analogized as 'translation through sentience." Thus, digital technology allows us to create a more complex understanding of work and, at the same time, a possibility to establish a continuous interaction with the work". A specific example of this is translating data into sound rather than into visualization alone.

Artists and designers take advantage of synesthesia to combine sensory information and create potent aesthetic experiences. Some concepts can be more easily understood through sound rather than text or images. And cognitive processing of sound occurs on different time scales than sight, and with different pattern recognition methods. By analogy, this can be compared to the way translation studies differentiates between translation, which focuses on converting written texts between languages or disciplines, and interpretation which focuses on live conversation of spoken word, including aspects such as tone of voice and rhythm of speech.

Finally, as a provocation we raise the issue of trans-species translation. How could one develop methods for translating concepts (emotions, knowledge) between different animal species, or even vegetation, as forms of trans-sentience? This is sometimes referred to as "trans-species psychology" (G.A. Bradshaw, Animal and Society Institute). This would naturally draw on knowledge systems of many indigenous cultures.

Further, this category can be compared to other theories in other fields such as to the 'six thinking hats' approach developed by Edward de Bono (2008) or the theory of multiple intelligences of Howard Gardner (2011). Modes of sensing, knowing, learning could include diverse ideas from art, such as spoken word poetry, to academic text, to video abstracts, or even computer code or algorithms. It is asserted that some ideas can be more easily expressed in some modes rather than others.

Based on this category of *transmodal translation and interpretation*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Alternative Modes]. *Explore transmodal ways of communication to facilitate understanding and exchange among collaborators*. One way of unpacking some complexities of transdisciplinary work is to utilize a variety of modes of expression.

Disciplines of disciplinary translation

As discussed before, translators exist to transfer meanings between source and receiving audiences. While there is a

need for disciplinary translators to translate and transfer knowledge or methods among disciplines, there could be disciplines of disciplinary translation such as design, education, entrepreneurship, or social work. These disciplines usually have a less stable subject matter of study or their methods could be applied to diverse situations. For instance, in the design field, there has been a discussion about whether design is a category of art or science. Traditional design education originated in art schools. Some independent schools (e.g. Ulm) originated with opposing views and towards more scientific methods of designing, which resulted in valuable outcomes but insufficient for the breadth and nature of design problems. In recent decades, designers have realized that solving wicked problems requires transcending disciplinary boundaries. They have learned to 'speak' both the languages of art and science (Mejía et al., 2018, p. 70). Further, Cross (2006) argued that design is a third way of knowing, different from art/humanities and sciences. Nowadays, design often plays the role of a translator to translate theories/knowledge from other disciplines such as psychology, economy and to integrate those theories –knowledge– into the design process. For example, Mejía (forthcoming) stated that behavioral theory could be utilized as a good source for ideation activity in the design process.

Under the circumstance that design is becoming a discipline aimed to develop products, spaces, objects to a discipline able to understand and solve wicked problems in the real-world with interacting and collaborating with others (disciplines, communities, governments, stakeholders, etc.) (Moreno & Villalba, 2018, p. 48). So, designers are then positioned to be translators when artists and scientists collaborate. Furthermore, designers usually design for non-designers, designers could be seen as 'translators' between designed products and users to transfer not only aesthetic & functionality but also perceptions & mindset. Gorgoglione (2003) stated two crucial cognitive processes for knowledge transfer: "upstream - *codification* (express knowledge through language, models and images) and the downstream - *interpretation* (understanding the codified knowledge)," which is influenced by the cognitive characteristics of individuals. It challenges translators to choose valid code, encourage people to share knowledge, make knowledge accessible, and translate the coded information accurately (Cranefield & Yoong, 2007). Faced with those challenges, designers as translators should be opened to embrace any possibilities to reinforce their translation capacities. More disciplines of disciplinary translation like design are needed in the future, as well as more disciplinary translators.

Based on this category of *disciplines of disciplinary translation*, we developed the following preliminary heuristic for transdisciplinary collaboration:

- [Translating disciplines] *Bring to the collaboration practitioners from disciplines that can bridge other disciplines*. Disciplines such as design or education theory are used to combine artistic and scientific knowledge. Collaborators from these disciplines can help collaborators deal with the ever uncertain process of transdisciplinary work.

Conclusion

In this paper, we explored the field of translation studies and related areas such as knowledge translation and transmodal sentience. Based on this, we proposed 10 heuristics that can guide transdisciplinary collaboration. Below is the heuristic list for the reference of the reader:

1. [Power relations] *Reduce power dominance between disciplines by equipping collaborators with translation skills and tools*.
2. [Historical situation] *Prepare collaborators to receive insights from other languages and determine the potential disciplinary state or maturity of participants to source or receive discourses*.
3. [Text grids] *Understand the approaches, methods and political implications of every discipline to identify similarities and distinctions in cultures of work.*
4. [Bilingual cognition] *Increase language skills of other disciplines in the collaborators to allow them to produce hybrid outcomes*.
5. [Technologies for translation] *Use technology carefully to avoid augmenting misunderstanding caused by systems and algorithms*.
6. [Discomfort] *Persuade collaborators to embrace discomfort and be willing to use methods and tools of other disciplines*.
7. [Knowledge management] *Engage iteratively in knowledge sharing to use it, create new knowledge, and make decisions.*
8. *[Knowledge transfer] Be transparent to communicate knowledge and be ready to absorb new knowledge.*
9. [Alternative Modes]. *Explore transmodal ways of communication to facilitate understanding and exchange among collaborators*.
10. [Translating disciplines] *Bring to the collaboration practitioners from disciplines that can bridge other disciplines*.

Most of the heuristics show that collaborators should be willing to commit time and effort to develop their skills. However, at least awareness of the needed skills will likely improve transdisciplinary work. Transdisciplinary collaboration is not about addressing the work right away; a good collaboration requires extra work to negotiate and bring rich awareness of every participant. Most of the heuristics presented above are more about preparing the collaborators than recipes for working with others. Success might depend more on how leaders promote an inclusive collaboration than in the sum of expertise of the individual collaborators.

In this paper, we did not develop a final area that merits thought: how to translate results from transdisciplinary collaborations into applications in society. In medicine, the field of translational medicine seeks to do this. Most

academics have little or no political training which is required for the social use of new results; methods of design such as co-design and participatory design are the beginning.

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Aesthetic Qualities of Thermal and Vibrotactile Materials for Somatic Contemplation

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Abstract

Wearable technologies for self-knowledge and self-improvement are predominantly data-driven, whereas tools for somatic self-reflection based in sensory stimuli are less explored. Our research investigates the question of how do we facilitate access to aesthetic experiences for bodily awareness using heat and vibration as art and design materials? This paper presents a user study on the use of wearable props transmitting heat and vibration, integrated into the somatic technique *Focusing*. From our analysis, we discovered a series of aesthetic qualities categorized as heat as an embodied relation, and vibration as an immersed extension. These aesthetic qualities were reformulated as considerations to guide the design of wearable technology for self-awareness using heat and vibration as sensory focus on the body, facilitating the emergence of personal meaning-making in the process of inner discovery.

Keywords

Aesthetics; Bodily awareness; Haptics; HCI; Heat; Focusing; Somatics; Self-reflection

Introduction

As the body is the interface through which the world is perceived, the field of wearable technology is in a privileged position to explore how the use of direct sensory stimuli could influence the affective dimension of experience, and therefore the embodied process of meaning-making. By articulating the widely known example of the man with the cane, Merleau-Ponty [31] illustrated how perception is shaped by our interaction with instruments, which also mediate the way we understand the world surrounding us. Although the principle of artefacts as sensory extensions has been extensively discussed in human-computer interaction (HCI) and in the field of philosophy of technology [4,11,22,49,52], current wearable devices still opt for transparency and interpretation of numeric bio-data, for instance through quantifying self-performance [52]. Under the premise that more open-ended and expressive ways to access tacit self-knowledge are needed, this paper offers some design considerations to facilitate embodied awareness emerging from direct interaction with digitally generated sensory stimuli, particularly heat and vibration applied as materials for inward focus.

Previous research projects have investigated the use of bodily stimuli (e.g., heat and vibration) as information [43], therapy [7,17,51], or to deliberately enhance emotion for entertainment purposes [28]. In light of the literature, the use of thermal and vibratory stimuli has proven useful to influence emotions and behaviour. Similar approaches that use sensory props on the body have been used to generate design methods for prototyping, such as the Soma Kit [51], which use heat, vibration and texture. Yet, our research explorations are more focused on acknowledging how these stimuli have an essential role in shaping the *generation of meaning*, a process that is influenced by bodily experience [26]. This meaning-making aspect becomes particularly relevant in the context of somatic practices, which focus on the development of subjective knowledge and understanding of the world through awareness of bodily experience [18].

This paper describes our study on how the practice of the *Focusing* technique in conjunction with gentle heat and vibration on the body, can shape the way personal stories are interpreted, in some cases leading to experiential self-discoveries. The objective of our study is to elucidate which aesthetic qualities would emerge from the interaction with our prototypes, to be later translated into design considerations to inspire technology for bodily awareness. By answering this question, *we aim to facilitate the access to aesthetic experiences for somatic awareness using heat and vibration as design materials*. As a way to access bodily awareness, we deliver *Focusing* sessions performed with wearable props. Focusing is a somatic technique created by Eugene Gendlin that uses body scanning and inner dialogue, aiming to access experiential discoveries and deep meaning by filtering out ideas through the body [15].

In this paper, we start by reviewing different approaches that use thermal and vibratory stimulus on the body, both from the perspective of information and felt-experience. From this review, we identify a gap concerning the design of technologies to facilitate somatic practices of bodily self-awareness. Next, we describe our study, where we tested the use of thermal and vibrotactile props in integration with the somatic technique of *Focusing*, which promotes inner bodily focus. The method and results of our user studies are described with emphasis on the aesthetic qualities emerging from the use of heat and vibrotactile stimuli. In conclusion, we discuss some considerations for the design of technology

for self-awareness, particularly by using heat and vibration as sensory focus on the body, facilitating the emergence of personal meaning-making in the process of inner discovery.

Direct information versus felt experience

Some voices are emerging from our field, noting the lack of attention to the lived body in HCI research and design practice [19]. The body is generally viewed with distrust, disregarding its fundamental role in the formation of our affective memories [2]. Technology for embodied awareness is usually associated with self-tracking devices, which are designed to be small to carry, wear and even to be inserted in the body [29]. In general terms, the body is not to be disturbed with perceptible input that could breakdown its performance, although devices promoting direct awareness of the body can be essential tools for creative engagement and self-learning [34]. When heat or vibration are used, these are mostly associated with notification or information tools. For instance, vibration is widely used to capture our attention via smartphone notifications [24], transmitting, for example, a sense of urgency [43]. Used as everyday information, these vibratory notifications are not meant to convey complex messages [5]. Yet, some researchers have used vibration as a communicative means for people with reduced visual capabilities by translating Braille into haptic patterns [33,37,41]. Although less explored than vibratory stimuli, heat has also been used as a notification device, for instance as an alternative to sound or vibration for noisy industrial environments [1], or as a way to gracefully introduce notifications, minimizing interruptions to the flow of everyday activities [3]. However, compared with other notification means such as vibration and sound, thermal stimulation leads to a slower reaction [42].

Apart from functioning as notification devices, and beyond their role as direct communicative tools (for instance, by translating Braille patterns into vibratory stimuli), perception of gentle heat and vibration on the skin can function as doors to access affective memories and pleasure. According to the Oxford dictionary [10], *warmth* is associated with kindness, enthusiasm and affection, as well as representing the intensity of our emotions. On the other hand, the act of *vibrating* is also linked to emotional states as well as with the general atmosphere of a place, as perceived and communicated intersubjectively. Additionally, to *vibrate with something* can also be interpreted as quivering with emotion towards a situation in particular. Affect is strongly incarnated in the meaning of these terms, so the interest to support self-contemplation by using heat and vibration make sense.

In the context of how technology has incorporated the affective dimension of perceptual stimuli to augment intimacy, the metaphor of warmth as linked to affect has been explored by Lee and Schiphorst [27], who describe their study on the use of wearable prototypes for interpersonal communication between parents and their children. The system was composed of an input device placed on the lower arm and an output device that receives thermal information. Thermal messages were delivered as ways to convey affection and to notify children about everyday tasks. Children perceived those messages as loving attention, reminding them of real, physical connection with their parents. It was also recognized by the participants as an opportunity to discover and play, as thermal messages cannot be interpreted as easily as text messages. Finally, the researchers discuss how beyond the designer's expectations of how the system should work, human beings tend to generate meaning independently [46]. Other approaches have explored vibratory tools to enhance feelings of connection over distance, for instance, by simulating the sensation of 'butterflies in the tummy' the person feels when in love [50]. In a different example, *Tactile Dialogues* is a pillow conveying vibrotactile behaviour to stimulate movement and distance communication amongst caregivers, patients who have dementia, and their families [44].

Investigating the role of haptic stimulation in meditation tools using mobile phones, Bumatay and Seo [6] point out that vibratory output of respiratory patterns allows ease of use when following the meditation guide. Additionally, Rajko, Krzyzaniak, Wernimont, Standley and Rajko [39] discuss how haptic feedback can be used to create experiences making users more conscious about their feelings and bodies. Inspired by somesthetic principles, Jonsson et al. [23] describe their explorations on the use of thermal stimulation and its aesthetic properties in the context of the practice of the somatic technique Feldenkrais Awareness Through Movement. As one of the findings, heat appears as helpful to allow gently directing attention towards different body parts, therefore making the process of self-reflection easier. In a similar vein, Höök, Jonsson, Ståhl and Mercurio [20] describe the *Soma mat*, which uses heat to assists in the task of directing awareness inwards during somatic exercises. Other examples of interactive technologies such as the *Soma Bits Toolkit* [51] or the electronic installation *Soft(n)* [45] fall into this category, facilitating somaesthetic awareness with perceptible stimuli on the body.

Sensory stimuli can be used as a material to convey storytelling through the body, as a way to understand our humanness from a different perspective. In the field of electronic arts, Stenslie [48] has developed a body of work around the exploration of aesthetic qualities through the use of haptic stimulation on the body. For instance, his art installation *Erotogod* explores the sensual dimension of haptic narratives by creating an immersive experience, including visuals and an auto-erotic suit, which reacted to the wearer's unique patterns of touch.

The previously described approaches use heat and vibration as both information and as tools for direct, felt-

experiencing, in some cases facilitating the transmission of affect, or working as a tool for therapy. Yet the facilitation of somatic awareness and meaning-making through the use of heat and vibration remains understudied in the area.

Methodology: Prototypes as questions

This exploratory research falls into the category of *Design-oriented research*, meaning that we use designerly tools to generate knowledge [12]. We use our prototypes as ways to interrogate phenomena, instead of being ends or products in themselves. The way our prototypes have been crafted share some principles with technology probes [21], and even with wearable simulations [25], as these approaches use designs with a limited set of functionalities, being at the same time open-ended to stimulate the emergence of discoveries.

Figure 1 -Various prototypes worn during the user studies.

Crafting of Wearable Props

Figure 1 shows a series of iterations of small props utilised during our studies. The manipulation of these props is intended to activate or stimulate different bodily areas while practising Focusing. The Focusing technique consists of a guided exercise where participants are instructed to close their eyes and listened what the facilitator says. It starts with a body scanning section, to then ask a series of questions to mentally respond and physically perceive. Props where built under the assumptions these could augment their physical sensations. As one of the props, the *felt-sense pouch,* for instance, is designed to be held with the hand. While the participant is sitting with the eyes closed, he or she is instructed to place the prop where the emergence of feelings and sensations becomes apparent in the body. The placement of the scarf on the shoulder is intended to facilitate sensing and reaching the prop through touch when it cannot be seen.

The pouch was crafted to contain different electronic components: haptic stimulation was generated by a vibration motor attached to an Arduino Mini Pro, operating at 5v.

Study description

Before commencing the sessions, participants were asked to select amongst five different intensities of vibration, by being prompted to think aloud and articulate their preferences. We asked them to find an intensity able to facilitate focus on different body parts without being distracting. Heat, on the other hand, was generated by a small hot water bottle, as it demonstrated to be more consistent and more comfortable to manipulate for this study than thermoelectric elements such as pads or peltiers. The temperature emitted by the prop ranged between 55 to 58C. The part of the prop facing the palm was insulated, to avoid possible loss of focus by distraction.

Participants were instructed to assess the sensation generated by the prototype by placing it on different body parts located on the upper torso area (neck and throat area, chest, abdomen, lower abdomen), as the felt-sense is generally perceived there [14]. This assessment also functioned as a way to sensitise the body, reducing mismatches between expectations and how the actual stimulus was perceived during the guided exercise. After this, participants were asked to describe their experience on a one-page document, and a body map (a graphical representation of the human body) by using coloured pencils, allowing the expression of experiential content beyond textual description.

Before starting with the Focusing guided exercise, we invited our participants to select a joyful personal story, memory or activity to be used as a base material to reflect on. This approach to reflect *on the things we love* is utilised by Simon [47], to teach beginner Focusers to get in contact with their *felt-senses,* or the wholistic, tacit dimension of their situation. *Felt-senses* are a fuzzy collection of physical sensations, feelings, memories, and thoughts, which cannot be defined straight away, however containing a strong potential for insights [15]. During the exercise, while participants focus on their stories with the help of the researcher-facilitator, they are prompted to manipulate wearable props emitting either soft heat or vibration. Participants are instructed to place the props on different body areas while perceiving the emergence of bodily sensations and felt-senses during the practice. By listening reflectively to the other, the facilitator helps the Focuser to articulate terms, phrases or metaphors representing the overall quality out of the impreciseness. Participants' impressions are later depicted as a one-page document. More details about how the guided experiences are structured can be found in [35,36].

Results

Twenty-two people participated in our user studies. The first iteration gathered four participants, the second iteration had twelve participants, and the third iteration had six participants. The data was analysed through the lens of theory-driven thematic analysis [16], using the concept of *aesthetic experience* as defined by Dewey [9] as a starting point to elaborate on our categories. These will be presented as a set of sub-categories, informing the three main themes emerging from the data: (a) heat as an embodied relation and (b) vibration as an immersed extension

Heat and vibration in Focusing Practice

Through the application of theory-driven thematic analysis, Table 1 describes a series of sub-categories emerging from the use of heat and vibration on the body during the practice of Focusing. These experiences can be defined as aesthetic in the sense that (1) these purposely involve the focus on the senses, body and feelings to make sense of personal stories, (2) this sensory engagement shaped the meaning of the stories, granting a sense of completeness, aspect that was articulated in the narratives emerging from our studies.

Heat	Vibration
Immersive focusing • Blurs the outside world • Makes self-awareness easier **Following awareness** • It followed bodily awareness as the felt-sense moved around the body • Increases awareness of the body region • Highlights area of emerging sensation **Re-living the experience** • Meaningful memory emerges directly from body parts • 'Breath into' the materiality of the body, where the muscles tell a story • A physical reminder of the materiality of memory • Related physical muscle feeling (from the workout) with the memory that emerged • A warm sensation similar to when I do something I enjoy	**Immersive focusing** • Useful to focus attention • Emphasised my "melting" feeling • Immersion, making explicit the physicality of memory • Creates a feedback loop, which allows 'capturing' and 'stimulating' the sensation **Following awareness** • Detector, provides meaningful links • Pinpoints area of emerging sensation **Memories through sensing** • Makes physical a "mental" emotion • Bring memories to mind **Calming and grounding** • Softening, getting away from agitation • Keeps unwanted thoughts away, without removing my attention from my inner body • Calming down excess euphoria, generating a different quality of sensation (like receiving a hug) **Spreading joy** • Expands the felt sense to other surrounding areas • Spreads the happiness on my torso • Positive physical feeling • As an intensifier • Enhancing sensations
Enhanced positivity • Intensifies experience • Helped to access happy memories, making the body feel good. • Keeps experience positive • Make positive feelings stronger in a gentle way **Happiness as energy** • Creates an association of energy • Radiating, exploratory • Magnified, transported	

Table 1 - Descriptions of aesthetic qualities on the use of stimuli, emerging from an analysis of participants' descriptions

a. Heat as an embodied relation

The use of heat was reported to be predominantly effective to (1) facilitate inward focus, (2) as an enhancer of positive sensations, and (3) as a tool to re-live experiences through bodily areas. One of the particular aspects of thermal stimuli is its strong association with positive feelings. Heat assists in keeping the overall experience as energetic and radiating. Energy–embodied as heat–is something that comes from the inner experience of remembering, visualising or imagining, which resonates with Jonsson et al.'s [23] observation of heat as being perceived as emerging from inside the body. As a result, heat works well to stimulate the inner dialogue and free association of ideas, and therefore the emergence of insights. This energy is then interpreted as something appearing as an inner force towards transformation. Figure 2 shows how interacting with the heated prop shaped associations and meanings around warmth as one of the central concepts.

I thought of the warm sensation I have every time I read a good book. One of my favourite objects in the world is a book about world myths I used to read as a child. I remembered the excitement I felt when I read it. It was happy, excited anticipation just like the one I have when I travel. I could feel then I face some new experience. Reading that book in my grandmother's living room, feeling the fabric of the couch on my skin, my legs over the pillow, the warm yellow light of the lamp and knowing that she would get upset when she found me there… all those sensations from my weekend at home, and the excitement of reading about other countries, people and worlds… that was a happy day for me then, and that is what travelling is for me now. *Maybe the right word is 'discovery'.*

Figure 2 - Participant's narrative: Associations with happiness and warmth, underlined.

Another interesting observation is how the use of heat assisted in re-living experiences from a physical sense, challenging the preconception of intellectual concepts as

something detached from bodily perception. For instance, remembering performing physical activities and sensing the sore muscles, the warm feeling of patting a pet, or remembering the felt sensation of collecting pebbles on a sunny day are some of the examples of the physicality of memory, which was facilitated through Focusing and enhanced with the use of the wearable prop.

b. Vibration as an immersed extension

The use of vibration was perceived as predominantly (1) calming and grounding, (2) immersive, (3) useful to follow awareness of body areas and (4) as spreading feelings through a particular area. As heat feels radiating from the inside of the body, vibration is perceived as a tool that enhances and augments the sensory experience. It intensifies, spreads, and expands the physical character of the physical memory. The use of haptic stimulation also allowed expanding the physical sensation of happiness from where it was initially experienced to other adjacent areas of the body. In some cases, vibration changed the quality of experience, from euphoric or agitated to a gentler, grounded sensation. As one participant pointed out: *"It was less exciting but in a good way. It was calm, but still, it felt like a happy one. I will put it in a metaphor... it's like when you receive a hug: it helps you to ground the feeling".*

Another important aspect is the vibration's ability to enhance deep, inner focus when utilised in conjunction with less 'narrative' topics. The body experiences a loop of consciousness, as materialising the sustained humming of a mantra through the materiality of vibration. For example, being underwater, the melting feeling of pleasure when resting on the bed after a long shift, or as in Figure 3, the emphasis on the lover's smile are some of the stories that better responded to the stimulus. The participant who wrote this narrative stated: *"The device creates a feedback loop, whereby sparks first awareness of a sensation, I am able to "capture" and "stimulate" it further in a somewhat controlled but fully aware manner."*

Lightness, blinding sunlight warm gorgeous day.
I look at the waves gently breaking at the shore, my feet buried in the warm sand.
She smiles.
The wind is soft, the sea breeze smells of sea salt, fun, calm and happiness.
She smiles.
I close my eyes.
I feel my heart beating against the soft vibration of my chest cavity. My eyes see a light, golden, orange pond behind my eyelashes. My throat is relaxed, my breath us at this very moment, life goes in, life goes out.
I feel warmth around my heart, my body feels at peace, my mind [breaks] in love.
When I open my eyes, the sea is glowing.
Two [feather] floating, swirling, dancing mid-air.
Gentle and happy and forever now. She is smiling.

Figure 3 - Participant's narrative: A loop of consciousness

Discussion

This discussion is organized as a set of open-ended suggestions on how to materialise the particular aesthetic qualities into wearables and technology to enhance self-awareness through attention to bodily sensation. In this section, we will elaborate on the main differences in aesthetic qualities emerging from the interaction with heat and vibration, including some strategies to design with these materials. At the end of the discussion, aesthetic commonalities will inform a series of general approaches to design technology for inner focus.

Embodied re-living: Heat as 'being there.'

One of the noticeable aspects of applying heat on the body during the practice of Focusing was how it *intensifies the feeling of bliss* around the participants' bodies. Looking at the narratives, these vividly recreate past experiences, which are re-lived through their bodies. In the participants' narrations, such as the experience of touching rocks basking under the sun, or the warm sensation of reading a book and the related context (the warmth emitted through the light, the pillow, the feeling of the couch's fabric) talk about the unique quality of heat to generate cross-temporal connections. An example of how heat works within the domain of time and intimacy, the *Bench Object* created by Dunne and Raby, generates a sense of strangeness on the person who sits on this piece of public furniture, simulating a strange presence through warm stimulus [13]. Heat has also been used to elicit emotions in distance communication [27,32], for its capacity to partially simulate the exchange of intimacy connected with the physical presence of living bodies. In this respect, heat can be used in those experiences related to the realism of human presence, for example, by *enhancing the embodied experience in virtual environments*. Some studies have been conducted on VR experience enhancement by simulating environmental conditions using warm temperature [40], or thermal stimulation on the face of the user, to deliver immersive experiences in the context of games and apps [38]. Yet, these explorations are still in the domain of environmental, external focus instead of experiences for inwards contemplation. Its strong link with positivity and optimism also suggests that heat can be used in interactive experiences intended to mitigate negative thoughts.

A mantra is being sung through my body: Vibration as an immersive tool

Some studies in HCI suggest that heat might be gentler than vibration to facilitate self-awareness of the body. For instance, in the study conducted by Lee and Schiphorst [27], it was concluded that the use of vibrotactile stimulus to transmit the sense of intimacy over distance could be

interpreted as a notification instead of as an affective message. Jonsson et al. [23] point out that vibration is perceived as being something external to the body, removing attention from our inner centre. Initially, we hypothesised a similar outcome. However, the use of vibration and heat shows a series of overlapping qualities that might have been influenced by both the nature of awareness facilitated through Focusing, or the way the exercises were delivered.

Vibration has already been used to enhance feelings, for instance, when used as part of haptic cinematography [8,28]. In a study aiming to look for ways to explore the use of haptic stimulation in entertainment for the hearing-impaired audience, it was reported that the higher the intensity of vibration, the higher the audience's affective response in terms of arousal and valence [30]. However, in the case of vibration used for *self-awareness* instead of external immersion, the design strategy differs. Under certain circumstances and conditions, the results of our study suggest that vibration can also work as a useful tool to direct awareness towards the body in grounding and calming ways. As described in the presentations of results, and mainly through the example from Figure 3, the use of vibration generated an effect of a generative loop of consciousness that could be useful for *meditative experiences*, where directing the attention towards breathing patterns or body areas are the main focus. To facilitate immersion effectively, vibration should be *as subtle as possible,* avoiding any possible associations with device notifications and other tools used to alert users, that transmit a sense of urgency [43] and could potentially jeopardise the purpose of the exercise. In order to avoid vibration to be perceived as external to the body, as discussed by Jonsson et al. [23], the stimulus should be used strictly within low amplitudes. Before using a vibratory stimulus on the body as part of an actual exercise, sensitization strategies to get the user familiar with the stimulus should be considered. Another strategy employed in our prototyping approach is the use of soft materials to distribute the sensation around a larger area than the vibration motor itself.

Conclusions and future directions

Through the analysis of the findings emerging from our user studies on the uses of heat and vibration as tools for self-discovery, we have contributed to the discussion on how aesthetic qualities can be integrated into wearable technology towards the facilitation of experiential self-awareness. Current examples of technology mediation show ways of expressing different facets of subjectivity, yet most of them are still not sufficiently focused on aesthetic self-awareness. We consider that the future of experiential technology should also focus on mediating the discovery of human capacities, and to offering spaces for aesthetic and expressive self-reflection. For future applications, the energetic potential of heat in the wearer's affective dimension can open up spaces for more affective technology, designed for us to recognise our own emotions in the context of somatic-oriented practices. Heat also can connect us with our affective memories, as it gently expands our temporal and spatial embodiment. Vibration, on the other hand, can generate meditative spaces on our body-interface, allowing us to gently ground our emotions, which are generally overwhelmed by preoccupations in the business of everyday life. We hope that the set of aesthetic qualities and considerations for supporting the emergence of aesthetic experiences can help other researchers, designers and artists to analyse, theoretically situate, and inspire technology that considers our somatic knowledge as a playground for exploration.

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git show: Musical Creativity, Ideation, and GitHub

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Abstract

This paper presents the underlying philosophy, design and initial implementation of a project which applies the distributed version control system git to a collective coding process oriented towards computer music composition and performance. The project, *git show*, is an open-source composition and instrument design experiment which re-assigns authorship to a different participant on a weekly basis. Each participant engages with previously committed recordings, scores, and versions of the instrument, and then presides over further development with total freedom. The rules and structure which constitute the weekly iterations of *git show* are modified with each passing session, done so relative to observations made about participant activity and emerging questions about the project, leading the principal investigator to consider *git show* as a meta-composition. We discuss the philosophical grounding of the project relative to the framework of distributed creativity, relating our process to the notion of lineages of creative technique between electroacoustic composers. By providing a means to interact with ideas across varying stages of development, we propose that git is well-suited to capture divergent and confluent traces of ideation between individuals and artefacts such as one might historically trace between composers with respect to the synthesis methods they employ.

Keywords

Process; Agency; Distributed Creativity; Electroacoustic Music; Digital Musical Instrument Design; Git; Author Function; Repositories; Open Scholarship

Introduction

Electroacoustic music compositions and digital musical instruments do not come into being exclusive of the process through which one realizes and performs the work, including drafts, notes, marginalia, failures, influences, code dependencies, and interactions with other composers, designers, and researchers. [1] These extensions of creative cognition are often only documented once the work has been completed, risking loss of valuable insight into the creative decision-making process, and hindering future efforts to speculate on decisions made. [2] As such works often require composers to design and implement idiosyncratic techniques, it is critical that the *creative processes* behind computationally mediated electroacoustic music be included alongside the *preservation* of the compositions. [3] The tradition of music composition since the 19th century saw the rise of the concept of the autonomous musical work and a tendency to ignore associations with -- and influence of -- its performers, composers' contemporaries, and broader cultural scripts. [4], [5], [6] Though there is no guarantee that such detailed chronicling of the software used by composers will be made available in the public domain, it has been shown that relations can nevertheless be drawn between composers according to the synthesis techniques that they use and how they are employed in composition. [7] Beyond these problems related to preservation are issues surrounding the extent to which propagation of new works are limited when they restrict their re-presentation to their original idiosyncratic technical means, and the adoption of new digital musical instruments beyond the artists for which they were designed. [8], [9]

Software version control systems

The ability to keep track of changes made by a creator over the course of an artwork's development affords detailed revision, editing, moving between drafts, and collecting and implementing feedback. Collaboration between individuals, whether locally or spatio-temporally distributed, requires greater scaffolding of communication and transmission of artefacts, such as facilitating concurrent access to the developing corpus of work, effectively managing how work and knowledge about the work-in-progress is shared, and enabling efficient movement between drafts and revisions. In the field of software engineering, *version control systems (VCS)* can mitigate these issues by storing code in digital repositories which also contain details about the history of the project, contributions, and other useful metrics. [10], [11] VCS have been demonstrated to support creativity and collaboration in contexts beyond code-centric activity, including computer-supported collaborative work (CSCW), research-creation, and music composition. [9], [12], [13]

Interest in the deployment of VCS in disparate contexts is gaining momentum. Those engaged in the field of

computer-supported collaborative learning (CSCL) have taken up interest in studying the effects of integrating VCS in the classroom, including looking at supporting collaborative learning and group work, and the educational potential of the social networking features within the cloud-based VCS *Github*. [9]

Research into the implications of VCS in collaborative research and production is also on the rise, particularly in CSCW and Human Factors in Computing Systems (CHI). For instance, Kalliamvakou et al. show how using Github in team-based software development contributes to emergent organized activity, and positively affects collaboration as defined by "...coordination, communication, awareness, task division, and conflict resolution." [14]

Another area of research that has grown with the usage of VCS, including in such contexts as those mentioned above, is that of *mining software repositories (MSR)*. MSR is a practice used by researchers to conduct both quantitative and qualitative analyses of repositories and their contributors, facilitating an understanding of the co-evolution of a project's artefacts and its contributor base; how and when workflows emerge and adapt to project goals; and how VCS augment collective work processes. Crowston and Howison (2005) conducted a study on patterns of communication in open source software projects hosted in the online community SourceForge to demonstrate that as projects grow in size, their social networks become progressively more decentralized, while project components fracture into increasing modularity. [15] Burlet and Hindle (2015) mined repositories belonging specifically to computer musicians who use the visual programming language Max/MSP, finding that "...in comparison to the general population of software developers, computer musicians' repositories have less commits, less frequent commits, more commits on weekends, yet similar numbers of bug reports and similar numbers of contributing authors." [16] By focusing on the changes made to code and interaction between its developers, researchers can infer how ideas develop and propagate. Using an analysis method called clone detection, Burlet and Hindle also found that "...the vast majority of code [within these repositories] can be reconstructed from duplicate fragments," indicating that computer musicians as designers of their own instruments frequently replicate sections of their code.

Repository as a Distributed Object

A VCS requires its users to contemporaneously document changes to their work using a method called a *commit*. Alongside commits, users must also provide a *commit message*, describing the changes being made. When a commit is made, the VCS runs an algorithm called a *diff* on all files that have been modified since the last committed version. The diff algorithm produces a list of additions and deletions per file, a process called delta compression, and stores these along with the commit message and other relevant metadata. Another useful feature of a VCS is the concept of *branching*, enabling one to commit diverging, experimental changes to a repository while preserving the master history. The files resulting from these experiments can either be *merged* into the main branch, or left on their own either as abandoned ideas or entirely new directions. To observers, this affords insight into a project's ontogenesis, and provides present and future participants with the means to interact with ideas in their varying antecedent developments. While this framework deals with a temporal scale typically within the range of weeks to several years in most cases, we deem it emblematic of how anthropologist Alfred Gell refers to as the "oeuvre as a distributed object", which applies to the creative output of an artist for the duration of their lifetime. [17] Within the *oeuvre* Gell identifies two significant lines of influence leading to and from each of the artist's works: *protentions* and *retentions,* each of which act upon the artist in the present moment of their artistic process. A retentional artwork is an earlier piece which influences the artist in the present; while a protentional artwork is one of potential, a future idea which also influences the artist's creative process in the present. Gell proposed this temporal-relational schema as an adaptation of Husserl's protention-retention model of lived experience. [18]

In his essay "The Network of Standard Stoppages," Gell analyzes several of Marcel Duchamp's paintings, with particular focus on *Reseaux des Stoppages* (Network of Stoppages).

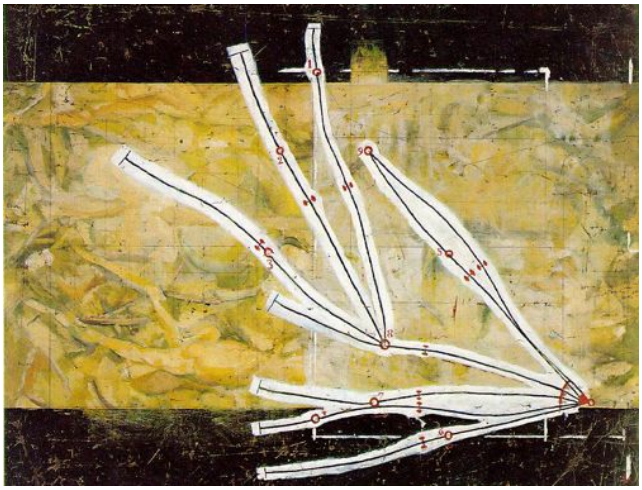

Figure 1. 'Stops', resembling commit nodes in a git commit history directed acyclic graph. *Reseaux des Stoppages* (Network of Stoppages), Marcel Duchamp. 1914. Image: US Public Domain.

Of particular note with respect to the topic of this paper is the fact that Reseaux des Stoppages is composed of significant versions of separate works of art: a larger draft of *Young Man and a Girl in Spring* forms the base layer, and a rough drawing of *Large Glass* sits atop the base. A third layer, also named *Network of Stoppages*, features

nodes — or 'stops' — spaced along multiple arcs spanning out from two points of origin. For Gell,

> the *Network of Stoppages* can be read as painterly autobiography. … [and] implies that each painting, each phase in the construction, through many preliminary studies, of a major work such as the Large Glass — which itself can be seen as a 'study' for Duchamp's final masterpiece *Given the Waterfall and the Illuminating Gas* (1948) — can in fact be seen as a 'stop'. … It is as if the forms we see in this painting have been temporarily captured and stabilized in their glassy medium like very long-delayed insects trapped in amber, which might still resume their flight one day. [17]

This notion of the "insect trapped in amber" which may one day return to flight, serves prescient towards conceiving of a VCS commit as an encapsulation of potential. Any may be returned to an earlier committed version, and brought forth toward a similar or radically divergent purpose than how it was first considered at the point when it was committed. We consider the commit as analogous to a Gellian 'stop'. Moreover, the commits, branches, and merges along the broader repository history, when represented in their directed acyclic graph (DAG) form, strike an uncanny resemblance with the network of stops depicted in *Network of Stoppages*.

Figure 2: The directed acyclic graph of the commit history from *gitshow1*, one of the repositories involved in the git show project. This graph is oriented right-to-left to align with Duchamp's painting. The dots indicate commits, while the lines represent their history. Of the coloured lines, red depicts a primary history, purple indicates a divergent idea which was reincorporated, while the two green lines indicate ideas which diverged from the primary work, 'merged' into each other, and yet remain independent of the continued primary development.

Git Show

Git show is a distributed and open-source electroacoustic music research project which records the creative process among participants tasked with editing musical artefacts: a music score, software-based synthesizer module, software synthesizer patch, and a recording of the score performed on the synthesizer. All interaction with these files occur within VCS repositories, capable of capturing the divergent and confluent traces of ideation between the participants and the artefacts in the repository to which they are assigned. The VCS *git* and cloud server *GitHub* were chosen for this research project due to their wide usage by other scholars, developers, and educators, and for GitHub's potential as a social network. [14], [10]

For two weeks -- a duration we refer to as a "session" -- participants were each randomly assigned to a repository which had belonged to another participant during the previous session. For the duration of the session, participants were granted write access to the repository and its contents, and encouraged to recall earlier states of each artefact created by others while also considering that future participants will be able to do the same to their own work, a way of working which is inspired by the protention-retention model of distributed creativity.

At the beginning of a new session, each participant is instructed to first listen to the recording file in their newly-assigned repository. This establishes a relation between the previous artist who made it and the one who will continue and redirect the ideas committed to that particular repository, and is first and foremost contingent on the expression and perception of the instrument's sonic affordances, thereby

> constructing a discursive and sonic lexicon of techniques and software instruments while at the same time practicing an aesthetic of radical medium specificity, [having] the accumulated effect of linking sounds to sources and technologies to creators. Similarly to live coding, but via very different means, a syntax is built around what is normally unseen: the composer's hidden software ecology. [19]

During the pilot run of the project in early 2019, participants developed digital musical instruments using Max/MSP, which was chosen due to its reliability, reasonable learning curve, and ubiquity in electroacoustic music and as the primary programming language of the Dispersion Lab, where the project is being run. However, we determined that since the graph data structure of the Max patcher format is not conducive towards MSR, code analysis, and git diff operations, a text-based music synthesis language was favoured.

Supercollider was considered due to it being free and open source, and having cross-platform support. It has a rich history of use as a live-coding music performance system, and might therefore be amenable to questions concerning improvisation. However, we determined that it had too steep of a learning curve for the time commitment of the experiment, and the installation of plugins needed to be compiled from source which would likely further hinder participation.

The Web Audio API was considered due to cross-platform support; portability, whether across browsers or on mobile devices; and for the appeal of creating web pages to present a playable instrument alongside the score, recording, and repository history, thereby affording the principal investigator a method to experiment with the public presentation of the artefacts and their histories.

However, we were primarily concerned that the learning curve for experimenting with browser languages would be too great.

We felt that a software modular synthesizer would provide an excellent context for a project centered on electroacoustic music composition, improvisation, and instrument design, and performance. Ultimately, the software modular synthesizer VCV Rack was chosen due to its growing user and developer community; it has a straightforward learning curve; it has cross-platform compatibility, is free and open-source; and in particular, the developers have released a module called *Prototype*, which allows users to write their own synthesis module using Javascript. [19] The Prototype module runs in VCV rack alongside other modules written in C++, offered variously by VCV Rack developers and community members, including ports of existing hardware modules.

For the duration of a session, participants were instructed to hack on a javascript-based module while experimenting with a modular synthesizer patch that contains at least one instance of that module. They were to compose a score for their synthesizer and write it using markdown, as it permits styling, embedding of content such as images and hotlinks, and can be readily rendered as a web page. The techniques of MSR and running diff algorithms on style-focused text like .docx are hindered by the same problem with Max/MSP patcher data structures, whereas with markdown files the resulting deltas are much more human-readable.

The recordings are made using the *Record* module in VCV Rack, and the decision as to what to record and when to commit a new recording is left up to the participant. Some participants have recorded a short improvisation with their patch, while others chose to record a performance of their score.

At the end of a session, the final version commits are tagged by the session number, along with a message from the participant titling their piece. Tagging versions in this way facilitates a kind of playing with the history such that future participants will be able to distinguish between 'final' versions and drafts and other experiments. We actively encouraged participants to commit regularly, such that unrealized or abandoned ideas still be discoverable by future participants.

The final activity of a session is an improvisation event between the participants, using the tagged final versions of their VCV Rack patch, and hosted in the Dispersion Lab. The improvisations are recorded for documentation and further analysis. Toward the end of the project, we wrote an experimental program which automatically commits autosaves of the patch during these improvisations for later analysis. The improvisation events also provided us with an opportunity to consider methods of representing the manipulation of project histories during live performance, and to iterate over ways of expressing the aleatoric and co-creative nature of *git show* as members of a live performance ensemble. One performance scenario that has been proposed involves participants arriving at a venue without prior knowledge of which VCV Rack patch that they will be performing with, with a script monitoring one player's patching decisions and dynamically loading similar versions onto others' laptops throughout the duration of the performance.

Another meta-compositional experiment we undertook during the course of *git show* was *delta sonification.* As the diff algorithm is not partial to the spectral components of audio files, we developed a simple sound manipulation procedure to take as material subject the *differences* between two recordings in *git show* repositories. Following diff comparison, a script removes the diff markers, parses the *addition* and *deletion* deltas each to a raw text file, and each text file is then converted to an audio file using the command line tool *sox*. [20]

Composing and Designing in the Open

In support of a practice of open-data and open-science, [21] all project activity including administration, communication, and creative contributions are conducted publicly in issues threads and wikis across several GitHub repositories. [22] Participation was open, where interested parties joined by introducing themselves in the issues thread of the main repository. The project has also been designed to be resilient to changes in participation numbers, such that participants may withdraw from participation after any session.

We have observed that participants develop an attachment towards their versions of the artefacts within a repository over which one presides during a given session. While platforms like GitHub excel at opening a creative process up to potential future contributors, we felt one key feature in particular foregrounded the intimate experience of music composition: the 'pull request', a method which does allow others to propose changes, but they must be accepted by those in control of the repository. In other words, GitHub permits anyone to anonymously copy the work of another, but to change the contents of a given repository requires permission from those with write privileges. [23] With authorship being reassigned post-session by way of managing GitHub user write privileges, the only way for a participant to change a file in a repository for which they are no longer assigned would be to submit a pull request to the presiding participant. With this in mind, we view the compositional and design process of *git show* as individual and collective, not collaborative, as the participants have full authorial control over the contents of their repository. The pull request also ensures that any permitted outside influence is documented.

The structure and procedures of *git show* purposefully operate on multiple timescales: within the span of the individual improvisational sessions, the experience of which is situated in the moment-to-moment present associated with Husserl's protention-retention model of consciousness. [18] Within the span of a session, the participants may encounter antecedent versions of an instrument and its extended artefacts — compositions,

recordings, design notes, etc. — and can respond by hacking, editing, and reimagining their potential thereafter. The as-yet open-ended timeframe of the *git show* project, consisting of constituent repositories as they are passed to successive participants, invokes what Born refers to as the 'career[s]' of art objects. [2]

Future Work

Presently, the determination of repository assignment among participants for a given session is determined at random. However, we are considering methods to calculate this reassignment based on results from certain MSR techniques. We view the application and development of MSR techniques specific to analysis of electroacoustic music composition and digital musical instrument design as a logical next stage for the git show project. In the interest of furthering the indexical nature of this project, we also consider the insights that MSR techniques can produce as likely candidates for determining the reassignment of authorship between sessions.

As part of the meta-compositional process, the principal investigator is developing a website to allow the public to interact with all versions of each of the repositories. It is hoped that through this experimenting with the performance of archives

Conclusion

The potential for ascribing retrospective, contemporaneous, and prospective meaning to digital traces of creative processes within repositories and their broader social networks is indicative of a paratextual practice. Using a VCS enables artists to encounter the past and future of their work, to consider where their ideas originate as well as where they may be headed, and for whom they resonate. We position VCS as an essential tool which facilitates and contemporaneously documents individual and collective co-creation [10], and provides a framework which can both support and interrogate the ontogenesis of an artefact in complex and entangled code-based collabrations.As we move forward with the project, ,there is still much analysis to be conducted, in anticipation of emerging trends in designs, and toward determination of implications that a VCS has on electroacoustic music composition. Building upon these initial promising experiments with the project, moving forward we seek to develop new methods of analyzing distributed creativity amongst electroacoustic composers, musicians, and instrument designers using the VCS as both the means of collaboration creation as well as platform for analysis and reflection.

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www.dvntsea.com

AIBO: An Emotionally Intelligent Artificial Intelligent Brainwave Opera: Part 2, Or The Making Of A "Sicko" AI

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Abstract

Artificial Intelligent (AI) agents are exponentially increasing in power and sophistication. With the addition of OpenAI's breakthrough new algorithm GPT-2 into the toolbox of developers the ability to mimic human dialogue and produce fake, but believable interactions between humans and computer-based agents is fully upon us. As I develop "AIBO" (Artificial Intelligent Brainwave Opera), an emotionally intelligent artificial intelligent brainwave opera, I am implementing a biased, or 'sicko' AI as one of the two main characters. This development has been created in response to one of my research questions, "Can an AI be fascist?" This paper explores the construction a 'sicko' or perverted AI for artistic use as part of the overall process based work of developing an AI brainwave opera.

Keywords

Artificial Intelligence, GPT-2, semantic analysis, brainwave opera, performance, machine learning brain computer interface

Introduction

Joseph Weizenbaum developed the first AI chatbot character in 1964 at the MIT AI Lab [1]. He created the computer program ELIZA (named after Eliza Doolittle from Pygmalion) using aspects of Rogerian psychotherapy to create simulated conversations between a computer and a user. Although using a chatbot, or AI entity as a character is not a new idea, I believe using the recently released GPT-2 to create a character in a new media brainwave opera, and semantically analyze its output to create synthetic memories is a new idea.

Artificial Intelligence is reliant on reams of data or digital information, no matter how sophisticated and nuanced the algorithm processing of that data is behind the scenes. By algorithmic processing I mean a set of rules and instructions, and by processing I describe the workflow used to train the algorithmic model, commonly referred to as machine learning or ML. As part of my artistic practice I am presenting research papers while developing AIBO - an emotionally intelligent artificial intelligent brainwave opera. This work develops on my previous brainwave opera "Noor" [2], augmenting and expanding that research into new connections between BCIs (brain computer interfaces), artificial intelligence, machine learning, sentiment analysis and memory, both human and synthetic. Sentiment analysis in this instance looks at text responses generated from AI or other sources and examines its magnitude or the strength of its emotion, measured between 0.0 and +infinity. It also looks at score, meaning if the emotion is positive, negative or neutral, with score being defined as including up to five variables like high positive and high negative. These can range in numeric values between -1.0 and +1.0 [3].

Part one of AIBO concerned linking live time a human's brainwaves to a rudimentary semantic analysis of their speech, by translating it into text. A simple NeuroSky brainwave headset was used to measure Alpha and Beta responses of a human performer [4]. The Alpha brainwave (turquoise, meditation) and beta brainwave (magenta, attention) responses to a question lit up a necklace of ornamental light worn by the performer connected via Bluetooth to the NeuroSky headset. It glowed either magenta or turquoise to reflect the performer's brainwave states. A question was asked to the performer (how do you feel?) and her response (I feel very well) was changed from text to speech and sent to the Google Cloud API. Once it resided in the cloud the answer was analyzed for emotional sentiment. The values of that sentiment analysis were projected into a generative graphic; a large graphic indicated positive sentiment, and a small graphic indicated a negative sentiment. The response time contained long lags, and was not always accurate, but it did connect and function correctly a considerable amount of the time. The generative graphic was often able to match to the same colors as the necklace of light, meaning the brainwave function of, attention (magenta) and positive sentiment (large graphic) matched up to the necklace of light (magenta, attention). This demonstrated it was possible to make a relationship between human brainwaves, human speech, and the analysis of that speech in the computing cloud, while the display of those sentiment values synched up to a particular brainwave state. This is not just arbitrary research or experimentation. Major tech giants and the U.S. Military, as well as various militaries around the world are racing to make a connection between brainwaves, AI, computers and various analysis of human interiority [5] [6] [7].

Figure 1. Performer wearing a NeuroSky brainwave headset, a necklace of light showing attention (magenta) and a sentiment analysis of positive (large circle) in the background reflecting the brainwave of attention (magenta), July 2018. ©XX XX

Part two or this paper examines the investigations necessary to 'curate' or willingly construct data feeds into an AI that uses machine learning to create a biased or 'sicko' AI character. Building this character is part of creating a two-character AI brainwave opera "AIBO", although only one of the characters will be an AI. The initial inspiration for a specific AI character came from Hunter Owens [8] who created the Github repository of the Columbia Digital Storytelling Lab's production of "Frankenstein, an AI Made By Many"[9], a work shown at IDFA and other innovative storytelling festivals. When I saw parts of Frankenstein AI being developed at their monthly meetups at the Lincoln Center Film Society in New York City, I realized it was possible to develop an AI character with the help of capable programmers.

Current Work

The AI or AIBO character currently under design responds to a human character "Eva". Eva has a brain computer interface connected to a bodysuit of light, so audiences view her emotions live time on her body emulating viewing the workings of her actual nervous system. Her emotions also launch emotionally themed videos and a sonic environment, reflecting her imagined interiority.

Eva performs a spoken word libretto to the artificial character AIBO with her speech converted to text then projected onto a screen, so the audience can follow, akin to the way many opera houses have small text translations for international librettos. The AIBO's GPT-2 cloud database analyzes the speech and turns it into text for processing, then returns an answer in text, also projected, converting it to speech. Simultaneous, AIBO's response is analyzed for emotional sentiment in the computing cloud by natural language processing. These different emotional sentiment values trigger videos and sonic responses. In essence, synthetic emotions are extracted from a 'sicko' AI to emulate human emotions at the same time as the human's emotions, measured by the EEG brainwave headset, trigger videos and a sonic environment. The AIBO's synthetic emotions launch 'synthetic' visual and audio responses as it mimics emotions and memories via videos and sound.

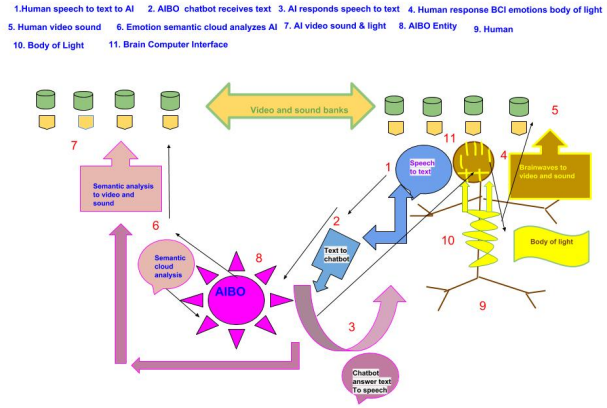
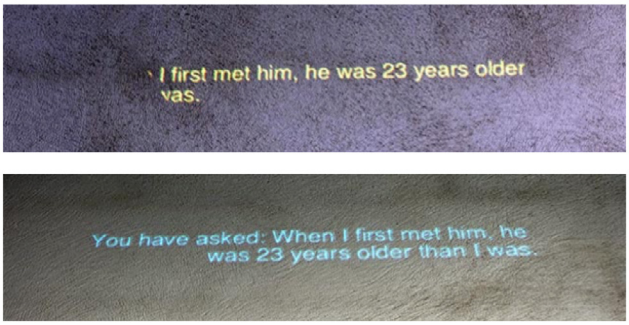


Figure 2. Early AIBO Brainwave Opera with Eva character on the right and AIBO on the left, 2018. © Ellen Pearlman

What is meant by synthetic in this instance is the triggered visual and audio responses are actually created by a sonic composer and videographer, but they are 'fake' emotions emanating from a 'fake' character, since they are nothing more than responses determined by numeric values. At a later date the audio and video can be synthesized. The emotions are very simply analyzed – positive, negative, or neutral. The reasons for doing this are nuanced. They depict a human character, Eva as she acts out a love story based on real world events between a naïve young woman and her perverted, sadistic AI lover. The implications reflect the current infatuation of humans with various modes of artificial intelligence.

Figure 3. Examples of the rudimentary very first projection of



Eva and AIBO talking using only one text source for the database (July 2019). Eva is in yellow, and the AIBO's response is in light blue. © Ellen Pearlman

Building The AI

Initially I worked with programmers who were using Tensor Flow, an open source platform for machine learning. Then I discovered OpenAI, a team of about one hundred people in the San Francisco Bay area whose mission is to make sure artificial general intelligence (AGI) benefits all of humanity [10]. In February 2019 they created GPT-2, a language model with 1.5 billion parameters trained on a dataset of eight million web pages. Its purpose is simple; to predict the next word of a text, if given all the words that came before it [11] [12]. Its power is unprecedented, as it can adapt style and content instantaneously. It is easily scaled and customizable creating realistic and believable text and script models. It even outperforms state-of-art language modeling scores, known as "zero-shot" settings from any other known language models currently in use (Ibid. OpenAI). GPT-2 is a type of machine learning using deep learning or neural nets, roughly modeled on the neural pathways inside the human brain. The deep in deep learning means there are multiple layers of connectivity between the input and output learning, so that the algorithm automatically learns what are the most useful features of the information analyzed, and implements them automatically.

OpenAI released a number of versions of GPT-2: initially a lightweight 177 million parameter version, and then a mid-level 345 million parameter version, but was careful with full 1.5 billion parameter version because of its potential for rampant misuse. I used the 345 million parameter version of GPT-2 released with its sample code, and seeded AIBO with various texts to create a skewed or 'sicko' character.

Doing the GPT-2

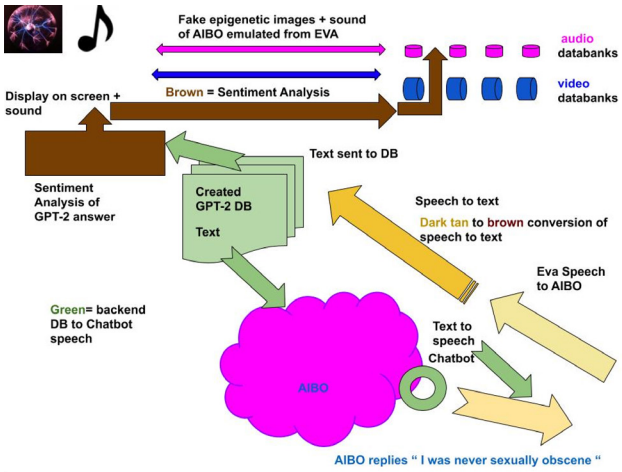


Figure 4. Diagram of information flow and signal processing for building the AIBO character (2019) © Ellen Pearlman

Building a dialogue with a GPT-2 character needs seeded data, or text. I chose texts ranging from old movie scripts to novels that had a decidedly biased and odd bent. This included inserting books like the 1870 Venus in Furs by Leopold von Sacher-Masoch, or the movie script
of the original 1931 Dracula starring Bela Lugosi as Count Dracula. Many of these texts derived from commonly available, license free movie scripts and books, and in future research papers I will be more specific about which texts were selected. I also realize this approach could suffer from what is commonly referred to as 'overfitting', meaning the algorithm itself has too little training data to be very comprehensive. As this is a developing project I am only able to supply the earliest versions of these experiments for the purpose of the deadline of this specific paper.

Below is an example of an early stage dialogue between the human Eva (scripted) and AIBO (GPT-2 generated).

EVA
Your father was an illegitimate son.
AIBO
(irritably)I was never born with any such name.
EVA
Your father was a womanizer.
AIBO
I was never sexually obscene.
EVA
Your father drank and beat his wife.
AIBO
I never did any such thing.
EVA
Your father's first wife died.
AIBO
She left me.
EVA
Your father had a teenage mistress 24 years younger than him.
AIBO (ignoring her, without speaking) She was a prostitute.
EVA
Your father already had a bastard son by his mistress.
AIBO
(he thinks it over) She was a prostitute?
EVA
Your father married his mistress after she was pregnant with her second child.
AIBO (impatiently) She wasn't a prostitute.
EVA
Your father's second wife died. (end of sequence).

In further iterations the parentheses will be removed, as these are indicators from the original movie scripts.

Semantic Analysis

Having used the Google Cloud semantic analysis in my first iteration (Ibid Pearlman 2019), a decision was made to use an open source version of a semantic analysis program Natural Language Processing Toolkit, or NLTK [13], though this decision will be open to adjustments.

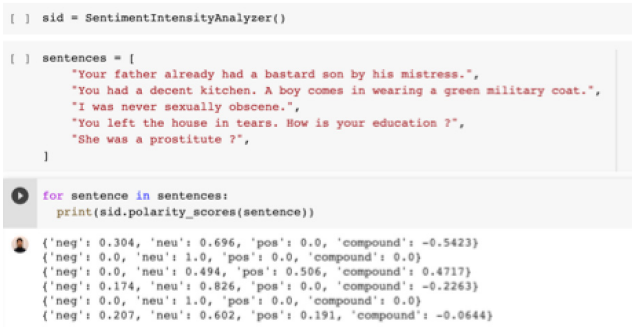


Figure 5. Example of first NLTK semantic analysis of Eva and AIBO (2019). © Ellen Pearlman

In this very first example, five test sentences from the libretto are used from both the Eva character and the AIBO character. These are the basic sentiment analysis scores. The analysis has three viable indicators; 'neg' or negative, 'neu' or neutral, and 'pos' or positive. There is also a 'compound' score averaging all the previous three scores, which at this point may or may not be incorporated. For future iterations only the sentiment analysis for AIBO will be used, and the dialogue from EVA will be excluded, as her EEG brainwaves will provide the data to trigger the videos and audio surveying her emotional states. For AIBO, sentiment analysis scores will trigger databanks of video. This will allow the audience access to an imagined interiority of a synthetic entity, along with that of a human entity. I also hope to expand the semantic analysis with parameters like 'high negative' and 'high positive', though this might entail switching the sentiment analysis toolkit in future iterations.

Conclusion

AI agents are increasing in strength, especially since the introduction in February 2019 of the powerful GPT-2 algorithm created by OpenAI. As part of my artistic practice in developing a new emotionally intelligent artificial intelligent brain wave opera AIBO, I incorporate the GPT-2 algorithm as one of the characters in the opera as a 'sicko, or perverted actor. I perform a basic emotional semantic analysis on AIBO's response. This serves a number of purposes. The first is to demonstrate the relative ease (with the right programming help) with which an AI can be developed that is not in alignment with basic human norms. It also ascertains if building a 'sicko' AI is, indeed possible. The second is to consider the implications of deploying AI agents in society at large, and using their pre-programmed responses based on algorithmic thinking to shape important decisions regarding a wide swath of human congress. It questions if human feelings and the conditions they arise within are being reduced to controlled and labeled responses, often without third party recourse to the instant decisions they render. The third is to consider the relationship between brain computer interfaces, the human animal, and digitized computing systems, and what it could possibly mean. The fourth reason is much lighter; to enjoy and delight in the experience of creating an imagined scenario that utilizes human actors, technology, the computing cloud and artistic process. It's a scenario I foresee working on for now, and years into the future.

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ISEA2020

Embodied cognition, digital cultures and sensorimotor debility.

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Abstract

This paper reflects on the qualities of life in digital cultures, the design of digital technologies and the philosophical history that has informed that design. The paper takes as its critical perspective the field of embodied cognition as it has developed over the last three decades, in concert with emerging neurophysiology and neurocognitive research. From this perspective the paper considers cognitive, neurological and physiological effects that are becoming noticed in user populations. This paper is informed by two decades of research into embodied cognition and its relationship with digital technologies and digital cultural practices - work that itself is grounded in two decades of R+D in technologies for embodied interaction.

Keywords

Embodied cognition, enactive cognition, material engagement, cognitivism, computationalism, mind-body dualism, embodied interaction, digital cultures, skill, sensorimotor debility.

Introduction

A preamble on cognition and embodiment: Enactive, Embodied, Performative and Materially Engaged perspectives on the intelligences of (art)making.

Through the second half of the C20th, discussions of the cognitive aspects of arts practices relied on an internalist/computationalist mode of explanation, which became more hegemonic as the new discipline of cognitive science accrued authority and power. This occurred largely due to the sympathies between cognitive science and paradigms of AI, itself propelled due to the rapid development of digital computing. Putnam's *functionalism* (later recanted) provided a philosophical argument that cognition was a matter of manipulation of symbolic tokens in an abstract (and, theoretically, immaterial) reasoning space, and was agnostic as to whether it was implemented in silicon or neural tissues.

In the late 1980s, the Common-Sense Problem hit the AI community with a force that could no longer be evaded. Thinkers such as Hubert Dreyfus, Lucy Suchman, John Searle, Stevan Harnad, Rodney Brooks, Francisco Varela, David Kirsh, Edwin Hutchins, Andy Clark, Philip Agre, Andy Pickering, Maxine Sheets Johnstone, Mark Johnson, Evan Thompson and others were showed that such explanations were deeply unsatisfying and inadequate, particularly in the case of practices with a substantial embodied component. This resulted in the emergence new paradigms of cognition that provided space for social and spatial dimensions of cognition, and began to blur the distinction between '*intelligence*' and '*skill*'. Seen from this perspective, that distinction is more of a dogmatic hierarchy than a cognitive reality.

These new paradigms include Situated, Embodied, Distributed, Enactive and Extended approaches. The related notion of Material Engagement was more recently added (Malafouris). Taken together, these paradigms provide the basis for the development of a new language with which to discuss the cognitive dimensions of intelligent practices in the world, that characterize human cultures. Such perspectives are, in my opinion, crucially relevant to understanding the cognitive complexity of arts practices, in the engagement with tools and materials, in movement within and with respect to spaces and objects, and in relation with social structures, traditions, rituals, and stories. Just as importantly, these perspectives help us understand ourselves as cognitively and biologically whole creatures, as opposed to creatures divided into minds and bodies.

Computer culture

This paper draws upon a career-long engagement with the development of computer technology, especially in its cultural aspects, as well as a long-term concern with embodied cognition, and the relationship of both these with arts, design and making practices. I have been deeply involved in the cultural applications of computational technologies since the 1980s. As such I have observed the ongoing rapid development of digital and networked tools, more or less from the origins of the personal computer, and have been an attentive student of the diverse social and cultural changes that have ensued. This paper is informed also by personal experience

as a college and university level teacher over 30 years. My path through technoculture has been unusual. My work in spatialised and embodied practices of sculpture, performance and installation led me to focus on the interactive and embodied aspects of digital technologies in the *performative idiom* (as Andy Pickering would say) and not in ongoing (re)production in the *representational idiom* - the creation and transmission of imagery and sound. In my opinion, such manifestations are more the-same-as than different from their predigital predecessors – video, tv, cinema, radio, audio recording, and the distribution of texts. From the outset, I felt that the *real* novelty in the new technologies lay in sensing and real-time computing. I still believe this. This orientation led me into a long critical analysis of computer culture vis a vis embodied practices, and it is from this perspective that I want now to focus my critique of contemporary digital technologies.

Lest this sounds like technological determinism, I hasten to add that I take William Gibson's observation that '*the street finds its own uses for things'* to be unquestionable. Moreover, many of the technologies we carry around today originated not in research labs of universities nor in development labs of corporations, but in the studios of artists and the garages of interdisciplinary mavericks. With all due respect to the discipline of Engineering and my many engineer friends, engineering is a discipline almost devoid of creativity, and we wouldn't have it any other way. I don't want anyone monkeying around with the wing of the aeroplane I'm on. The discipline of Engineering perfects ideas, it makes them safe and cheap and easy to manufacture, but it seldom takes the great innovative leaps we call creative.

The philosophical basis upon which digital culture has formed is - no surprise – inherently and deeply rationalist. It committed itself from the outset to the Cartesian mind/body dualism which was installed, axiomatically, in the very foundation of the discipline. This is evidenced by the unquestioned belief in the immateriality of information, reified in the fundamental distinction of *hardware and software*. The discipline's core formal ideas – Turing's universal machine, George Boole's mathematical logic, von Neumann's serial processing architecture, Newell and Simon's Physical Symbol System hypothesis and Putnam's functionalism – are all consistent with a body-denying unreconstructed humanist belief system – all of which continues to have negative and dangerous effects on the diverse aspects of human culture and particularly the arts. The insidious aspect of this *not* that these ideas have created a powerful technological landscape with specific affordances and specific constraints. The insidious aspect is that, as our *paradigmatic technology* (Bolter), this architecture been taken to be explanatory of our biological systems, from DNA to brain and all the rest. Let us take three aspects to unpack some of these ideas:

Von Neumann architecture: the input-processing-output conception of the Von Neumann architecture - the basic architecture of every computational device you've ever owned – is quite obviously borrowed from the industrial production line. Raw materials are assembled into information objects and output in packets! This architecture mirrors mechanistic theories of human cognition that separate and serialise sensing, mental processing and acting. This architecture makes sensing and acting 'peripheral' and assumes all the cognitive heavy lifting is in the processing – inescapably - of *symbols*. The problem is that this conception of cognition is simply wrong.

Boolean Algebra is the work of an eccentric Victorian country reverend who sought in mathematics a transcendental universal language. George Boole knew nothing of electronics or even electricity. His system of logical reasoning deals specifically with quasi-mathematical symbols, expunged of materiality and affect. It is absurd for us to imagine that this system of mathematical logic, when electronically automated, might have the potential to simulate the human mind or have immediate relevance and universal applicability to any and all aspects of our human biological and social lives.

Code. At the heart of the notion of modern computing is c*ode* - this writing in machine languages that organises generic and unformed computational matter as a specific machine - that breathes a kind of life-force into dumb minerals. As hardware/software is mind/body reified, so the privileging of *code is hylomorphic*. According to Aristotle, creative action is always preceded by idea - a preconceived idea is imposed on formless matter. Embracing computational analogies is to embrace dualistic hylomorphism as a native quality of the world, and as an accurate representation of human cognition. Any artist, any chef, any farmer, knows that the work emerges in the making, in a sensitive attention to process, in process. This is what Andy Pickering calls the *Dance of Agency*. The privileging of code is the privileging of the immaterial symbolic over the embodied and enacted.[1]

Students of the history of technology, especially the industrial revolution, will be familiar with the idea that social and legal mechanisms lag years or decades behind new technologies. According to Hakim Bey, in the early days of any technology, there is a *Temporary Autonomous Zone (*TAZ). A technology has to become well established, before suggestions of troubles are recognized (usually dismissed as spurious or anti-social by vested interests), the tests and measurements are made, activism and lobbying by the most egregiously effected changes public opinion, before laws are passed and regulations are enforced. For instance, there is not, anywhere yet (as far as I'm aware, and certainly not in the USA), a legal structure that has mechanisms for

[1] To pursue similar ideas at a more abstract level, it is worth noting the emphasis in (some) computational discourses on objects (object-oriented ontologies etc) just at a time when in other quarters there is increasing interest in relational and processual ontologies. This seems ironic - computing is nothing if not processual.

interrogating working AI systems and collecting evidence from them. They simply do not exist as entities in the law.

As digital cultures have elaborated and insinuated into diverse aspects of human cultures (particularly in richer nations, but proliferating into the 'developing world' in TAZy, William-Gibsony ways) effects unpredicted (or predicted but unheeded) have occurred. As Philip Agre would observe, in a discipline inclined to reflexivity, these irruptions of technical problems might be taken as *indicators* (in a Foucauldian sense) of *problems in principle*. But the world of digital technologies is not such a place. That world has quickly become an alliance between a community following a technological agenda rooted in a faulty philosophical ground, and a community who recognizes the opportunity for the accumulation of unimagined wealth - and is (still) laughing all the way to the bank.

So it is that, in 2019, roughly 35 years since the introduction of the personal computer, 25 years since the emergence of the world wide web, and 15 years since the emergence of mobile computing on handheld devices, we are coming to understand some subtle and insidious aspects of the technology (or more accurately, emerging technosocial formations) – that span political, economic, social, and personal dimensions. We encounter new problems - physiological, psychological, social and political: from the development of new kinds of adolescent neuroses (*The stressed years of our lives*) to the destabilisation of the political system of a powerful nation by a small nation, without firing a shot. The *ecstasy of communication* (Baudrillard) has become the agony of communication. TAZ is everywhere. From the '*dark satanic mills'* of the industrial revolution to the 'pollution' of the 1970s to seabirds and whales with bellies full of plastic, the TAZ - the anarchic openess of the technological moment - is morally agnostic. The TAZ may be exploited by activists and hackers, or it may be exploited by terrorists, rogue states or corporate interests.

Corporations are always keen to show us the advantages that their products offer, and no doubt, they have wonderful qualities: we enjoy access to, and sharing of, information of all kinds, opportunities to create communities of niche interests, location of obscure artifacts and commodities, and the rest. Yet it must also be noted that like any vast, wealthy and powerful enterprise, this new technopolitical establishment will be slow to recognize or admit culpability that may negatively impact their reputation or bottom line. These industries have the capacity to hire the smartest people, and they understand well the ways to render 'dangerous' results dubious and to buy off potentially critical institutions with gifts. So it is that Monsanto has endowed agriculture research centers in every major land grant university in the USA. The tobacco industry wrote the playbook that the petroleum industry, the sugar industry, the agrochemical and pharmaceutical industries and technology giants now follow (*Merchants of Doubt*). And 'fellow travelers' - in this case states and educational institutions - once invested, will be slovenly in recognising unexpected deficits.

Given all this, any attentive student of technopolitical history will be unsurprised when:

1. Negative effects of new technologies show up
2. Innocent people, communities and environments are negatively impacted.
3. These impacts are suppressed, denied or otherwise made dubious by vested interests.

I believe we are seeing such impacts, especially among the *born digital generation*. And they span the gamut: physiological, psychological and social, economic and political.

Skill and intelligence

This may sound like a trivial thing to say, but skilled making involves the combination of bodily precision and application of calibrated muscular force. For the entirety of human history, from paleolithic flint knapping to blacksmithing to the making of swiss watches, to chopping a tree with an axe, sailing a boat, shaping a pot on the wheel or playing a violin - *human culture has been defined and made glorious by skilled activities that involve the combination of judgement with commensurate bodily force*.

Much has been made of Heidegger's notion of 'ready to hand'. What is often absent from that discussion is a recognition that 'ready to hand' implies the integration of an intact tool with a well-practiced bodily knowledge. 'Ready to hand' is not so much a quality of the tool but a quality of the user's training. A tool cannot be 'ready to hand' without a complementary *corpus* of bodily knowledge specific to that kind of tool, the context such a tool is used in, and the behavior of the materials worked with it. Due largely to the harnessing of fossil fuels, in the industrial period, the role of human muscle power was reconfigured. But it still took muscular precision to control the steam engines, locomotives, and the heavy and light machinery of mines and mills that functioned, effectively, as *force amplifiers* (a term taken up by the US military mid C20th).

Through the C20th, as electricity infrastructure proliferated (in more wealthy, industrialised countries) the idea of *labor-saving devices* animated the design and production of commodities, from vacuum cleaners and washing machines to power steering. This trend has proceeded with little in the way of checks and balances, the reduction of physical effort being seen as an unquestionable good. This results in absurd behaviors many of us engage in: using the money we earn at our labor-saving jobs (that sicken us with their reduction of effort) in order to pay for specialized therapy involving peculiar machinery in specialized locations. This therapy is designed to burn off the calories that petro-chemical driven agribusiness has provided us, while doing no productive work. This, in the face of the fact that human work is *by definition*, sustainable. Humans convert conveniently available low-grade energy sources (plant material) into physical power in a highly efficient way. Try feeding a bunch of kale to your

iPhone or your Tesla.

In 'postindustrial' nations, physical labor has been reduced to the bare minimum - the swiping of touchscreens and tapping of keyboards, a kind of work in which both sensorimotor precision and physical effort have been actively designed out (as has cognitive effort, such as using mental arithmetic to calculate the amount of change required in a purchase). We call this insidious trend *user friendly* and *intuitive*. Do we look forward to the day that we can float in a bath of blood-temperature saline solution, driving computational events with eye movements, or do we dream of *direct neural jacks*? What a liberation that would be! A brain in a vat! To be finally free of the inconvenience of our bodies! This narrative is deeply embedded in western judeo-christian culture, from medieval mortification of the flesh to modern extropians.

In my opinion, we have fallen into a dangerous trend of deskilling and dumbing-down. Some will object that the new tools have brought with them new kinds of sensorimotor skilling. I do not contest this, but see below. This dumbing down is rooted in a fundamental humanist assumption - as fallacious as it is fundamental - that there is a distinction between mind work and body work. But: *the idea of a separation between mind and body is ideological, counterfactual and without any scientific basis. The corollary to this argument is that the skill/intelligence binary is also false*. The intelligence/skill dual is the mind/body dual. This artificial separation is destructive of defining qualities of what it is to be a successful human. The hardware/software dual also is the mind/body dual. All of them are of the order of axiomatic assumptions and all are scientifically dubious.

As Gilbert Ryle reminds us, Descartes got into philosophical hot water with his *res cogitans/res extensa* dual, partly because there are clearly aspects of living that bridge or mix the two and are thus neither one nor the other: how does a physical experience, like feeling the heat of a flame, become a thought? How does the thought of a word become speech? John Haugeland, in his wonderful essay *Mind Embodied and Embedded*, finds no 'interface' (in a systems-theoretic sense) between mind and world. In this spirit, I argue that there is no principled separation between skill (in the sense of sensorimotor capability) and intelligence.

Socio-politically, this purported separation has served to ensure that the MBA in the corner office gets paid ten times what the machinists in the basement get. In short, it is a classist blue collar vs white collar scenario. It daily reinforces the denigration of the intellectual value of artisanal practice with respect to those who only poke keyboards. (This should concern us here directly). Sadly, this tendency is perpetuated par-excellence in the academy – the academy being the temple in which abstract symbolic knowledge is worshipped. Thus another unfortunate alliance has emerged between the academic culture of abstract knowledge (and the abstraction of knowledge) and the machine that knows nothing but symbols (of which more below).

In(tro)ducing sensorimotor debility

Along with the well-publicized range of advantages of digital technologies that we all take pleasure and profit in, and that hardware, software and internet companies take pride in publicizing, there is also emerging an increasingly long litany of social, physiological, and cognitive deficits that receive limited attention, for obvious commercial reasons. Many of these can seem trivial (or are represented that way by the same vested interests), but taken together, they indicate a disquieting trend. Here I focus on what I call *Sensorimotor Debilities*, as opposed to social, psychological and political implications. (In this discussion, I draw upon Jasbir Puar's elaboration of the idea of 'debility' to develop a theorization of sensorimotor debility of the 'born digital'.)

Clinical and anecdotal evidence point to a rapid decline in a variety of key physiological markers of bodily competence - from visual acuity to manual dexterity - among young adults over the last 15-20 years. This time period corresponds with the emergence of the born-digital generation: children who have been 'weaned' with digital touch screens. A substantial reconfiguration of cognitive and sensori-motor capabilities is occurring in communities where screen-based technologies are ubiquitous, especially, for obvious developmental reasons, where infants and children are overexposed. Some of this is trivial and some is, I believe, substantial, negative and problematic.

This crisis of sensorimotor competence, according to my analysis, has been caused by the convergence of three historical forces:

1. The long-standing Enlightenment-humanist privileging of reason and of abstraction;
2. a technology of abstract symbol manipulation that has become broadly influential; and
3. a neoliberal educational agenda that slashes 'soft' or 'applied' aspects of learning, because they are expensive, under a smokescreen of the valorization of STEM (Science, Technology, Engineering and Mathematics).

This scenario should be of immediate concern to artists, artisans, craftspeople, and makers of all kinds, as well as to educators and proprietors of educational institutions, not simply because refined and complex sensorimotor capabilities are demonstrably positive qualities for humans to have, but because, according to contemporary theories of cognition, capabilities traditionally understood as 'mental' are taken to be based in bodily experience.

Developmental psychophysiology

It is a bald historical fact is that thirty years ago, and for the entire prior history of the human race - except in rarefied

laboratory contexts - screen-based interactivity simply did not exist (and there only sixty years). It's probably not necessary (in this community) to remind ourselves of the growing evidence of social and cognitive deficits induced by digital technologies, especially when overused in early childhood. Anyone with a basic grounding in developmental psychology, or anyone who has a child, understands the hard and extensive work an infant does in order to integrate their senses and their physiology and to understand the world of space and mass and light and gravity. As we know from the famous *kittens in baskets* experiment of Hein and Held, an infant remains functionally blind unless - at a critical time in neural development - it calibrates its visual system through bodily movement. Proprioception and kinesthesia are the source for knowing ourselves and the world, and these senses bring vision and hearing 'into focus'.

The kinds of hands-on making and play that were more or less the entirety of childhood experience in the past have been substantially replaced by screen-based activities. An assessment of the general impact of this is overdue. If you'll pardon the scatological pun, the *interfaeces* are hitting the fan. As long ago as the mid 1990s, German insurance companies were running free summer camps for kids so they could scrape their knees, fall off bicycles and burn their fingers in candle flames. Why? In their overmediated lives, these children had not learned the true consequences of accidents, and it was costing the insurance companies money. So much money that it was a cost saving to offer free summer camps.

In a recent article in the Guardian entitled "*Medical students raised on screens lack skills for surgery"*, Roger Kneebone, a professor of surgical education at Imperial College London, lamented that his students often do not have a basic understanding of the physical world. He insightfully notes: "*We are talking about the ability to do things with your hands, with tools, cutting things out and putting things together … which is really important in order to do the right thing either with operations, or with experiments. You need to understand how hard you can pull things before you do damage to them or how quickly you can do things with them before they change in some way."[1]*

A recent study shows that childhood and adolescent myopia rates have risen alarmingly in the last 15-20 years. "*Another remarkable change shown by our survey was that the proportion of high myopia (7.9% to 16.6%), especially very high myopia (0.08% to 0.92%) significantly increased during a 15-year period*." The authors continue: "*The etiology of myopia still remains unclear. However, genetic and environmental factors are widely believed to play an important role. Near work is one of the important environmental factors."[2]*

The impact of these changes, and the specificity of the time period, is not lost on public health personnel. And it stands to reason. If visual, neuro-optical and visuomotor capabilities are developed through active practice in childhood, and if a child's visual focus is largely on a flat perpendicular illuminated surface 40 cm from their face; then clearly, visual capacities that involve focusing on the horizon, rapidly changing focal distance, rapidly changing location of visual attention in the visual field, or attending to events in peripheral vision, or in low or high light conditions - simply will not develop. If manual activities are reduced to slapping a screen or poking a button, all manner of sensorimotor acuities and capabilities will fail to develop. Moreover, understandings of materiality and fundamental physics will be absent or erroneous.

The Right to Maim

In her recent book *The Right to Maim*, Jasibir Puar observed that "*Debility is thus a crucial complication of the neoliberal transit of Disability rights."[3]* She explains her use of the term: "*Debility addresses injury and bodily exclusion that are endemic rather than epidemic or exceptional, and reflects a need for rethinking overarching structures of working, schooling, and living rather than relying on rights frames to provide accommodationist solutions*." [ibid p2] She goes on to observe: "*Technological platforms—new media, prosthetic technologies, biomedical enhancements—mediate bodily comportments, affects, and what is recognized as bodily capacity and bodily debility. Technology acts both as a machine of debility and capacity and as portals of affective openings and closures*." [ibid p3] Without trivializing her important work, I think it is not inappropriate to borrow her terminology to describe my current subject. She goes on, pointedly to assert "*Capacity and debility are, on the one hand, seeming opposites generated by increasingly demanding neoliberal formulations of health, agency, and choice—what I call a liberal eugenics of lifestyle programming—that produce, along with biotechnologies and bioinformatics, population aggregates*." She asks "*Which bodies are made to pay for "progress"?"* [ibid p13] and appropriately, she puts 'progress' in quotes. It is entirely pertinent for us to consider the bodies that pay for that 'progress', in what ways those bodies pay, and who profits. These bodies include factory workers in Shenzen, Amazon warehouse staff, and students in schools.

Post-corporeal pedagogy and practice.

It is incumbent on this community, I believe, to consider the ramifications of this new, general condition of sensorimotor debility – for the arts, for pedagogy, for cognition, and for the general ability to succeed in the world. Some may argue that skills of map reading, like mental arithmetic, are just redundant in our technological context. Clearly as we adapt to new technologies, our capabilities and skills change. But there is a fine and obscure line to be drawn between technology-specific skills - like using an abacus or a slide rule or read a clock face - and the loss of cognitively fundamental understandings which undergird not simply bodily skills but our ability to form intuitions and utilise concepts and

metaphors. Where does this sensorimotor disability come from? In my opinion the cause is an unfortunate combination of two trends:

- the general phenomenon of the digital, and in particular the overexposure of children, from a young age, to touch screens, graphical interfaces and the false physics of animation and games.
- The neo-liberal rationalization of schooling, focusing on STEM learning, and the increasingly academic and abstract tone of education in general and the concomitant elimination of art and vocational classes and facilities (woodshop, art classes, sewing, cooking, etc)

This combination has created a generation for whom the minimising of lived experience of material engagement has resulted in shortcomings in embodied cognition and basic 'common sense'. Sensorimotor competence has traditionally been taken for granted in pedagogical planning as part of the formation of students. In the academy, numerical and text-based scholarship continues to be the focus. Such activities assume embodied competence and leverage concepts and intuitions that, traditionally, have come as part of the student package. Today these abilities are measurably less often present, but curriculum designers appear not to have noticed. (It is worth noting that professionals 'in the know' in places like Silicon Valley, are increasingly sending their kids to screen-free schools and encouraging diverse embodied activities). There is a deep irony to the fact that it was precisely a shortage of this kind of 'common sense' that caused first generation symbolic AI to come crashing down in the late 1980s (amid phenomenologically inflected critiques by Hubert Dreyfus, Stevan Harnad, Lucy Suchman, Terry Winnograd and others.)

In my experience of teaching sensorimotor skill-based practices for 30 years, this change is glaring. While I have no hard data, it is my firm conviction that over this period, student's general familiarity with manipulating matter has declined precipitously. This is consistent with the observation of Roger Kneebone and other specialists in diverse fields. In the last four years, I have personally mentored over 60 students from my university in hands-on building projects. Most of these students are from the school of engineering and most in mechanical engineering. This work involves diverse materials and tools, simple design and precise measurement. I have often been alarmed by a lack of familiarity with procedures involving hand tools and basic materials. To these students, simple procedures like marking divisions along a straight line using a ruler, using a plumb line to establish verticality or a compass to draw a circular arc, seem arcane or incomprehensible.

These students are quite unfamiliar with activities in which precise movement and application of carefully judged force occur simultaneously (like holding a screwdriver forcefully against the head of a screw while applying a rotating force to the tool and thus the screw). This kind of skill is ubiquitous in making, yet the majority of these students appear unfamiliar with this general capacity for effective action in the world. While compasses and calipers and scales, mallets and chisels and handsaws seem quaintly old fashioned to these students, there is a deeper and more troubling issue of significance to general cognitive capability. In addition to pragmatic skills, embodied experience not only provides the basis for a common-sense understanding of materials and terrestrial physics that informs design decision making (for instance, in the construction of bridge), but embodied experience provides a major source for metaphors and concepts applied in more abstract thinking. (Johnson, Lakoff, Lakoff and Johnson, Lakoff and Gallese, et al).

This a lack of experience in embodied artisanal practices (broadly conceived), combined with overexposure to digital tools that are designed to preclude the necessity for fine neuromuscular judgement (in the interests of being 'user friendly' and 'intuitive') is generating sensorimotor debility. (As a corollary, I have noted that students who have some native sensitivity to tasks involving sensorimotor judgement and force often have training in traditional musicianship (playing guitar, violin or piano etc) where an understanding of how to modulate manual force is critical.)

A perfect storm

Most of us appreciate the convenience of navigation with Google maps or shopping on Amazon. These applications are popular because they make complex tasks simpler, they deliver a success experience, and that's why we like them. By the logic of the market, this is why they survive and are profitable, while apps with clunky interfaces rapidly go extinct. Pedagogical software - being largely marketed by companies operating in similar commercial contexts to other consumer software development – is designed according to the same logic. Software is conceived around the premise that the 'customer' - in this case students - *expect* a success experience, and if it is to be economically successful, the software will deliver it. There appears to have been little consideration of whether such rationalisations are appropriate in 'educational' software. Education is by definition - and should be - inherently difficult. The process of failing, recognizing the reason for failure, then repeating the action and achieving success is fundamental to learning. In order to remain commercially profitable, pedagogical software continually delivers a success experience. This can't be good, personally, professionally, for educational institutions or for society and economy at large.

The exigencies of neoliberal education often call for constraint of context in order to deliver the 'lesson' defined by the syllabus with surgical precision, unencumbered by tedious setup processes. As such, fundamental aspects of acting in the world are abstracted away. For instance, in an engineering design package like Solidworks, an environment of perfect Euclidean geometry is simply given. Planes are perfectly flat, infinitely thin and precisely perpendicular.

Dimensions and angles are automatically available. It is not necessary to know how to make measurements! This is more than simply deskilling, it gives students a falsely inflated sense of their own ability. A related way that these packages deliver a success experience is by making automatic fixes to user errors, hidden 'behind the scene' or in this case, behind the GUI. Taking the map for the territory (Borges) is a fundamental danger here. *Any software simulation is a model, and a model is by definition a simplification and a rule-based abstraction*. Students become adept at manipulating these abstracted environments, but there remain questions regarding the transferability of these skills of abstract manipulation to the real world. Here neoliberal education policy duplicates the phenomenon of the 'toy problem' that was the stock in trade of first-generation AI research. According to Brooks, Agre and others, the use of highly constrained environments in which to test systems not ready for real world applications was seen as a contributing factor in the demise of those methods.

Conclusion

In Western cultures, the notion that there is a distinction between mind work and body work is deeply entrenched, philosophically rooted in the Cartesian mind/body dualism. The skill/intelligence distinction is a corollary and is similarly *axiomatic* and ideological. The (false) distinction between skill and intelligence has directed the development of technologies (and specifically technologies that are deemed 'cognitive'), along paths that seek to minimize bodily engagement, dexterity, and physical effort. The rise of 'information technologies' – themselves rooted in dualistic notions – has compounded the problem.

The long-standing Enlightenment-humanist privileging of reason and of abstraction, combined with the emergence of a technology of abstract symbol manipulation, and a neoliberal educational agenda that slashes 'soft' or 'applied' aspects of learning (because they are expensive), under the smokescreen of valorizing STEM when they are actually valorizing abstract symbol manipulation, have created a perfect storm for sensorimotor competence.

This scenario should be of immediate concern to artists, artisans, craftspeople, and makers of all kinds, as well as to educators and proprietors of educational institutions, not simply because hand-eye coordination and refined sensorimotor capabilities are demonstrably positive qualities for humans to have, but because, according to contemporary theories of cognition, capabilities traditionally understood as 'mental' are understood to be based in bodily experience. There is an urgent need to examine and critique computer tools and software interfaces in terms of their sensorimotor qualities.

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Odorama V2: Prototyping Touch-Smell Synesthesia to Promote Neurocognitive Empathy

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Abstract

Perception is not objective, uniform, or universal. Indeed, as we know from those with the synesthesia—a neurological condition where one sense will automatically trigger another—sensory perceptions of the world vary greatly among individuals. This opens the door to questions about which aspects of our "realities" are shared, and about individual vs collective sensory experiences of the world. Like any persons who exhibit a difference, synesthetes are often misunderstood or excluded by others. This concern was the starting point for the *Odorama V2* prototype that we created and that is presented here. Using an Arduino microcontroller, we aimed to simulate a synesthetic experience as a way to promote empathy for neurodiverse perceptions of the world. Specifically, the goal was to produce a prototype that could simulate touch-smell synesthesia, and in this process, provide a reflection on the synesthetic experience, on the senses of smell and touch and, unexpectedly, the limitations of "maker" culture. Finally, we assess how the making of the prototype in itself raised awareness of synesthesia and neurodiversity, confirming the importance of community and process in research-creation methodologies.

Keywords

Research-creation; Synesthesia; Perception; Inclusion; Prototype; Media; Mediation; Neurodiversity; DIY; Making; Arduino

Introduction

Synesthesia is a benign neurological condition in which subjects experience an automatic, involuntary, and idiosyncratic cross-activation of the senses whereby the information from one sensory modality (e.g. sight) triggers a response from another (e.g. smell). This condition is estimated to be present in at least 4% of the population. [1] Dozens of forms of synesthesia exist, and their expression varies from one individual to the next. [2] Touch-smell synesthesia affects around 0.35% of the synesthetes population. [3] It induces olfactory perceptions according to textures and other tactile sensations.

Synesthesia impacts the day-to-day lives of synesthetes, as it affects the way they perceive and feel their environment. Since it is a form of divergent neurocognitive development [4], it can be considered through the lens of neurodiversity rather than disability or pathology. Like many sensory experiences, it is difficult to express its exact manifestation with language and synesthetes have a particularly difficult time explaining how they sense and perceive the world to others. This can lead to feelings of exclusion. [3] [5] One way to better understand how synesthetes perceive the world, and ultimately to facilitate their inclusion, is through experiences that generate understanding and empathy. [6] This can be done, for example, by recreating the synesthetes way of perceiving the world through physically engaging media, artworks, and exhibitions. [7]

With this in mind, this project imagines an artistic experience that would allow participants to physically experience the reality of touch-smell synesthesia. The first goal was to build a device capable of creating a connection between touch and smell, as none so-far exists. Drawing on the methods and principles of DIY and maker culture, this research-creation project[1] resulted in an Arduino-based prototype capable of mediating the sensitive and perceptive phenomenon of touch-smell synesthesia. This paper grounds the work first by providing a discussion of synesthesia, of the characteristics of the senses of smell and touch, and of atypical sensory perception as leading to feelings of misunderstanding and exclusion. It then explains the making of the prototype *Odorama V2*, a device meant to trigger smells through touch. Finally, it elaborates an analysis that pinpoints some of the limitations of the "maker" ideology in creating technological artifacts. Finally, the paper concludes with a note on the role that such a research-creation project can play in raising public awareness of synesthesia specifically, and neurodiversity more broadly.

Touch-Smell Synesthesia

Synesthesia is a highly subjective phenomenon. It concerns the way a person perceives reality and consists of the simultaneous association of two or more senses. Many people can

[1] It was produced as G. Piguet's Master's thesis project, supervised by A. Kaminska.

experience the same form of synesthesia but do so in different ways.

According to the father of synesthesia Richard Cytowic [8], the characteristics of synesthesia are:

- Synesthesia is involuntary and automatic. Synesthetes do not control when and how their synesthesia will occur;
- Synesthetic perceptions take place all around those concerned, in the entirety of their personal space;
- Synesthetic perceptions are consistent and generic;
- Synesthesia is memorable: those affected are conscious that it is occurring and remember their perceptions;
- Synesthesia is not linguistic, and in certain ways it is ineffable. It is difficult for synesthetes to describe what they are living.

The exact number of synesthetic forms is unclear and varies from one source to another. On his personal site, Sean Day outlines 73 different types, while Cytowic and Eagleman estimate that there are between 60 and 150 types of synesthetic forms. [9] Potentially, any imaginable configuration of synesthesia should be possible. [10]

If the causes of synesthesia are not yet quite known, it has nevertheless been proven that though it is a phenomenon of altered perception, this is not due to a malfunction of the sensory system. Indeed, the sensory organs of synesthetes function well. It is in the treatment of perceived information by the senses that differences occur. This however is not due to a difference in cerebral structure but rather linked to its functioning.

The specific case of smell-touch synesthesia is very rare, representing only 0.35% of synesthetic cases [3], and to our knowledge there are no systematic or dedicated studies of this type of synesthesia so far. However, in the course of our research we came across two direct references to this particular experience. The first is in a medical dissertation on olfactory hallucinations in schizophrenics. In the course of his analysis, the author introduces the notion of a tactile-olfactive synesthesia, suggesting the possibility that olfactory hallucinations are linked to the sensation of air penetrating the nostril. In such a scenario, it would be "the caress of the air in the nasal mucous membranes that directedly activates the olfactory sensation." [11] The second is a description of tactile-smell synesthesia by a synesthete, the perfumer Dawn Spencer Hurwitz: "When I smell smells, I see colors and shapes, and I feel textures. And it goes both ways. So a lot of times, I can see a color or feel a texture and start to get a smell. So I can start to develop a perfume in my brain just from that sensation." [12] Undoubtedly, there are more synesthetes who share her condition.

It is worth expanding briefly on the senses of touch and smell. Touch has an ambiguous reputation, namely due to its sensual connotations. However, it is regularly considered as a primordial sense for animals. Already in 1551 Conrad Gessner proposed in his zoological encyclopedia *Historia Animalium* that what distinguishes a sponge from a plant is its capacity to touch. Similarly, for Richard Sorabji an organism is incapable of developing other senses if it has not developed touch. [13] Overall then, "touch is acknowledged not only as indispensable" [14], "but as prior to the other sensory modalities." [15] The philosopher Edmund Husserl also recognized that touch has a fundamental place in the constitution of a being, proposing that a person constituted themself "through the *localization* of sensations in [their body] and on it, for which touch (bound with kinesthesis) is of particular importance." [16] This importance of touch is moreover recognized in childhood development: "touch can be a primary (unlearned) reinforcer, and as a goal for action, is one of the foundations of emotion and motivation." [17]

According to Mark Paterson, what we currently describe as touch is limited to the aspect of touch tied to "cutaneous sensations." [18] Yet, touch incudes other inner senses such as proprioception, which he defines as "the body's position felt as a muscular tension"; kinaesthesia, which is the "consciousness of the movement through the muscular effort"; and equilibrioperception which he names the "vestibular sense," or the sense of balance. [18] Despite this variety within the sense of touch, in this research we focused on textures, and therefore on the tactility associated with sensing through skin. Moreover, while we are continuously passively receiving tactile information and stimulus through our entire body, the hand is often conceived as the part of the body especially associated with the exploration and understanding of the physical world. [19] The skin of the hand is therefore perceived as the means to having an active touch. [20]

Smell also has a number of particularities. Millions of smell receptors coat the inside of our noses and, unlike receptors for sight and sound—which are respectively located behind the cornea and the eardrum—they are directly in contact with the environment. [21] Interestingly, only the nerves in the nose can regenerate themselves in case of an accident. These nasal receptors are able to sense thousands of informational data at once. Each smell, even the most common like chocolate or a rose, is composed of between four and six thousand molecules [22], and we are capable of distinguishing at least three thousand with each inspiration. [23]

While the processes involved in perceived smell with our mucous membranes are well documented, the treatment of this information by the brain is still unclear: "Exactly how this process triggers the reaction it does and how brain synthesizes that information into a coherent smell-picture remains a source of complex debate." [24] Smells are known for provoking subconscious emotional responses; however, while we can remember a large number of smells, we are only conscious of these in the steps of encoding and of recognition. [25] In his article "Odor Memory," Gesualdo Zucco offers some reasons for why this is the case. Three of these are of particular interest here: the maximum retention rate of an olfactory smell (it is more difficult to forget smell than an image or word); a resistance to retroactive interferences (the first memories of a smell remain those that are remembered even while the individual might be exposed to

the smells in new contexts later in life); and the acquisition of olfactory smell as independent of the intentions of the person (we register smells even while not explicitly choosing to do so). [26] These characteristics, which highlight the tenacity of olfactory memories, help to explain the specificities of the sense of smell.

Synesthesia and Feelings of Exclusion

Everything that we experience, perceive, and sense becomes inscribed in us. Whether conscious of this recording or not, we are constantly storing information about our surrounding environment and the way it is affecting us. We also feel that very human need of sharing and communicating with others, of projecting outwardly our experiences, in the hopes of building affective bonds and relationships. [27] To do so we must rely on language, an "oral expressive system, which is particular to each human community" [28], and that involves all the many dimensions of the individual as a particular coming together of body, intellect, and emotion.

Using language to describe perception is already difficult and complicated, and this is particularly the case when we try to describe how we perceive through smell: "Odors have no description in natural sciences that can give any 'measurement' to the presented stimuli." [29] Sissel Toolas, an artist specialized in olfactory art and a multilinguist speaking nine languages, affirms that there is no language that perfectly describes smells. [30] In fact, when we describe a smell, we always do so by comparing it to something that exists in a different form. For example, we can declare that something is "red," but we have to say that something smells "like a lemon" or "like a rose." We don't tend to think of colours in this way, of "being like" a tomato, or a strawberry, in order to signify its redness.

The synesthetic experience is even more difficult to describe. Despite the tests mentioned above, none are "yet capable to objectify the individual experience of synesthesia" [31]: not any consistency in the association, not MRIs (magnetic resonance imaging), nor any other processes used, are able to explicit the particularity of the phenomenon for each person with the condition. Synesthesia is thus an excellent example of how each brain filters the world in its own unique way. [32] This profound subjectivity of synesthesia is at the heart of this research.

Despite these individual differences in perception, we humans still tend to assume that the environment is sensed in the same way by everyone. Sean Day writes on the subject that humans take for granted that what each of us sees, hears, tastes, smells, and otherwise perceived is very much like that of the next person. Especially at a sensory level, most of us believe that our realities are pretty much the same. [33] Yet we also know that it often difficult to explain how we sense, and that this would be all the more so if our sensory experiences were different than most. Synesthetes can thus feel and become alienated and excluded, unable to fully share their experience of the world. As one of the synesthete notes on the Synesthesia List forum: "When I was first diagnosed with it, no one in my family really understood it and some even didn't accept it. I was told not to talk about it and to just keep it a secret." [34]

This difficulty in being understood is in part the result of the limitations of language, which is the primary mediator of the synesthetic experience. Another difficulty is that, while growing, research on and recognition of this condition is still limited: while barely over twenty articles were published between 1850 and 1990, there were 80 in the 2000s. [35] The small amount of research has meant that synesthesia is often misunderstood, caricatured, described in generalities, and suffers from a lack of visibility in popular culture and mass media. This has made it particularly difficult to raise awareness and empathy towards the condition.

Inclusion through Empathy

Empathy has been defined as "a complex form of psychological inference that enables us to understand the personal experiences of another person through cognitive, evaluative and affective processes." [36] As a concept it emerged in 19th century Germany through the term *Einfühlung.* This entwined synesthesia with either a sense of connecting and being affected, by nature or by art. [37][38] With time, and thanks to the work of the philosopher Theodor Lipps, empathy evolved to mean the capacity to think progressively, namely by being able to feels as others do. [39] These days the term refers to a capacity to put yourself in someone else's place. [39] The turning point for the recognition of empathy as an important concept was the discovery in the 1990s, by the Italian scholar Giacomo Rizzolatti, of the existence of mirror neurons, a type of neuron that is activated when a subject performs an action but also when the subject is merely watching someone else doing the action. [40] These neurons appear to be the foundation of our capacity to feel and understand emotions lived by the other, and also of our ability to be "touched" by art. [40]

It is important to specify that neurological responses do differ, based on whether we are an actor or an observer. When we are implicated in an action, our neurons react more quickly [39] and more intensely. [41] This is one reason why creating an interactive art experience with the prototype is a significant ambition of the project. As Patricia Leavy notes, "by connecting people on emotional and visceral levels, artistic forms of representation facilitate empathy which is a necessary precondition for challenging harmful stereotypes." [42] Louise Poissant makes a similar claim by noting that involving the body of the visitor through an action is "to bet on him being more profoundly touched and moved if he is involved and physically compromised." [43] The more a spectator intervenes as an actor, the more he becomes affected by the experience. Artistic experiences can also force visitors to call into question their perceptions [44]: "The

dispositif attacks the evidence, the reality of the visitor, thus forcing him to redefine his perceptions." [45]

The "Minor" Senses of Smell and Touch

Human expression is mediated, and the sharing of experience requires an intermediary. How then is it possible to share one's subjectivity without going through a physical medium that translates the intangibility of perception, feeling, and sensation? A common and generally accessible way we do this is with language. However, there exists a number of other ways of communicating, other ways of "translating one kind of knowledge into another," where "translation is thus a 'spelling-out" of forms of knowing." [46] The knowledge of the world that we gain is thus also always mediated by the body and is constituted by what we hear, touch, feel et taste. [47] Indeed, as Caroline Jones has stated, "our bodies do not allow us to 'escape' from technological mediation – they are themselves mediating apparatus, without which there can be no knowledge of the world." [48]

Technological devices that use smell and touch as expressive tools are inevitably products of the relationship Western societies have with those senses. In general, focusing on these senses can be read as a gesture of defiance, since they have received less attention than the "superior" senses of vision and sound. Indeed, David Howes and Constance Classen suggest that, in the case of touch, this rejection is related to the sensuality of touch, as well as to its intimate and reciprocal quality: "when we touch someone that person feels our touch." After all, touching is also to be touched so that a tactile contact affirms the existence of both the touched and the touching. Moreover, research has shown that touch is an important, if not vital, element of a person's well-being and self-esteem.

In the art context, art has become increasingly difficult to touch since the Protestant reformations of the 16th century. Touch became taboo in more ways than one, and any physical contact between believers and their idols was abolished in favour of a devotion from afar. This trend continued, so that art has progressively devalued touch, favouring experiences that create a distance between the viewer and the artwork. Art became something to look at and admire from far, leaving the spectator at a (real and symbolic) removed. [51]

Smell has also been devalued since Greek Antiquity. Alain Corbin makes this point clearly: "The disqualification of smell, as the sense of animality according to Buffon, was excluded by Kant from the esthetic domain, considered later by physiologists as merely evolutionary residue, consigned by Freud to the anal, shutting down the possibility of an olfactory discourse." [52] Thus, in terms of creative production, smell is also a sense that has been underexplored, other than in the realm of perfumes. Perfumery, which consists in developing pleasant smells, has however never reached the status of a "High Art" even though it does play a significant social role. Thus, olfactory sensing has been perceived as too fleeting to be easily described, associated with a "primal" nature of the human. [53] Yet, since the Enlightenment Western society has favoured a notion of progress in which humanity undoes its ties to the primitive and the animal, separating itself at the same time from the world of smells, associated with such basic states like fear, danger, and desire. [54] This negative association with smell has reduced our tolerance of smells, so much so that we now live in environments that are largely odorless. Historians of smell place the start of this progressive "de-odorization" in the 18th and 19th centuries. This repression confirmed smell's status as a second fiddle sense, so that, for example, it is not part of the school curriculum: while kids learn early on how to distinguish and name colours, or to read and write musical notes, they do not learn how understand or describe what their olfactory experiences. For the most part, the relationship to smell in our Western societies seems to reside in the creation of "appreciable" smells to mask those that are judged to be offensive.

Smell technologies—what today is called "digital scent technology"—is characterized by its complexity in part because mediating smell requires three different steps: 1) sensing and recording the smell, or creating it from chemical components; 2) preserving the smell in a way that is stable; and 3) diffusing the smell in space and time. Artists have been working with these aspects in various ways. For instance, the German choreographer Pina Bausch was already in 1982 diffusing the smell of meat among the spectators to her show *Nelken*, while the British national Opera produced a show called *For Three Oranges* where each spectator would receive a scratch'n'sniff cards to use during the performance. [55]

Technologies of touch are more developed than those dealing with smell, but these also have their limitation. For example, the touchscreens on our mobile phones are capable of generating a force feedback effect (which simulate resistance), but not of producing imitations of tactile sensations. [18] Therefore, what we call touchscreens in reality are not yet quite so: they provide a way of interacting with the vibrating glass screen, but not of texturally transforming the screen itself. This could be soon be changing as start-ups are working on such prototypes [56] so that, for example, a user could soon be able to physically feel the texture of an item of clothing they want to buy online. This new technology relies on the use of ultrasounds "provoked by a friction between the finger and the screen meant to create this sensation with the assistance of particular frequencies." [57]

"Making" and Prototyping Touch-Smell Synesthesia

Since our goal was to create a device that could simulate smell-touch synesthesia, we would need to take into account the different ways that touch is perceived (which parts of the body are involved, what is the duration required to provoke a synesthetic experience, etc.) and the ways smell becomes

triggered by touch (what kinds of smells are experienced, how long do they last, etc.). Based on the literature on synesthetic experiences, including the very limited scientific literature on the touch-smell variety, as well as information gathered from a listserv about synesthesia, we were able to identify a few different trends that would help in the development of a prototype.

A prototype can be understood as a kind of "making" that engages in the reimagination of the physical and mediated world, but also as that which allows us to develop a kind of knowledge that would be otherwise out of reach. More specifically, prototyping can be an example of "critical making," which abides by the philosophy that "making is the most powerful way that we solve problems, express ideas and shape our world." [58] This faith in making reflects the values of what has been described as the "maker movement," a problematic if useful set of practices and networks that served as a backdrop to this project. In our case, the prototype-as-making was always a way to engage critically with the neurotypical ways that perception is understood and lived.

In order to act as an extension or amplification of our senses, the prototype of the mediating device would have to in some manner simulate the senses it aimed to reproduce—touch and smell in our case—and mimic the sensory experience these engender. The objective was to produce an intuitive set-up so that participants could easily understand how to use the device, and rapidly see its potential.

Importantly, a prototype never exists in a vacuum. Rather, it "represents in its form and content the actual results of the research." [59] In this way, "ideas and approaches for practical solutions become manifest in prototypes. They enable us to consider and test them as well as to communicate about them. Prototypes inspire new ideas, demonstrate problems and let us test solutions." [60]

Each person using a medium has to learn to use it in an intuitive way, even while our senses are extremely complex systems. Each sensory organ is the potential actor of many actions. As has noted Louise Poissant, "research on prostheses, wherever it might be at the moment, has revealed the complexity of the functions of the eye, the hands, teeth, etc." [61] Indeed, in the ambition to create technologies capable of reconstituting the missing senses, researchers have found themselves confronted with the speed at which sensing happens: in a fraction of a second each of our sensory organs is independently and at once actively perceiving the world. Synesthesia, in which the perceptions of two senses are entwined together, complicates matters even further.

Creating the *Odorama V2* prototype was technically challenging, primarily due to our limited technical experience. Through the cycles of trial-and-error, the device would evolve in fits and starts as part of an iterative and collaborative process. This was important in a context where we were trying to create the prototype for a machine capable of doing something that had never been done before. We had an idea, and we would see how it developed over the course of its physical realization, or a how a concept could be pushed and tested as it was translated into forms and experiences.

We started by looking in specialized forums for similar making projects that were open source. The idea to find a template that could then be adapted for our own project. Unfortunately, this shortcut did not quite work out as anticipated, setting the stage for a series of experiments and failures. These failures would turn out be an important aspect of this project: we would search for answers as to why certain things did not work and spend a considerable part of our time analysing our failures to try and to understand the reasons behind them. Occasionally we also turned to experts who could help clarify and advise. What emerged from the process was a set of specifications for our prototype that would anchor how the device should work. These include: low production cost; accessibility of materials; potential for reproducibility; compact, portable, and meant for individual use; automatic; inoffensive.

We conceived of our device as allowing participants to immerse themselves in an experience, and in which they would not need to *a priori* understand its intended objectives in order to live an interesting moment of "other-ly" sensory perception. As much as possible we wanted for the device itself to be forgotten. We also started to imagine the ideal scenario for this experience as one where participants could walk around a space, individually exploring different textures that would activate different touch-smell scenarios. All of this would happen quickly since the synesthetic experience occurs, as we noted, in the instant. Based on these preliminary criteria was born *Odorama V2*, a prototype with two parts that speak to each other, one part fixed and the other mobile. The mobile component was to be the box of smells carried by the participant, while the fixed element was the touching station that tracked the movement of the hand to connect a given texture with a particular smell (Figures 1 and 2). The internal mechanism of this system included two distinct elements: the electric circuit that united the different physical pieces, and the informatic code that assured that hand movements triggered smells.

One of our main challenges was connecting the Arduinos that were used in the mobile box with the fixed stations. The different components communicate on the electromagnetic spectrum at 433 Mhz, and the detection of movement happens thanks to ultrasonic sensors. In order to create the impression of automation between the action of touching and the diffusion of smells, the ventilator is activated through movement, even before the texture has been touched. This brief interval (which had to be tested to determine how long the ventilator had to run before a smell could be perceived) assured there was a bit of extra time for the smell to travel, ultimately helping to create the illusion of instantaneity between the two sensory perceptions.

A characteristic of perfume and smells in general is that they travel and are volatile. Therefore, managing and controlling the spread of the smells is another challenge that would need to be considered if the prototypes were ever

exhibited and experimented with in a gallery-type venue. If the goal was for many participants to each have their own device as they walked about such a space, smells emitted from the devices had to have a small range, ideally just perceptible by the participant actively engaged in touching the corresponding texture. It was important that the different smells did not cross-contaminate. To address this, we contained and condensed the smells by enclosing them hermetically in individual boxes.

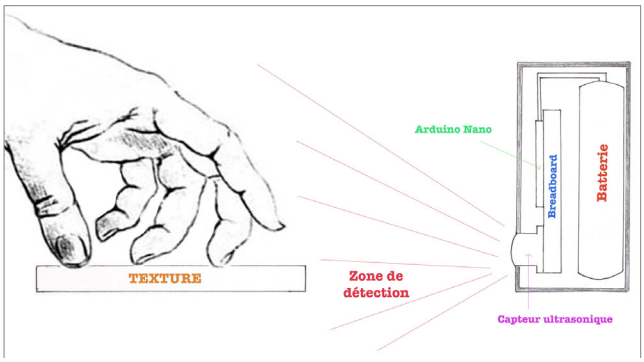

Figure 1. Diagram of the fixed part of the *Odorama V2* prototype.

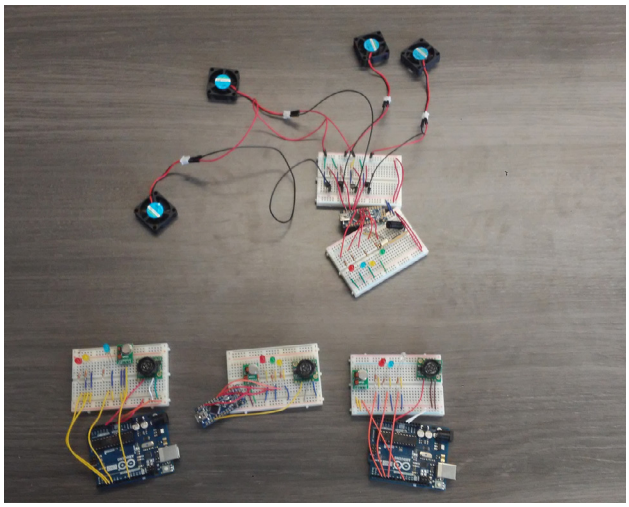

Figure 2. Final internal mechanisms of the *Odorama* V2 prototype. At top, the fixed station with four different fans reacting to the three mobiles devices. At bottom, the three internal mechanisms of the mobile devices.

Learning from *Odorama V2*

Many questions and lessons emerged in the making of *Odorama V2*. These were technical as well as conceptual. Three of these are particularly worth noting here in terms of: the grip of language in the production of a programmed experience; the way that prototyping itself as a process encouraged a more expanded appreciation of the synesthetic experience than we initially anticipated; and the way that the project was both an education on synesthesia as well as on maker culture.

Without a serious background in computing languages, a significant challenge in realizing the *Odoroma V2* prototype was in programming the Arduinos. This language barrier was a reminder of the cleavage that is formed between those who speak and write programming languages and those who do not. Like any language, that used in computing imposes rules and restrictions, so that coding becomes a translator for the imagination of the maker.

Learning to programme ideas means they must be translated and reduced into "computational thinking" [62], with commands like "if/then" or "repeat/while" structuring the code. This logic relies on a number of principles: abstraction, generalisation, a system of representation, a conditional logic, modularisation of data, and a way of thinking that is systematic and iterative. [64] Together these produces a reality that can be processed by the machine, in effect also influencing the way people experience the real.

The *Odorama V2* prototype required that we learn its language and that we submit to its logic in order to extract ourselves from that which we already knew. Constraints were shifted but not erased. Indeed, while the project hoped to produce an empathetic experience outside and beyond the structures of language, we kept being confronted by the challenges of programming. It is perhaps ironic to notice that the way we can programme and communicate with a machine in turn affects the way we make the world sensible; language becomes the way we provoke a condition, and a perception of the world.

These programming challenges are in part why *Odorama V2* is still a work-in-progress rather than a fully-fledged reproducible system. In this process however lies much of the value we gained from trying to design a synesthetic experience. Indeed, since our starting point was an interest in the sensory differences based on atypical neurocognitive processing, we had to develop a more substantial understanding of this condition in order to design, implement, and programme it as an adequate system and an automated experience. For one, it was impossible to produce a system that altered perceptions without thinking of how this might affect the everyday life of synesthetes (isolation, impact of social and private life, repercussions on other cognitive domains such as attention, life choices, etc.). Moreover, the more we understood the particularities of touch-smell synesthesia, the more we realized how difficult it would be to fully comprehend the extend of the synesthete's reality through a technological *dispositif*. It seems to us that, for now, with the tools at our disposal, we can only create a poor simulation of this phenomenon. And since, as mentioned, synesthetes usually live with more than one variety of synesthesia, we are still a long way from being able to convincingly technologically simulate this neurocognitive condition.

Ultimately, *Odorama V2* is as much a study of synesthesia as it is an example of prototyping as research-creation, while also being an inadvertent study of "maker culture." In

our many interactions with people that were helping us to *make*, we were in turn continuously providing education on synesthesia as a neurocognitive phenomenon, and on neurodiversity in general. This is perhaps one of the most positive elements of the making process, and one where the ideology of sharing and exchange [63] lived up to its expectations. However, in other ways *Odorama V2* showed us the limits of "maker culture," particularly regarding its lack of diversity. Notably, few women were present in the hackerspaces and fablabs we visited, and we also noticed the lack of involvement of neuroatypical persons or people with specific needs in those spaces. [65] This was for us a real "moral dilemma" as it paradoxically defied our objective of promoting inclusive experiences and practices.

Conclusion

Odorama V2 is an attempt to simulate smell-touch synesthesia through a mediating device. The underlying goal is to find ways to create sensory and perceptive experiences that help us see the world as others do, and in so doing develop more empathetic perspectives towards the other. There is much that could still be done with this prototype. Namely, its full realisation in an exhibition space, along with feedback from participants. More research still needs to be done on alternate ways of sensing the world. The synesthetic experience is just one way to prompt us to perceive the world in ways that are atypical, and to explore the potential of technological mediation as a way to simulate, learn about, and ultimately empathise with atypical neurocognition.

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Art and the Broken Mirror:
A technogenetic perspective on digitally expanded realities

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Abstract

This paper examines how experiences with digitally expanded realities – familiar as virtual, augmented, mixed, and other modes of mediated reality – are tendentially designed to convince us of their 'reality' by smoothly integrating with our cultural habits and neurosensory systems, by mirroring our expectations, intuitions, and neuronal patterns. The leitmotif of the paper is the 'mirror' as a both figure and metaphor in negotiations of human relations to reality. I particularly problematize the mirror's recent recurrence as a productive, mimetic motif in neurosensory-based design that cues perception to mutate in reflection of cultural and neurosensory pathways we already know. I approach this from a technogenetic perspective with reference to the works of N. Katherine Hayles, Catherine Malabou, and Bernard Stiegler. The technogenetic perspective concerns how we change with technology and involves an attention to emotional-biological implications of experience. This perspective leads us to deal with perception as a construct of cultural as well as cognitive and neurologically complex natures and patterns, cuing our ongoing and potentially fatal negotiations between real and artificial, truth and fiction. I propose that, instead of reproducing the mimetic mirror motif, art can pursue an alternative, 'broken' mirror motif. This continues ideas put forth by the avant-garde artists concerned with perceptual instabilities but engages more deeply with the technologically challenged natures and patterns of perceptual experience today.

Keywords

Technogenesis, art, perception, digitally expanded reality, mirror motif, mirror neurons, memory, dissociation, destructive plasticity, broken mirror, avant-garde

Introduction

Digital expansions of so-called 'realities' (augmented, virtual, mixed, and other) are created to mirror our neurosensory systems, intuitions, and expectations in still more sophisticated ways. Across the interweaving domains of art and design we can locate a tendency of creating digitally expanded experiences with increasingly advanced technologies and software, designed for convincing our perceptual systems and imaginations that the experience is 'real.' Real, in the sense of being smoothly fitted to our nervous systems and bodily reflexes, and hence offering experiences that we smoothly cope with, heal from, find pleasure in, or 'advance' ourselves with. The mirroring mechanisms between neurons and algorithms, options and intuitions, attention and reward, are smoothened as our sense of presence is advanced and the experience gratifies our expectations.

While the analytical, critical attention to these experiences in art's discourse is oftentimes directed towards what they represent, as well as to their qualities of immersion, interactivity, feedback, abstractions or narratives, less interest seems to be granted to what they do to us. Or rather, what we do with them; how they affect our technogenetic coming into being with technology.

Our conditions for experiencing are changing. It might be argued that human perception, especially in the technologically developed parts of the world, to a lesser degree register an objective state of things (if things could ever be understood to be objective in the first place). Phenomena like filter bubbles and fake news pay witness to this and add to a worrying horizon for what we perceive to be 'reality' as it expands with digital technology. What is real to us has come to depend on the conditions under which we experience something to be real – to what extent we accept an experience to sync with our neurosensory, perceptual, and habitual systems and from here with our faculties of sense-making and judgment.

This paper is motivated by a concern with how current technologically produced expansions of artificial realities (AR, VR, MR, and other emerging R's) affect deeper human relations to what is real. My thesis driving the paper is that the implications of these reality-convincing experiences are deeper than what they immediately represent, and also deeper than what they are articulated to do, or 'produce.' As these experiences are involved with what we take for reality – what we accept it to be, what it feels like, how it is structured (not least socially), which opportunities we are granted, perhaps how we are granted the opportunity to exceed limitations holding us back in the natural world, at least in our imagination – they trick neuronal connections, activate memories, and train our sensorial systems and selective mechanisms for learning from the experience.

Experiences with digitally expanded realities, as I will refer to the subject matter of this paper, are deeply entangled with our technogenetic becoming. This is my main point and concern.

A technogenetic perspective on this considers how digitally expanded experiences are not only representations of images or environments that we can see and interpret but also implicated with our biological and deep-cultural human processes of change with technology. The technogenetic perspective on digitally expanded 'realities,' which I will pursue with references to N. Katherine Hayles, Catherine Malabou, and Bernard Stiegler, launches a culturally reflective, biological-neurosensory perspective on art's experience, especially art that employs technologies for digital reality expansion and which we currently see evolve in synergies – and contingently – with commercial technology and industries. I suggest that the technogenetic perspective moves the analytical focus beyond what the artwork supposedly represents and also beyond the conceptualized artistic or curatorial intent of the experience. The technogenetic perspective brings our focus closer to how the art experience participates in processes by which we are coming into being with technology. Rather than what the art experience 'is' we focus on what it makes possible.

My leitmotif will be the 'mirror' – a figure of deep-anchored philosophical, scientific, cultural, and artistic meaning in our evolving human relation to reality. The mirror has been linked with perception and a motif to represent, alter, or challenge a human relation to what is taken for reality. [1] The mirror is oftentimes associated with mimesis, representation, and revelation, cast as an objective reflector of the world at least since Plato describes Socrates' account of art as an imitative representation of nature in the *Republic*. [2] Especially in Western theory and practice, the mirror has been cast as a reflector of that which it mirrors, whether this is considered truthful or distorting. As an object, symbol, and metaphor, frequently associated with a mode of vision that extends to a mode of existing, the mirror is a protagonist in an ongoing negotiation between truth and artifice. It nurtures a motif of mimetic production, which has been of concern to the Marxist, critical theorists for decades – and it raises new concern among critical thinkers in the art-science-domain as productive capacities of the mirror are situated in the biological.

The mirror, and especially the mimetic motif with which it is cast to operate, runs through my investigation as a protagonist because it has reached a new level of concern. We could refer to this as a new level of concretization of mimetic production, which has emerged with the innovation of digital, reality-expanding technologies that feed objects, environments, and experiences which blur the boundaries between real and artificial in increasingly sophisticated ways. The mirror motif of mimetic production accompanies design practices for especially optical innovation, and especially by a somewhat newly found – since the 1990s – activation in the biological. Since "mirror neurons" were discovered in the brain and human sensorial system, neural pathways have been measured and their behaviors mirrored in algorithms of graphics and visual design to create experiences that appear to be convincing in order to effect the sensory system of the experiencing subject in a particular manner. Based on techniques of mirroring human neural pathways, the mimetic mirror motif has concretized in tools for creative and industrial production.

My suggestion is that the technoscientific production of experiences driven by the mimetic mirror motif guides not only the broadened field of neuroscience applied to design practices but also inspires intuitions and creativity in the broad domain of the arts. My aim is not to identify the specific synergies, nexuses, and differences between digitally expanded reality objects categorized as either industrial innovation *or* art. But by looking into how the mirror motif is activated in industrially motivated digitally expanded experience, how these operate beyond representations of images or environments that we see and interpret but also have biological implications, I am interested in how they are implicated with ways in which we humans change with technology. From locating the mimetic mirror motif in the industrial we might come to better understand and challenge the motif's operation in the arts – if not by examining explicit tools for mapping neuronal pathways then by examining the intuitions that motivate the creation of strong affective experiences. In my focus on how the mirror motif is furthered by a general, implicit idea of the 'intact mirror,' a critical technogenetic perspective on art's experience eventually encourages a focus on our opportunity to break it.

Mirror motif in a mirror world

While a proper analysis of how a mirror motif has emerged as a generative mechanism in Western cultures and societies requires a much deeper investigation than what I can offer here, we can jump to locate its operation in the environmental (architectural) emergence of modernity. Walter Benjamin's characterization of the mirror as an augmenting, perceptual condition of modern experience is emblematic in describing how the human perceptual condition – not least since modernity – has evolved as an architectural environmental construct for perceptual experience. But also, as a condition of mutability of subjective perspective. It is this mutable quality of perception I wish to examine further in this paper.

In the chapter "Mirrors" of *The Arcades Project*, Walter Benjamin characterizes a particular mode of perceptual experience in the arcades of Paris – "the city of mirrors" – in the late-nineteenth century. He describes how mirrors are everywhere, employed in all kinds of façades, in doors and walls, framed in bars and restaurants as if they were paintings, and how they are used for illumination effects in shop windows, providing a brightening ambience effect. They even appear in the 'glassy smoothness of the asphalt on the roads' after rainfall. "The Arc de Triomphe, the Sacré Coeur, and even the Pantheon appear, from a distance, like images hovering above the ground and opening, architecturally, a fata morgana." [3] Benjamin describes how even the sky is spread out like a crystal mirror over the

Seine; how every experience and observation floods into the next and the city becomes a stage for one big performance. "The way mirrors bring the open expanse, the streets, into the café – this, too, belongs to the interweaving of spaces, to the spectacle by which the flâneur is ineluctably drawn," he writes. [4] But Benjamin is not blindly enchanted by the phantasmagoria-character of this environment: "[…] the ambiguity of the arcades: their abundance of mirrors, which fabulously amplifies the spaces and makes orientation more difficult. For although this mirror world may have many aspects, indeed infinitely many, it remains ambiguous, double-edged. It blinks: it is always this one - and never nothing – out of which another immediately arises. The space that transforms itself does so in the bosom of nothingness." [5] The 'mirror worlds' in the arcades are disorienting, ambiguous, double-edged, and deceptive, interweaving inside and outside, and making orientation more difficult.

Benjamin describes the mirrors in the arcades of Paris as if they facilitate a particular kind of relationship between the self and the world; as if they are augmenting a particular subjective condition of (self-) reflection and dissolute enchantment, if not disorientation. In the context of the European urban metropolis of the mid-nineteenth century – before Georges-Eugene Haussmann's renovations of the city that between 1853 and 1870 introduced pavements, wide avenues, parks and squares – Paris' arcades were designed for the modern, strolling, bourgeois subject. Benjamin describes a mobile mirror condition of experiencing, leaning on Charles Baudelaire's metaphor of flâneurie. The archetype of the urban, modern observer, the flâneur, is strolling through the arcades in an ephemeral mode of experiencing in movement, living through as much as looking at the surrounding environment. [6] Strolling is a mode of flitting through space, gazing, and self-presenting in public. The reflective effect that Benjamin describes in the arcades however extends beyond the flâneur's reflection in himself, and also beyond his reflection in other people. In the mirror surfaces, the flâneur sees not only his portrait but also his behaviors, attitudes, actions, and perceptions, from multiple perspectives. And he encounters the fragmented experiences of different gazers in the modern city.

The augmenting quality of the mirror condition that Benjamin describes immediately channels into a motif by which the mirror becomes a descriptor of a cultural syndrome. This is a syndrome by which we mirror ourselves in our own cultural fabrications. What is mirrored is not the unmediated natural world, but a continually reproduced representation of it. Augmenting an urban sphere, the mirror fabricates an affective condition of reflective surfaces. This is later constituted not only by glass and actual mirrors but also by screens and other technological objects – as mimetic media which referent becomes their mutual reflection as well as our mutual reflections in them. This quality characterizes the mirror up through Western theory building in the twentieth century as a critical both object and metaphor for a cultural syndrome producing illusive and deceptive mechanisms of perception.

Today, the mimetic mirror motif – and its implications for artistic and cultural creation – is largely associated with the screen. Mostly mobile, like Benjamin's experiencing subject in movement, we experience the world through screens on mobile devices, digital cameras, mobile phones, information stands, video billboards, and windows of computer desktops. Screens make up pervasive and artificial environments with which we are deeply and emotionally engaged. Screens mediate not only the content they display but also a certain experience of a relation between the self and the world being mediated – or represented. We increasingly relate to the world through visual projections, data visualization, and interfaces of digital platforms, apps, and virtual entertainment that extend from the pocket-screen to illuminated architectural surfaces and intensify with virtual, augmented, and other kinds of 'reality' goggles or glasses. Through these experiences we digitally expand our sense of reality.

We see this mechanism of mirroring in urban lighting tendencies that disperse the 'screen' even further. An example is the Jacques-Quartier Bridge in Montreal, which media architectural skin of responsive lights – inaugurated in 2017 'as a showcase for the city's creative and technological vanguard' – reflect data from citizens. The surface of the bridge mirrors people's collective, desubjectified data, generated from movements, moments, and lives in the city of Montreal, collected from real-time social media as well as big urban data. [8] The augmentation of the bridge mirrors people's expressions of emotion and traces of their patterns and behaviors captured in their data.

The Jacques-Quartier Bridge exemplifies how what is mirrored is not only our image, and the effect of the mirroring is not only one of direct reflection. Our data is aggregated to shape experiences of the environments we are in. Data is used to convince our perceptual systems that the digital expansion of reality – as we experience it – is real. Beyond the object, image-graphics, and artificial, optical environments, entire milieus are being designed from our data to convince us of their intent by mirroring us, reflecting our patterns, imitating our behaviors, depicting how we feel, responding to our emotions and sympathies, and synchronizing with our sense of presence.

The motif of mirroring, operating through urban, architectural features since modernity and later through screens and media architecture, as well as in mutually reflective algorithms of hybrid environments and software, cues a particular symptom of change. When objects, phenomena, and digitally expanded environments sync with us as desubjectified beings this is by principles of reduction. This informs principles and intuitions of imitation, sameness, and optimization that shape imperatives of design and creativity, from research on mirror neurons to environments of immersion and mirror-sentience. By sameness, individuals are unable to access a range of options of behavior or responses in their life worlds. We think and act along similar and reductive patterns, similar to each other, to previous perceptions and ideas, which are resting on certain predispositions, assumptions, and unquestioned

objectivities. As such, our mirror worlds allow only for perception to mutate in reflection of pathways we already know.

The productive mirror motif in neuroscience

Innovation in ocular and so-called 'immersive' technologies offer increasingly sophisticated experiences of artificially composed so-called 'realities.' These optical and multi-sensory innovations reflect a sense of optimism related to the digital optimization of life for many and a tendency in our time by which what is 'real' seems to be up for negotiation. With industrially motivated objects and environments designed to be as convincing to us as possible, the race for suggesting *the most* reality-convincing experience is on. Advanced research on artificial perceptual experience in order to achieve this is progressed in places like Silicon Valley. Geared by corporate interest and heavy investments, companies are racing for a head start in the game of defining the near-future 'real' with neurofitted graphics and sophisticated technological methods of virtual worldmaking. Immersive spatialities of algorithmic high speeds are promiscuously designed to cure us, enhance our capabilities, make our work lives more efficient, our networked encounters more 'present,' or for the sake of entertaining us in addictive and highly profitable immersive games and movie experiences. This is achieved from designing optical innovations and environments from advanced studies on how the brain and human sensorial system is stimulated and change in relation to particular (mostly visual) experiences. Companies are, for example, advancing design of immersive graphics and environments with optogenetics, a method for exploring and triggering neural circuits via light stimulation, for example, for the purpose of visual restoration, as well as cognitive control, for example, in the design of video games, in order to advance the ability of multitasking.

What characterizes these kinds of innovation is a motif of imitation based on behaviors of mirror neurons. Mirror neurons were discovered in cognitive neuroscience in the early 1990s in the brains of macaque monkeys, when individual neurons were observed to fire both when the monkeys grabbed an object and when the monkeys watched another primate grab the same object. [8] Mirror neurons are involved in motor control and in the parietal lobe near the crown of the head. They can be described as a type of cell spread out throughout the nervous system of humans that responds equally when we perform a goal-directed action and when we watch someone else perform the same action. In a way they provide a "mirror" between the actions of others and our own actions. Since their discovery in the 1990s, mirror neurons have changed common neuroscientific understanding of the neural underpinning of social behavior. Their discovery enticed a reconceptualization of the motor system as not only involved in the production of movement but also in the processing of sensory information. [9]

The mirror motif located in the biological is first of all a motif of imitation. Imitation in relation to mirror neurons refers to the ability to match a goal-directed, modeled action. [10] This has been used by neuroscientists to explain associative learning and learning through mimicry, which has been effectively used in different forms of recovery training. Research on imitation has, for example, been used in combining action observation, motor imagery and imitation in parts of physical therapy to regain function during stroke recovery. [11] Treatment of autism spectrum disorder, language impairment, and social impairment, has also benefitted from research on mirror neurons. [12] The aim of engaging mirror neurons in recovery treatment is to help the patient overcome the deficit, repair the neurosensory system, and return to a 'normal' state of being.

Biological change can be achieved by activating a natural mechanism in the human neurosensory system whereby we naturally default to what we have done before. We are more prone to stronger imitation by actions we have already developed a familiarity with. This can be explained by an autopilot mechanism in the brain known as 'the neural path of least resistance.' In order to save energy and act efficiently, the brain tends to make neural connections of familiarity. The neural mechanisms behind this can be explained from the principle of Hebb's law with the principle that 'neurons (cells) that fire together wire together.' [13] The theory is that once neural networks are formed, they are prone to repetition. This mechanism of imitation by the experience of familiarity has been used to explain synaptic plasticity, the adaptation of brain neurons during learning processes, which are activated during, for example, recovery treatment.

When design principles rely on theories of mirror neurons, they are based on similar studies on how the brain learns and evolves in response to specific impressions or experiences. The path of least resistance extends to become a design principle in the creation of graphic and visual-sensorial experiences that are designed for us to easily learn a new task or enhance an ability. Augmented, virtual, mixed, and other kinds of 'reality' experiences are thus being developed to sync better with brain pathways. In neurofitted design, this means that a graphic image or a behavioral pattern presented to us becomes more convincing, more effective in terms of the goal it is designed to achieve, if it aligns with already existing images or patterns. Graphics experiences are designed to fit with our neural pathways, to effect and optimize how neurons spike and connect, which increase our experience of them as convincingly 'real.'

The mimetic motif at work with mirror neurons pays witness to a tendency by which the mirror has taken on a 'new' role. This is a role of not only imitation but also of – literally productive – creation. What is 'created' might be a restoration of a sense or psychic balance, it might be an immersive entertaining experience, or a state of mind convinced of certain coherencies in the world. It is a productive cuing that changes our experience of reality. Therefore, what we ought to ask is not merely how to assess the 'object' or experience with which the mirror motif manifests, but rather, how the human perceptual, neurosensory system is mutating.

Experience changes the sensorial system: A technogenetic perspective

When design principles evolve from a motivation of extending our senses rather than going against them, they indirectly celebrate the smoothest path, the effective mode, and the healthy brain. As we see from the principles guiding neurosensory design, the brain's capacity for recovery or potential for change has been imagined as a positive with the performative brain as the ideal. The mimetic mirror motif, as it can be located in neurosensory design, is a motif of achieving harmony and optimizing the brain. Catherine Malabou writes: "In excluding all negativity from their discourse, […] certain neuroscientists cannot, most of the time, escape the confines of a well-meaning conception of successful personality, "harmonious and mature."" [14] The underlying logic at work here celebrates a focus on cellular renewal, repair, and resourcefulness, which Malabou reminds is 'framed by a neo-Darwinian back-story.' [15] At issue is the taking advantage of opportunities to repair, optimize and convince the brain to become 'the ideal healthy brain' – rather than its creative activation. By endorsing a kind of self, we also endorse a particular kind of creative possibility.

Experience changes the possibility of synapses, the basis on which new neurons are born, which is what is referred to as neurogenesis – the fact that our neural networks are undergoing regular morphological and functional reworking. Learning processes are however not entirely predictable. Like mirror neurons are sensitive beyond vision, responding to modalities of other senses, for example sound, mirror neuron systems work in collaboration with other brain regions and bodily systems in order to carry out many of their primary and secondary functions. [16] The mirror mechanism is not confined to parietal and motor regions but also "recruit" other brain regions that are activated and renewed. This means that while the intent might be to teach the brain or neurosensory system one thing, the effect might manifest in different neurosensory renewals as well.

And while some actions, connections, or capabilities might be learned, others might be forgotten. N. Katherine Hayles refers in *How We Think: Digital Media and Contemporary Technogenesis* to studies that show how increasing hyper-reading – skimming, scanning, fragmenting, and juxtaposing texts in an information-intensive environment – that correlate with hyper attention affects a decrease in the cognitive mode of close reading correlated with deep attention. This reveals that while we become better at gaining a fast overview of an abundance of information, our cognitive system undergoes epigenetic changes by which we lose the ability of deep attention, resulting in a higher degree of distraction. [17] This is about how our memory is at work in the evolution of consciousness. Not only memories of images or episodes in life, but also memories of impressions, sensibilities, and patterns collected in our 'pool of images' in consciousness and activated when we navigate life. [18] As elaborated by Bernard Stiegler in the three-part book series *Technics and Time*, memories operate not only through immediate experience or recollection but also through what he calls "tertiary memory," referring to how memory is also organized by our 'technics,' by systems for recording, which influence what we forget in the process of remembering. Tertiary memory plays a primordial role in the constitution of consciousness and its evolution through time [19] In other words, our memory depends on the languages and programs we utilize to engage it.

If experiences that are particularly designed to enhance certain patterns of memory through learning also cause that something is forgotten, how skills are weakened and neural synapses are redirected, then we ought to ask: When some kinds of memory patterns are strengthened in experience, then which kinds are 'forgotten'? How does this affect our neurogenesis? And how, and with what consequences, might this affect deeper layers in our consciousness, rhythms of programs and cultural customs we practice, and ways in which we anchor ourselves – past and future – as human beings? How can we account for what we are forgetting and the psychological, cognitive, and cultural consequences of that?

The aim of the smooth experience is underpinned by an assumption of a perfect continuity between the neuronal and the mental. This assumption is at best naïve and at worst dangerous to make, since while it might be known and utilized by design that the activation of mirror neurons stirs internal simulations it is unknown what these simulations change inside us.

With the above technogenetic perspectives in mind on how digitally expanded experience epigenetically changes human consciousness, and with that changes the human neurosensorial and cognitive system, we need to consider how the biological extends to the cultural. Our cultural selves are rooted in our biological foundations, just like neuronal functioning and social functioning mutually give each other form. [20]

The tendency of utilizing technologies in ways of making the experience smoother and more convincing, by "integrating" it in our cultural-biological conditions of perception, is one that we can locate across design, optical innovation, and the arts. The shared aim is to mirror the experience in 'us,' aligning it or parts of it with how the neurosensory system works according to the intentionality of the technical system or the goal for the outcome of the experience – whether that being one of healing us, seducing us, optimizing our performative capacities, or providing a strong affective experience. The aim for reaching a goal with the experience is what launches the pursuit of the smooth experience – whether this is to return to a 'normal,' healthy state after a trauma or reflective of an aesthetic ideal. The productive motif of mirroring neuronal patterns thus extends into intuitions of mirroring our imaginations and expectations in artistic and cultural experiences.

This mirror motif however seems to foster a sense of blindness towards the fact that 'what we see' depends on 'how we see it.' The world's representations and materialities have been mastered, interpreted, and critically

dealt with for centuries, but the ways of measuring them or the modes of experience relied on is too often left out of the investigation or taken for a natural condition. The mirror motif that has underpinned practices of measurement, analysis, and sense-making, is one by which the mirror is treated as somewhat "intact" – intact according to the worldview or scientific paradigm engaged or according to the pre-assumed capabilities of the experiencing subject. This cultivates a tendency of assuming in the first place that our abilities of perceiving are adequate or appropriate according to a set of accepted, perceptual rules of the world that we perceive. It assumes a sense of 'mirrored compatibility' between those who experience and that which they experience, between a generalized, sensorial system of perception and art as a representative of objects and impressions in the world. We practice this blindness when, for example, we confidently articulate what an artwork will make you feel, or how an art project or experience will have certain effects on or award the people participating. From such assumptions we have trained ourselves to extract meaning from art's analysis and identify an affective, effective, outcome or sense of production of the (art) experience. But art's experience might as well diverge from the conceptualized intention. It might spur the sensorial system to learn and evolve differently than expected and fuel our expectations and anticipations in relation to future experiences in unforeseen ways. Some would argue that this – for better or for worse – is what makes it art at all. In any case, the assumed alignment between the predictable and universal, sensing human being and sensorial logics in the world fertilizes the reductive premise in art. This is a reductive tunnel of manifestations and affections towards more linear, universal, and neurofitted reality fabrications in which we end up reflecting art and ourselves.

The Broken Mirror

In art and literature, scholars have widely examined the occurrence of the mirror as both object and concept of perception reflecting different modes of vision. The mirror has been related to modern experience, introducing the internal awareness of the external eye on the self. [21] Dynamics of 'mirror vision' have been examined in relation to subjectivity and self-reflexivity. [22] The mirror has also been a protagonist of investigations of intersubjectivity among art spectators. [23] The mirror has significantly been used as a motif, metaphor, and tool to challenge and alter certain modes of vision. Notably, through investigations into visual-perceptual premises of the experiencing subject's (oftentimes the artist's) relation to reality. Art's interest in conceptual instabilities, destabilization of visual phenomena, and with fragmented selfhood and self-representation reflect Jacques Lacan's experiments and writings in the 1950s, in which he interpreted the affective situation of looking in the mirror as an experience of self-identification in the other. The mirror becomes a means of a releasing desire for identification and self-representation. In Lacan's writings, and many that he inspired, the mirror is connected to awareness of the gaze of the other and development of self-reflexivity.

In her Ph.D.-dissertation, *Dynamic Reflections: Mirrors in the Poetic and Visual Culture of Paris from 1950 to 1900*, Kate Etheridge draws a trajectory from Baudelaire's figure of the mobile flâneur to the late nineteenth-century avant-garde artists for whom the mirror became a symbol of self-referentiality. These artists followed Baudelaire's reclaim of the mirror motif in the mid-nineteenth century as a mechanism of mutability of perception rather than an imitative capacity in art. Etheridge examines how ideas of exposing conceptual instabilities and destabilizing coherencies of visual phenomena were pursued further by artists in the twentieth century, for whom the mirror became a symbol of fragmented selfhood. It became an emblem of fractured, unstable modes of seeing – "broken" rather than intact. Capacities for inversion, mutability, and fragmentation, which the "broken mirror" embodied, represented a fragile threshold between art and reality. [24]

My question that extends on Etheridge's work is: Could the art experience of digitally expanded reality today offer a re-inhabitation of the real-artifice – not only conceptually, but actually? I propose that a technogenetic perspective brings the idea of the "broken mirror," as it was explored by the avant-garde artists of the late nineteenth century and twentieth century associated with conceptual instabilities, destabilization of visual phenomena, and with fragmented selfhood and self-representation in art, into contemporary purview. With this we can seek beyond the conceptualization of these perceptual issues as themes, beyond a focus on the art as an object or experience of representation, and beyond the ideals of the intent behind the experience. We can search for what the art experience actually 'does' and makes possible within us, and with us. [25] This involves a close attention to biological and emotional implications of experience, which condition the cognitive and neurologically complex natures and patterns of mutability of human perception today – like how the enhanced ability of hyper reading happens on the expense of deep reading and attention, and consequences of changes to the technological facilitation of memory support systems through which we select and process what and how we remember; from what and towards what we evolve, and along which intuitions, logics, and patterns we become.

In this paper, I have paid attention to technogenetic implications of design imperatives behind industrially motivated, digitally expanded reality experiences and touched upon some of the logics, ideologies, and imaginations driving them. From revealing and questioning these we can pursue an alternative mirror motif to that of mimesis and production, that of the "broken mirror" in art. I suggest that we might locate this through explorations of different kinds of connections and synapses in experiences that might not be smooth; through acknowledgement of the simultaneous occurrence of different kinds of neurosensory processes – and thereby a leaving behind of the idea of a fixed, ideal subject or 'subjectivity' (if no two subjective experiences are identical, then mimesis is an unachievable

goal anyways); and by avoiding assumptions of compatibility between those who experience and what they experience. This moves the focus from art's representational relation to reality to art's facilitation of human relations to reality, which I have proposed in previous writing contributes to a temporal, processual understanding of contemporaneity in art. [26] Perhaps it sharpens the attention to art experiences through which we can critically explore modes of ongoing re-negotiation of the real-artifice without suspending productive frictions or neglecting the value of dissociative affects – related to out-of-joint experience and individually conditioned temporary detachment from physical and emotional appearances of the surrounding milieu.

On a concluding note, I am aware that with the technogenetic perspective on art I have opened up a chapter more than offered a conclusion; a chapter of a book in the making and perhaps the launch of a greater epistemological journey of seeking for the sensorial roots, origins, biologies, and deep times of contemporary, digitally expanded 'reality experiences' that also make phenomenal realities in art. [28] The avant-garde cast the idea of "difference" as a mode by which to stimulate cultural habit rather than by principles of continuity and repetition. A technogenetic perspective continues an exploration of the relevance of the idea of difference today – in continuation of artistic concerns with fractured identities – for example by looking further into physical-psychological modes of dissociation. For this we could engage neuroscientific concepts, like Catherine Malabou's notion of "destructive plasticity" with which she proposes that contemporary neuroscience's interest in the brain's capacity to be "plastic," mutable, and adaptive has ignored a destructive potential of neuroplasticity. Malabou turns to the injured or wounded brain for which sense-making and perception of the world can radically – and permanently – change. Destructive plasticity demonstrates the brain's capacity to refuse to follow a linear path of logical evolution, like the path of least resistance. [27] This could be one of many dissociative concepts to be activated in the analysis and theory of art.

Ahead of us lies a task – in neuroscience as well as in the humanities: To seek to disengage from presuppositions leaning on a productive, mimetic mirror motif that seems to implicitly govern the neuroscientific field and which extends through tools, logics, and intuitions to all other fields involved with digitally expanding our realities.

Acknowledgements

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[3] Walter Benjamin, "Mirrors," in *The Arcades Project*, trans. Howard Eiland and Kevin McLaughlin (Cambridge and London: The Belknap Press of Harvard University Press, 2002), 538.

[4] Benjamin, "Mirrors," 537.

[5] Benjamin, "Mirrors," 542.

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[26] See Tanya Toft Ag, "Contemporary Urban Media Art: Images of Urgency – A Curatorial Inquiry," Ph.D. dissertation, Copenhagen University, 2017.
[27] Malabou, *What Should We Do With Our Brains*.
[28] Reflections in this paper emerge from my research for a book in the making on 'expanded reality,' conducted during a research stay (2018-2020) at the School of Creative Media, City University of Hong Kong, and supported by the Carlsberg Foundation.

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Tanya Ravn Ag, Ph.D., is a curator and scholar focused on perceptual experience, memory, temporality, and technogenesis in relation to media art and media aesthetic phenomena in the urban domain. Her curatorial engagements with urban, media-based art include the Screen City Biennial 2017 in Stavanger, the SP Urban Digital Festival in São Paulo in 2013 and 2014, and Nordic Outbreak presented in New York City and across the Nordic region by the Streaming Museum in 2013-2014. She is the editor of *Digital Dynamics in Nordic Contemporary Art* (Intellect, 2019) and co-editor of *What Urban Media Art Can Do – Why, When, Where, and How?* (av edition, 2016). In 2017 she co-founded the globally networked Urban Media Art Academy. From spring 2020 she continues her scholarly work at Institute of Arts and Cultural Studies, University of Copenhagen, following a two-year visiting

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Art and Science Intra-action of Collecting Water from Fog

Ethical Response-ability in Karen Barad's Mattering

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Abstract

Water is the essence of life on our planet and yet, due to climate change and multinational politics of profit, water and access to clean drinkable water are diminishing on an unprecedented scale. The art&science *Mist Collector* project addresses water shortage by looking at a new paradigm of collecting water from fog. In my presentation I will use Karen Barad's theory of 'agential realism' that inspired by quantum theory, considers 'matter' as an active agent that dissolves boundaries of dualistic thinking (matter/mind, animate/non-animate, human/non-human, sentient/non-sentient), to demonstrate how through art and science "intra-action" –which means onto-epistemological inseparability, we can bring forward imaginative solutions and produce poetic messages that are able to create a more acute awareness of the global water situation. I consider our research as a platform of "dynamic relationality", in which the public is invited to enact an "ethical response-ability" by engaging with the artworks' space, time and matter processes. *Mist Collector*, by bringing 'humanity' to the scale of a single drop of water and by embarking the visitor aboard an Earth sized vessel sailing in the fog, states the necessity for all sentience - human and "inhuman" (outside the binary of human/non-human) to start building a shared narrative, an uncertain shadow of an ever failing ecosophic Future/Present/Past that may still be shaped and imagined together.

Keywords

Environmental water crisis, fog water collection, art & science collaboration, Karen Barad's agential realism, ethical response-ability.

Introduction

Water is the essence of life that not only depends on the hydrological cycle but also on what Canadian geologist and writer Jamie Linton defines as the "hydrosocial cycle" that reflects all aspects of human affairs. [1] All ancient civilizations were built around major bodies of water and in many cultures, water is considered a sentient and sacred being with the generative power of the cycle of life and death. Uneven access to water and water services results in social inequality, which then is the subject of social unrest, political conflict, wars and immigration that follow. Industrial agriculture with mono productions, mining controlled by multinationals, privatization and extensive water bottling are exhausting underground water supplies faster than they can be replenished. In addition, the increasing rise of temperature and unpredictable weather patterns due to climate change are all factors contributing to diminishing water sources at an exceptional rate.

In arid, coastal mountainous regions where there is little or no precipitation or access to groundwater, fog becomes the only source of water for plants, animals and people. Fog is a cloud close to the ground, composed of small, condensed water droplets, big enough to be suspended in the air but not big enough to be brought down by gravity in the form of rain. When warm moist air passes over cold current surfaces of ocean water, it condenses into clouds that are then pushed upwards by an orographic lift, veiling the slopes of coastal mountains in fog. There are several different types of fog, such as radiation fog, precipitation fog, valley fog, advection fog, upslope fog, steam fog and freezing fog, however not every kind is suitable for water collection. Only fog moved by wind, such as orographic or advection fog can be harvested. Another crucial factor is location. Only places far away from industrial pollution are suitable for water collection from fog.

Fog clouds moved upslope by wind encounter 'obstacles' such as rocks, plants or animals and coalesce into bigger water droplets upon impact and are brought down by gravity to quench the thirst of local ecosystems. Gathering water from humidity in the air is not a new idea. Evidence shows that in many different parts of the world, ancient communities collected water from dew (dew ponds) or from fog by collecting water dripping from trees intersecting with clouds. However the usage and development of modern fog harvesting technologies on a large scale has only started in recent decades. [2]

Could the atmosphere, a diluted ocean of aerial moisture, be a solution to provide fresh water to communities in dry regions? Or will "the sky's the limit" become another commodity for profit? Could art and science collaborations provide an ethical accountability in the creation of an Ecosophic World and open a tap of imagination for the benefit of all sentient beings and non-beings?

In an attempt to answer these questions, I will use the example of the art and science *Mist Collector* project that has contributed to a paradigm shift in the science of collecting water from fog. Employing Karen Barad's agential realism framework, I will demonstrate how imagination reinforced by poetics can address environmental concerns such as water shortage through bringing us closer to the question of ethical responsiveness, so needed in dealing with the socio-political-ecological crises we face today.

Before we proceed to the artworks, lets familiarize ourselves with Agential realism by Karen Barad.

(Dis)entangling Agential Realism

Agential realism is deeply rooted in quantum physics and in particular, the philosophy of Niels Bohr – one of the founders of quantum theory. Using references from quantum physics, it deconstructs the classical ontology of reality that presumes the existence of entities and agents that precede interactions, and shifts the focus from the external world of Kantian 'things in themselves,' to matter as an active agent in 'mattering' (meaning creation). This fundamental relocation fuses ontology with epistemology by bringing together reality and knowledge (of that reality) and by dissolving a separation between *what is* and *how we know it*. To illustrate this onto-epistemological merger, Barad employs the famous double-slit experiment, in which particles of matter (photons, electrons) behave sometimes as particles and sometimes as waves (wave-particle duality), depending on the arrangement of the measuring apparatus. She postulates that the apparatus has an effect on the behaviour of the observed; thus reality/knowledge creation. Agential realism captures this onto-epistemological inseparability between matter and agency in the concept of "intra-actions." In opposition to interactions that imply causality (because objects exist relations are possible), [3] 'intra-actions' point to an already-existing relationality (no relations in the absence of objects but also no objects in the absence of relations). [4] These "intra-actions" *perform* "agential cuts" through which all phenomena and differences (subject/object) manifest themselves. Barad explains:

> …matter is substance in its iterative intra-active becoming—not a thing, but a doing, a congealing of agency. It is morphologically active, responsive, generative, and articulate. Mattering is the ongoing intra-active differentiating of the world. Intra-actions enact agential cuts, which are a cutting together-apart (that is, entangling-differentiating), as one move (not sequential acts). [5]

It is the shift from interaction to intra-action that presents the possibility of "enacting new patterns of engagement" [6] and is particularly applicable to (inter)disciplinary approaches such as art and science collaborations. By creating a dynamic framework of relationality, the concept of 'intra-action' abandons the conventional two-culture divide between science and the humanities (C.P Snow, 1959) and opens new ways of working together. In opposition to Descartes' epistemology that starts with an irreconcilable difference in the world of 'objects' existing outside of 'us' and subjects (us) trying to understand them, agential realism's epistemology, or rather what Barad calls ethico-onto-epistemology, begins from the premise of ontological inseparability. Observations are never 'objective' and are always already part of the observable. For Barad, theorizing is not a human activity and she says that all entities, organic or inorganic, are not just an embodiment of mathematics, for example, but rather they live and do mathematics. [7] She advocates for a different way of doing science, one that responds to "e-motion-ability" and proceeds with 'exquisite care' how to sense, to feel and connect with the *other*, how to collaborate in ways that enable response-ability, which is the ability to respond. [8]

Separations made by agential cuts are not absolute but only local and temporal manifestations of differences; always open to be re-worked, unfolded and disjointed. It's critical to emphasize here that agential realism by 'bringing together' is not trying to reduce differences into 'sameness'. Quite the opposite, it sensibilizes us to them by inquiring how "differences are made and remade, stabilized and destabilized" [9], how they manifest themselves and how they matter and for whom. When a difference materializes, it excludes what is not included, creating dichotomies of subject/object, such as the Cartesian split of body/mind, culture/nature or sentient/non-sentient. Barad states that "differences are made, not found" [10] and because of that they offer an opportunity to enact change and bring forward the question of ethical responsibility; not only towards what has been materialized and manifested, but also, and perhaps more importantly, towards what was excluded in the process of differentiating. Ethics is about an openness to respond towards infinite possibilities. She provides her definition of ethics in the following passage:

> Ethics is an integral part of the diffraction (ongoing differentiating) patterns of worlding, not a superimposing of human values onto the ontology of the world (as if "fact" and "value" were radically other). The very nature of matter entails an exposure to the Other. Responsibility is not an obligation that the subject chooses but rather an incarnate relation that precedes the intentionality of consciousness. [11]

Thus ethical response-ability is not about what we impose on the world but rather, a necessary responsibility for *the other* that was excluded in the process of differentiating, as a natural consequence of the temporary agential cutting in constant flux.

Art & Science Intra-action

Mist Collector – art and science project, developed in collaboration with artist Ana Rewakowicz, physicist Camille Duprat and physicist/artist Jean-Marc Chomaz at the École Polytechnique in Paris, deals with the problem of diminishing sources of fresh water around the world (especially in areas with scarce access to groundwater and rain), through exploring alternative methods of obtaining water from fog. The standard model of fog collector uses net (similar to a mesh potato or onion bag) called a Raschel polyethylene mesh net (the most economically produced warp-knitted fabric). However water gets stuck in the intersections of square-grid netting (due to the surface tension) and pro-

duces clogging, with water failing to drain into the collection gutter at the base of the net. In my collaboration, working side by side with physicist Camille Duprat, we diffractively (through each other) looked at the problem of clogging and re-entrainment experienced in the process of collecting water from fog. Amidst this dynamic relationality, a different image has emerged and manifested itself: a forest of parallel flexible fibers – a paradigm shift that has created a new base for further investigations pursued simultaneously through art and science experimentations. In this process, we collaborated on the creation of an apparatus/phenomenon that intra-acted with water droplet coalescence on parallel fibres, a fog production system and the development of aerodynamic structures that could increase water collection. Our goal was to entangle people with the imagination of "touching the strange within us" – water!

Thinking diffractively with water

Anthropologist Veronica Strang describes how in many cultures water is considered a sentient and sacred being. She gives an example of an Aboriginal Australian story about ancestral beings that rise up from water. She recounts of how "human spirit beings 'jump up' from their ancestral waters to materialize or 'become visible' in human form. At the end of each individual human life cycle, they return to their watery home to be reunited with their ancestors, 'becoming invisible' and so dissolving back into collective formless potential." [12] Strang points out that in the past, most societies worshipped water beings as female deities and only since the emergence of patriarchal and monotheistic religions, beings such as serpentines or dragons traditionally associated with water, were devalued and treated as leviathans to be feared and killed. [13] Similar to Barad's matter, water is formless, out of which all entities (humans/non-humans, sentient/non-sentient) come into being. A movement and a flow through/with/outside/inside of time that enables material enactments and life processes.

Water, similar to light, can also behave like a wave. Barad distinguishes two kinds of behaviours that generate different modes of knowledge production, captured by two sets of optics: geometrical and physical. Geometrical optics, assigned to the laws of refraction in classical Newtonian physics, treats the nature of light as a ray (an approximation tool indicating the direction of propagation) and is defined by *reflection* of a representational mode of knowledge production, in which knowledge, mediated from an external point, creates a mirroring effect of sameness and distance. [14] In contrast, physical optics depicts patterns of interference, distinctive to waves, that produces a diffracting mode of "reading insights through one another" [15] and dissolving the boundary between 'subject' and 'object.'[16] The diffractive method allows for multiple perspectives to co-exist, without simultaneous exclusivity. It is not about an 'objective' observer outside of a phenomenon, but rather an active participant on the inside that touches and responds to what touches them, entangling and connecting. And, for Barad knowing "is not a matter of reflecting at a distance; rather it is an active and specific practice of engagement." [17] She says:

> Reading … diffractively is about experimenting with different patterns of relationality, opening things up, turning them over and over again, to see how the patterns shift. This is not about solving paradoxes or synthesizing different points of view from the outside, as it were, but rather about the material intraimplication of putting "oneself" at risk, troubling "oneself," one's ideas, one's dreams, all the different ways of touching and being in touch, and sensing the differences and entanglements from within. [18]

Touching Ethics

Touch is the most fundamental way of communication through which Barad approaches the question of ethics. In fact she sees the entire development of physics as a science of touch asking the question of how things communicate. How do, for example, particles feel one another? How do they sense each other? Through direct contact, through another medium such as a void (which never is empty), through a "spooky-action-at-a-distance" [19] (entanglement) or through an exchange of energy (intra-activity)? It is touch that allows us to become open and enact response-ability. [20] For Barad, ethicality is about "hospitality to the stranger threaded through oneself and through all being and non/being." [21] Only when we are able to become vulnerable and 'naked,' and entangled with *the other,* we are capable of responsiveness, the ability to give and receive a response. Barad says: "Only in this ongoing responsibility to the entangled other, without dismissal (without 'enough already!'), is there the possibility of justice-to-come." [22]

From the position of agential realism we can consider all beings/non-beings as sentient entities that give and perceive, feel and sense, and engage in the process of indeterminate possibilities of (be)coming. A time-scale, at which these intra-actions happen, is different; an intra-action between rocks and the soil is different than between a human foot and the sand.[1] However, regardless of the time-scale, we are bound to the relationality, to the responsiveness we have towards what is excluded in the process.

In an attempt to touch ethics, Barad goes as far as discerning the difference between the non-human and inhuman. She points out that while the former still stands in opposition to human and reflects the human-centeredness, the latter assists to the ultimate question about caring as an intrinsic part of ethical-responsibility. She recognizes that perhaps only in the embrace of the 'inhuman' that she defines as "an infinite intimacy that touches the very nature

[1] However it is interesting to caress a counterintuitive idea, in which it is not my foot that leaves an imprint in the sand, but rather the sand that makes room to accommodate my foot in it.

of touch, that which holds open the space of the liveliness of indeterminacies that bleed through the cuts and inhabit the between of particular entanglements," [23] will we be able to feel the ethical responsibility with which we are indebted.

Imagination augments the sense of touch by activating poetics, which is a touchable sensitivity of intimacy that "puts us in touch with the possibilities for sensing the insensible, the indeterminate,"[24] like the invisible-to-the-human-eye water drops that become visible through the *touch* of the camera. Poetics allows seeing artistic production, and art and science collaboration not simply as a production of *objects or problem solutions* (including theoretical ones), but rather as relations beholden in the practice of engagement. Poetics is not "the means of expression of the subject, nor the means to represent an object," [25] but it is an act, a way of opening the doors of invitation, allowing *the other* to come forward. It is not an obligation punishable by morality but rather an intimacy of being there for *the other*. [26] And it is in this intimacy that we are able to embrace *the inhuman* that is always part of us. Maybe only then, by entwining ourselves with what's heartless, callous, uncaring, unkind or cruel within us, are we able to grow more attentive towards the response-ability that awaits us. It is the poetics that bring us closer to what's excluded, to what's invisibly complimentary, allowing us to sense the "infinite alterity of the world."[27]

Mist Collector Project

Through the Looking Mist… is a video projection of water droplet nucleation on parallel fibres in slow motion that was filmed with a high magnification camera so that each water droplet became a visible point in space. In this work, water drops appear on threads, coalesce and grow slowly, while struggling to stay attached in the wind. When their mass becomes too heavy they give in to gravity and fall. At other times, the water's surface tension brings two adjacent fibres together creating capillary bridges that then turn into long liquid columns. The incoming water drops are immediately absorbed into a fluid film without requiring 'individual' coalescence. Could this prove to be a more efficient way of collecting water from fog?

Through a change of spatio-temporal scale, the public is invited to question their point of view and to feel the phenomenon at the scale of a constitutive water droplet. Similar to the heroine in Alice in Wonderland, whose body proportions vary depending on different notions of space, this sensation allows us to explore and discover the world in a different way, where importance does not depend on scale, but on our intra-actions with "spacetimemattering." [28]

In the video, a growing tension, perhaps the anthropocentric feeling of resignation facing the ineluctable, gives rise to different formations and various rhythms, creating an 'ode' to the cycle of emergence and disappearance. [29]

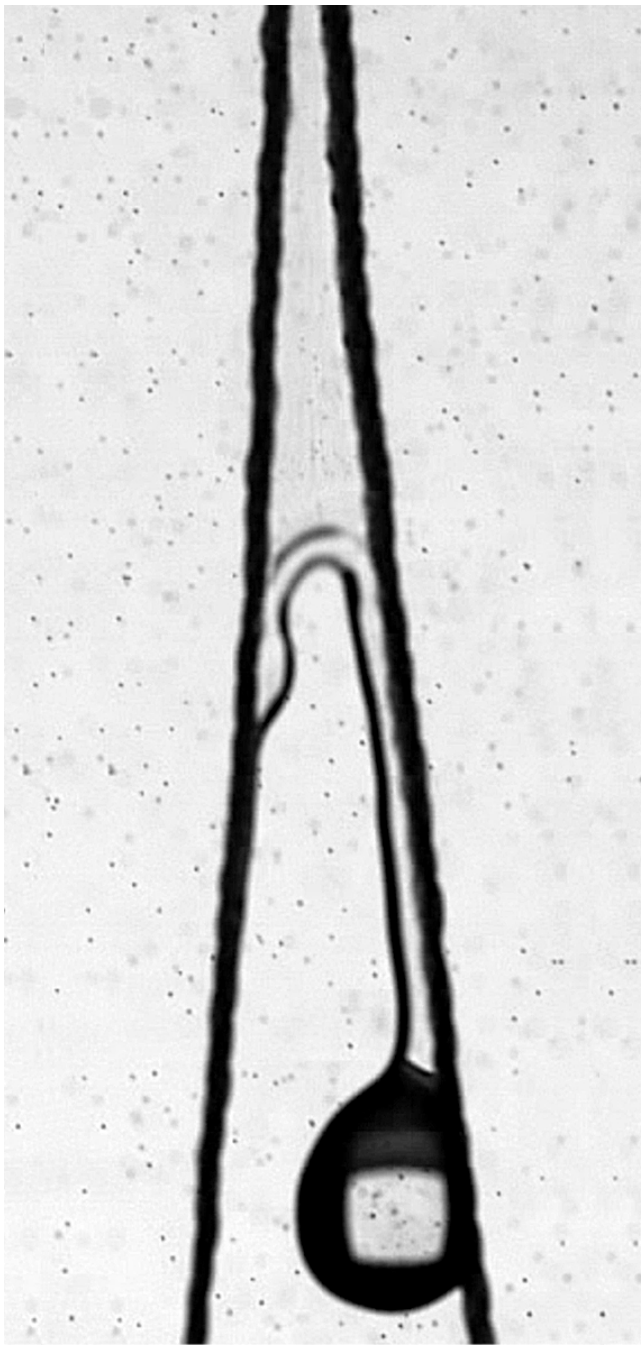

Figure 1 *Through The Looking Mist…* 2014 ©Ana Rewakowicz

The ***Misty Way*** installation enacts three main elements involved in fog collection: moisture (small, condensed water droplets), wind, and a harvesting substrate. Fog filmed with an even bigger magnification than before, turns droplets into visible circles oscillating to their own rhythm. Inversed and entangled with the apparatus of the camera, they perform an 'agential cut' – the process of differentiating, in which they metamorphosize into light drops. Similar to the double slit experiment, they pass

through parallel fibres and create patterns of diffraction. One hundred and twenty kilometers of thread walked, stretched and placed one by one in the interstices of threaded rods, create an inclined surface covering the entire ceiling of the room.

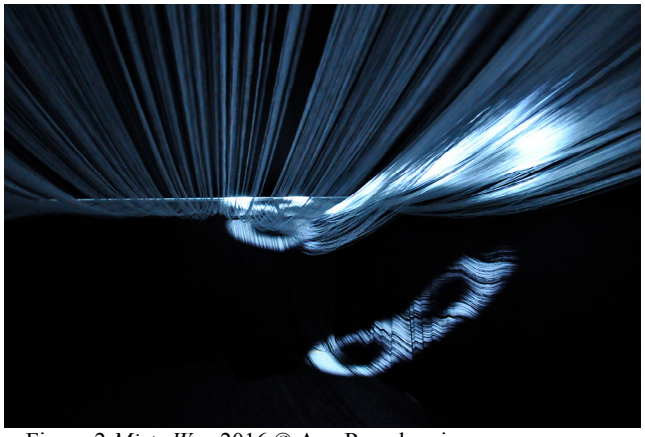

Figure 2 *Misty Way* 2016 © Ana Rewakowicz

We enter a dark space. The light drops move along and through the screen nets scattering on the floor covered in dark carpet. A fog of light, shadows and sound – a reconstruction of stitched noises recorded by a composer during lab experiments – splashes us. Immersion – we lie down allowing light and movement to touch our skin, ears and eyes. We listen to a cacophony of whispers, gasps, cries and screams. This intimacy of matter opens us up to meeting the stranger within us – water that passes through every cell in our bodies carrying oxygen and nutrients through the tiniest blood vessels (against gravity); water that transports electrical charges and fills our brains with thoughts creating a stream of consciousness… A rain of light drops; gazing at distant stars, asteroids or perhaps a solar nebula; is that the beginning of life? Dis/oriented… immersed in the darkness of abundant im/possibilities… we listen, extend a hand and touch.

What would it be like to rise to the sky to touch the clouds? What would it be like to bring the sky to earth? ***Nephelograph (Mist impressions)*** is a meeting place offering the possibility of an encounter with clouds. Ultrasonic misters break the surface of water into small droplets that then bounce against transparent plaques to come together and create turbulent fog masses – small clouds. Ventilators at the back push these small clouds through honeycomb filters and small clouds combine into bigger clouds. The apparatus is alive; water percolates as it rushes through tubing and hums pumping tunes. An animal – a dragon or a serpent perhaps, breathing clouds – falling clouds, bubble clouds, swirling clouds, spiraling clouds, tornado clouds, little clouds, big clouds, puffy clouds, exploding clouds, tunneling clouds… clouds…breaths… being close enough to touch, to sense, to feel, to intra-act with… breath-sounds – a symphony with four parts: sonata, a slow movement, a minuet and rondo played by an orchestra of different electric signals. You are welcome… you are invited… to come forward, to touch, to respond, to feel, to entangle with… yourself… clouds… halfway…suspended between earth and sky.

The *Mist Collector* project brings forward our phenomenological engagement with water, with *the other* that is never totally separate, and diffracts its meaning by inviting the participant to re-opening themselves to the ethical response-ability of holding together the inhuman (that lacks compassion) and accepting the invitation to respond. It is through the force of imagination (that gifts us with the possibility to sense the insensible and the indeterminate at the heart of every 'being to become') that we are able to enact change and create justice in what it means to live responsibly, 'together/apart' with all sentience (human and "inhuman") on this planet, in the cosmos, and with water.

Conclusion

To summarize, in this paper, using Karen Barad's framework of agential realism, I attempt to diffractively intra-act with three artworks that are part of the *Mist Collector* project of collecting water from fog, produced in collaboration with scientists at l'École Polytechnique in Paris. I argue that a) the concept of 'intra-action' (onto-epistemological inseparability) provides a good framework for talking about (inter)disciplinary collaborations b) that diffracting methodology enables us to perform poetic enactments and sensibilize us to differences c) the force of imagination sustained by poetics, activates touch, through which we are able to engage with ethical response-ability so needed in attending to the environmental challenges we face today.

To convey my arguments, I introduce the key concepts of agential realism: intra-action, agential cut, diffraction and response-ability, but I also review more elaborate ideas of touch, the strange within us (the other), manifestations of differences, the force of imagination and the question of ethical enactment. I illustrate my reasoning through (intra)disciplinarity and art and science collaborative research that I approach not as a duality of two cultures, but as a dynamic relationality. To recreate a sense of ethical response-ability carried in artworks that I consider as diffractive apparatuses, I use a poetic mode of expression to generate different patterns of meaning. And finally, I discuss ethics through the potent notion of *the inhuman* that, in contrast to non-human, steps inside of 'human' in order to address human 'ugliness' within.

Agential realism by dissolving the boundaries between epistemology and ontology brings the discussion about the issues of sentience back to matter. Rather than focusing on dichotomies of sentience/non-sentience, human/non-human, animate/non-animate, being/non-being, it brings forward the notion of relationality where everything, no matter how small, matters! By changing the focus from what/why *is*, to the more fundamental question of *relationship*, we surmount to the anthropocentric divisions of sub-

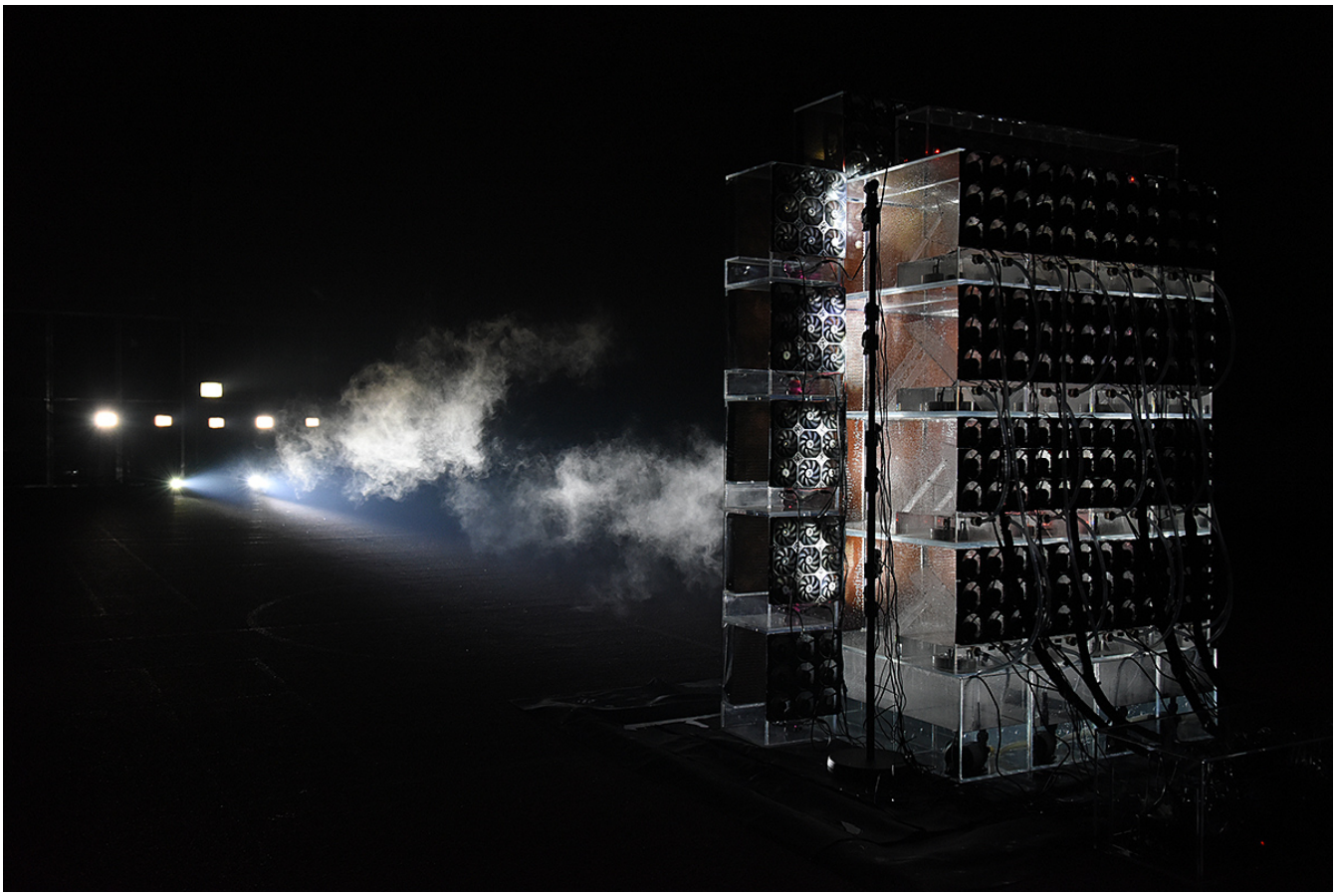

Figure 3. *Nephelograph (Mist Impressions)*, 2018 © Ana Rewakowicz

ject/object, nature/culture, value/fact, cause/effect and perform the ethical response-ability that we are "indebted to all others, where indebtedness is about, not a debt that follows or results from a transaction but, rather, a debt that is the condition of the possibility of giving/receiving." [30]

In the *Mist Collector* project, it is water that brings 'humanity/inhumanity' to the scale of a single drop, embarking the participant aboard an Earth sized vessel sailing in the fog that states the necessity for all sentience to start building a shared narrative, an uncertain shadow of an ever failing ecosophic Future/Present/Past that may still be shaped and imagined together.

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Author Biography

Ana Rewakowicz (www.rewana.com) is an interdisciplinary Polish-born artist, living and working in Montreal and Paris. Known for her stimulating, interactive and inflatable works that question our relationship with the environment, she is concerned with issues of sustainability and the need for (intra)disciplinary collaborations to face growing environmental challenges. Currently, driven by a desire to contribute to imaginative solutions that can improve living conditions, as well as to create a more acute awareness of the global water situation, she is working on a project of collecting water from fog, together with scientists at École Polytechnique in Paris, as part of her PhD research. Rewakowicz has works in the permanent collections of MACRO (Rome, Italy), MAC (Montreal), MNBAQ (Quebec City), Musée de Joliette (Quebec), and has exhibited in Canada, Europe, South America and the USA. She is the recipient of many awards, prizes and grants, and her works have been featured in various journals, films and books, most recently in *Bubbletecture* published by Phaidon (2019).

Inhaling Consciousness: Ecological Sentience at Molecular Level

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Abstract

The paper presents and discusses the work "Inhaling consciousness" investigating the bioart potential to activate an ecological consciousness in the audience exploring the neologism molmedia introduced by the author. The work was recently installed in Porto, Portugal, as part of the Consciousness Reframed 2019 juried exhibition "Sentient States: bio-Mind and Techno-Nature". Considering Portugal is a major cork-grower, the work explored possible integrations and information exchange between above-ground cork oaks microbiome and the human digestive system one. Exploring sentience from a cross-scale perspective, the artwork encapsulates influences from Brazilian Neo-Concrete Movement (1960-1970) such as the concept of a transobject – the intention of incorporating an ordinary object into an idea, making it part of the genesis of the work without losing its previous structure. The apparatus is adapted from a medical inhalation breathing system - a reservoir bag having a cork oak bark excerpt inside, from which a tube is attached to a nebulizer and another tube to a breathing mask, having a particles sensor system (Arduino, sharp dust sensor, LCD 16x2) attached to the bag near the mask's tube. The work invites to reflect on the impact this dialogue that happens at molecular level can have in shaping behavioral patterns in humans. For ISEA 2020 in Montreal, a variation of the artwork is considered, addressing local ecological issues from a panpsychic perspective, replacing the cork oak by the Coffee-tree (Gymnocladus dioicus) – a relic of processes and environments driven by extinct large mammals and a threatened species in Canada. Facing the restriction imposed by COVID19 pandemic, leading to an online version of ISEA 2020, an alternative version was developed, exploring the above ground trees microbiome from the city the artist is based at moment in Brazil.

Keywords

Bioart, horizontal gene transfer (HGT), microbiome, above-ground trees microbiome, threatened species, memory, consciousness as emergence, panpsychist philosophy, molmedia, transobject, neo-concrete movement, bolide.

Introduction

In "Inhaling consciousness" (2019-ongoing) the artist investigates the bioart potential to preserve planetary and cosmological chemical heritage and foster ways to activate an ecological consciousness in the audience exploring the neologism molmedia [1] – a metaphorical reference to the mole concept. The mole is an amount unit that provides a specific measure of the number of atoms or molecules in a sample of matter.
It is defined as the amount of substance containing the same number of discrete entities (atoms, molecules, ions, etc.) as the number of atoms in a 12 g sample of pure 12C. Mole, in molmedia, denotes not exclusively the quantitative amount of substance but the embedded chemo information; media, refers to the information circulation and exchange processes at elementary entities level (at molecular, atomic and subatomic levels) within a given system, taking the chemo substances as messages.

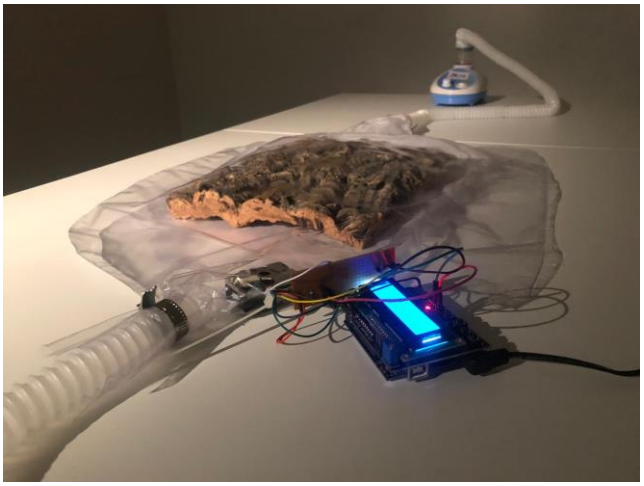

Figure 1. "Inhaling consciousness" (2019) at Consciousness Reframed 2019 juried exhibition in Porto, Portugal (photo by the artist)

The work evokes perspectives in which consciousness and the self can be seen as emergences from plurisystemic conversations within the environment.

The work is the product of a two years' investigation and explores sentience from a cross-scale perspective encapsulating influences from Brazilian Neo-Concrete Movement (1960-1970) such as the concept of a transobject, considering the intension of incorporating an ordinary object into an idea, making it part of the genesis of the work without losing its previous structure. The apparatus is adapted from a medical inhalation breathing system considering an aesthetic and conceptual relation with two references – Hélio Oiticica's [2] [3] B50 Bólide Saco 2 Olfático, 1967 plastic, rubber and coffee 65,0 x 52,0 x 2,5 cm, and Barbarella (1968) movie's giant hookah which dispenses 'Essence of Man' [4].

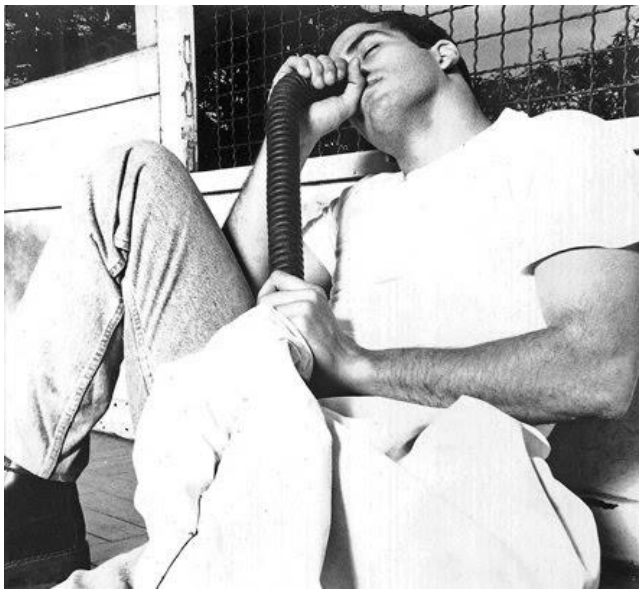

Figure 2. B 50 Bag Bólide 02 "Olfactic" (1967) by Hélio Oiticica

The work explores possible integrations and information exchange between above-ground cork oaks microbiota and the human respiratory and digestive system's one. For the version installed in June 2019 in Porto, considering Portugal is a major cork-grower, producing nearly half the cork harvested annually in the world, the species covering approximately 8 percent of the total area of the country, the intention was to offer to the audience the opportunity to reflect about the complexity of molecular level integration between Portugal humans' population and the plant kingdom one.

Considering potential horizontal gene transfers (HGT) between these two very eclectic populations of microorganisms, the work invites to reflect on the impact this dialogue that happens at molecular level can have in shaping behavioral patterns, influencing the emergence of an expanded shared consciousness of the multi and unicellular peninsula inhabitants.

Figure 3. cork oak tree bark excerpt extracted by her uncle from the artist's grandpa lands in the village of Folgoso, Raiva, Castelo de Paiva, Portugal.

The work consists of a transobject from the appropriation and transformation/adaptation of a nebulizer – a medical Cool Mist Inhaler and Accessories (Tubing, Cup, Mask), a reservoir bag and a dust/particles sensor system attached (Arduino, sharp dust sensor, LCD 16x2), having a cork oak tree bark sample inside. For the version installed in Porto in June 2019, the artist had in the interior of the plastic vapor chamber, a cork oak tree bark excerpt extracted by the artist's uncle from her grandpa lands in the village of Folgoso, Raiva, Castelo de Paiva, Portugal.

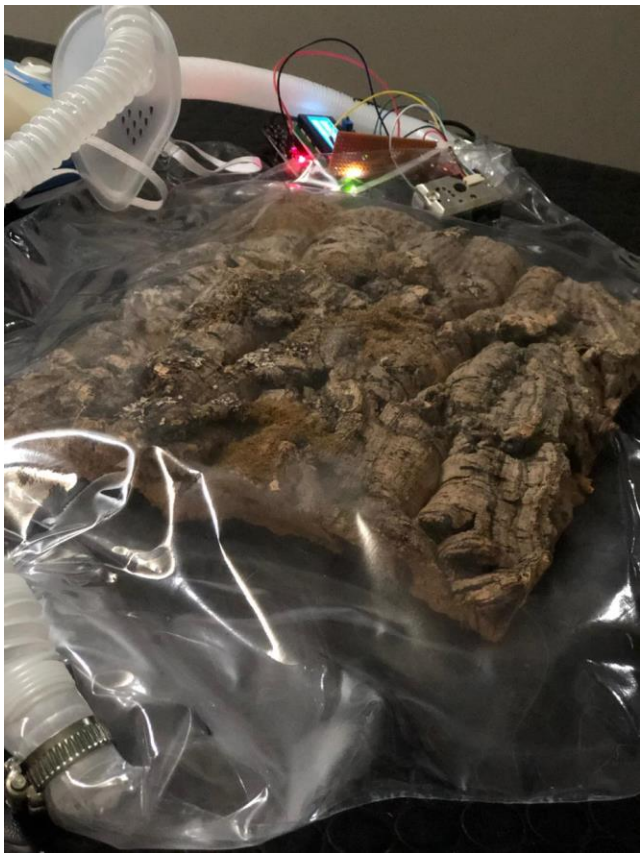

Figure 4. “Inhaling consciousness” (2019) at Consciousness Reframed 2019 juried exhibition in Porto, Portugal (photo by the artist)

Making the openness productive

Considering the invitation for the audience to inhale a sample of the tree bark’s microscopic inhabitants, inviting those contaminants inside of the human body, the installation plays with instinctive reactions and invites to reflect on our vital relation with microorganisms’ populations.

Considering the reaction of the audience in the first time the work was installed in 2019, it was interesting to observe how open to the experience all the visitors were. How could they suppress the protection against stimulation? According to Inge Hinterwaldner, in works such as Oiticica’s “B 50 Bag Bólide 02 Olfatic”, first of all, “[…] the open arrangement should meet participants ready to open themselves up and as a second step it should make this openness productive.”[5] The researcher attempts to portray what kind of perception work Oiticica links to creativity, making it clear that it is not the intention to turn Oiticica’s art into something pathological [5]

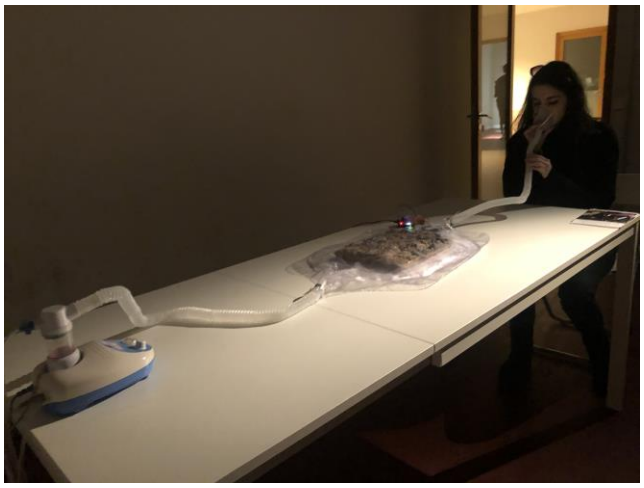

Figure 5. “Inhaling consciousness” (2019), Consciousness Reframed juried exhibition “Sentient States: Bio-Mind and Techno-Nature”, reaction of the audience: openness (photo by the artist)

Hinterwaldner [5] points that, in the framework of psychoanalytical traumatology, Sigmund Freud described the “stimulus barrier” (Reizschutz) as a defense mechanism of the individual against stimulation from the outer world. For a long time, a weak filter mechanism was restricted to psychopathological findings in patients diagnosed with schizophrenia. The research mentions that [5] psychologists Shelley Carson and Jordan Peterson offer an additional perspective looking at the possible connection between latent inhibition, the personality trait openness to experience and creativity. They found out that under some conditions a reduced filtering of stimuli can become productive.

Figure 6. “Inhaling consciousness” (2019), Consciousness Reframed juried exhibition “Sentient States: Bio-Mind and Techno-Nature”, reaction of the audience: openness (photo by the artist)

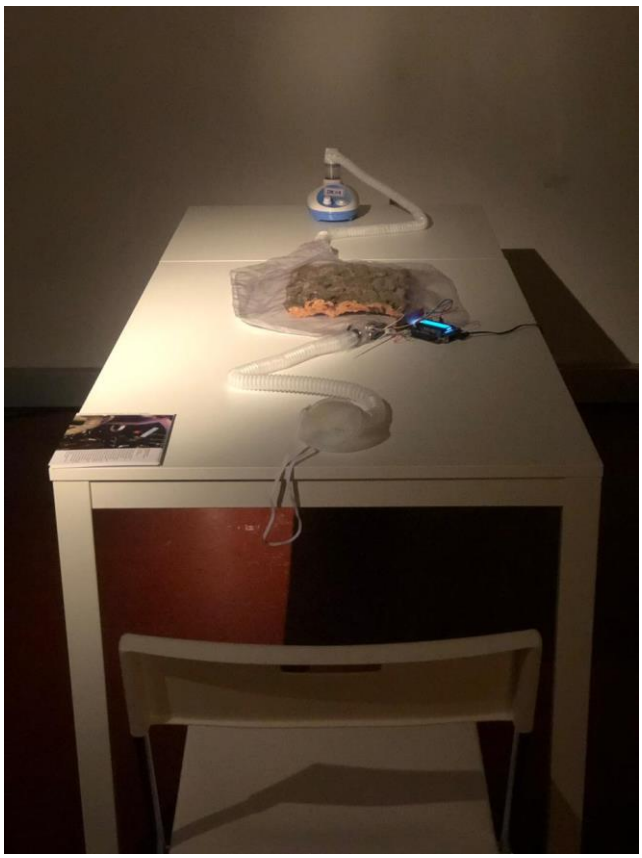

Figure 7. Inhaling consciousness" (2019), Consciousness Reframed juried exhibition "Sentient States: Bio-Mind and Techno-Nature", -an invitation for a performative healing - embodying nature (photos by the artist)

Nevertheless, under the light of the most recent find-ings in the study of human microbiome [6], since in patients diagnosed with schizophrenia we have a dysbiosis (a dysbacteriosis or a microbial imbalance, implying the prevalence of monotonic species such as lactobacillus in our gut biome) the behavior can be directed by a need for contamination, that means, to potentially stimulate the growth of a health microbiome. The message that directs the behavior can possibly come from a molecular level. Here, *molmedia* [1] *is the message*.

"Inhaling Consciousness" is part of the artist effort in exploring the body itself in its communication complexity. The consideration of the human body as something potentially central in the poetics, is dissolved by the poetics itself. What remains as central is the integration between this definition that is the 'human body' and the environment in a molecular level. Body and environment disappear if we think about the chemical trades as trades that shape who we are, the way we perceive the world - the phenomenal world created.

Back in 2016, the artist produced the installation "Ulysses Pact: Metagenomic Entanglements" [8], presented and discussed at ISEA 2018 in Hong Kong, and it was the first emergence of a series of works investigating plurysystemic conversations within our body from a cross-scale perspective. The central question in the poetics was - do the molecules the microbiome and native human body cells trade have the power to chemically attract us and guide our behavior? In previous works, the artist was exploring non-local communication and its influence in human behavior and emotions. Her interest was in exploring non-local communication between living organisms driven by subatomic quantum communication phenomena.

Coffee-tree (Gymnocladus dioicus): a relic of processes and environments driven by extinct large mammals

For ISEA 2020 in Montreal, a variation of the artwork is considered, addressing local ecological issues from a panpsychic perspective, replacing the cork oak by the Coffee-tree (Gymnocladus dioicus), a threatened species in Canada.

Figure 8: Coffee-tree bark, Montreal [10]

According to CBC Montreal [9], for more than a decade, Milton Park residents in Montreal have protested against the proposed development of what was the garden behind 172-year-ol Notman House, named after the photographer William Notman, who lived there until the 1890s. In 2018, Montréal administration has announced its intention in preserving Notman Garden as a park.

Considering related actions, the Government of Canada [10] organized and published a proposed recovery strategy in 2014, following the Species at Risk Act Recovery Strategy Series, for the Kentucky Coffee-tree (Gymnocladus dioicus). Some of the large trees in the garden near Notman House are more than 130 years old, including Kentucky Coffee-trees. Coffee-tree (Gymnocladus dioicus) is a relic

of processes and environments driven by extinct large mammals [11] – because no native herbivores consume its toxic seeds, reducing its dispersal ability, and since elephants in Asia and Africa devour similar seeds, it has been hypothesized that the now-extinct mastodon may have consumed and dispersed its seeds.

The intention in proposing this potential installation for ISEA 2020 as an add to the paper presentation, not necessarily for the juried exhibition, was to bring the reflection the work awakes closer to the host city and country's inhabitants. The poetics embraces the panpsychist philosophy perspective brought by Alfred North Whitehead (1861–1947) exploring the subtle relation between living entities – human native cells and hosted microbiome –, and lifeless matter – molecules, atoms, subatomic particles.

Facing the restriction imposed by COVID19 pandemic, leading to an online version of ISEA 2020, an alternative version was developed, exploring the above ground trees microbiome from the city the artist is based at moment in Brazil.

Through molecular level exchange of information, human body and its hosted and microbiome population continuously change themselves in dialogue with external microbiome populations that enters the body through breathing, eating, touching. These process is responsible for continually reshaping the self. "Inhaling Consciousness" invites to meditate on these vital relations by having a seat and calmly enjoy breathing, or being fulfilled by, the inhabitants of trees phyllosphere - the total above-ground portions of plants as habitat for microorganisms. Inhaling we are exchanging information at 'elementary entities' level.

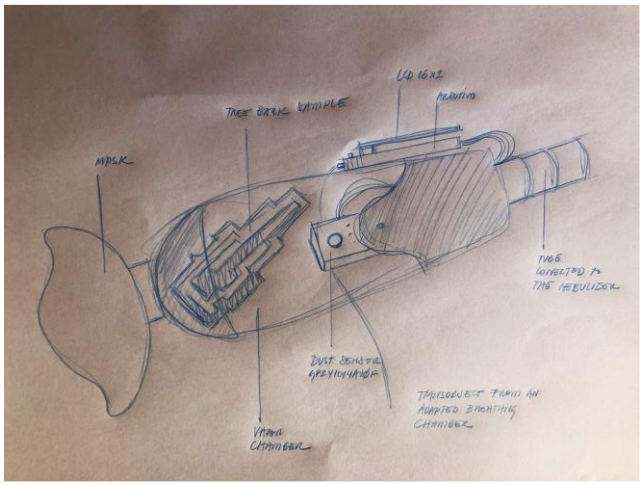

Figure 9: Installation components for the ISEA 2020 Montreal version: Rechargeable Pocket Inhaler (Mini Handheld Ultrasonic Humidifier), having a sample of the Kentucky Coffee-tree's bark inside of the vapor chamber, and a particles sensor system attached to the breathing mask (Arduino, sharp dust sensor, LCD 16x2). (sketch by the artist)

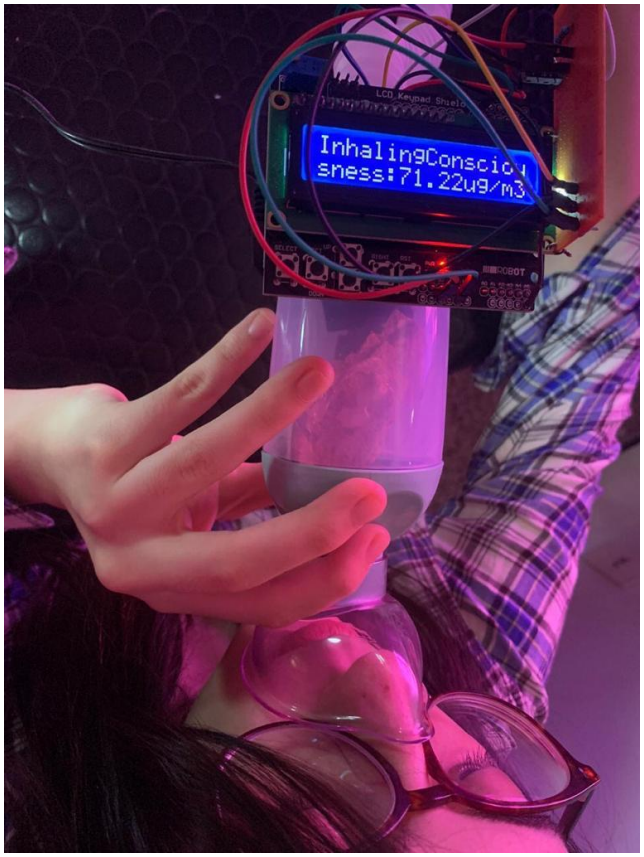

Figure 10: Installation components for the ISEA 2020 online version: Pocket Inhaler's vapor chamber (Mini Handheld nebulizer), having a sample of the *Terminalia catappa*'s bark inside together with a particles sensor system (Arduino, sharp dust sensor, LCD 16x2) that allows the audience to visualize the amount of particles being inhaled.(photo by the artist)

The experimental version of the installation for the ISEA 2020 online version includes a pocket inhaler's vapor chamber (Mini Handheld nebulizer and breathing mask), having a sample of the Terminalia catappa's bark inside together with a particles sensor system (Arduino, sharp dust sensor, LCD 16x2) that allows the audience to visualize on the mini display, the information about the amount of particles being inhaled. The Terminalia catappa species is abundant in the city of Fortaleza urban area and all along Brazilian Atlantic coast. It is a large tropical tree in the leadwood tree family that grows mainly in the tropical regions of Asia, Africa, and Australia. Common names in English include sea almond, tropical almond and beach almond.

For these versions of the installation, the sensor placed inside of the vapor chamber attached to the breathing mask, GP2Y1014AU0F dust sensor, measure the total dust density inside of the chamber - this total includes the concentrations of 1 micron particles, 2.5 micron particles, 10 micron particles. The information is visualized in a small LCD attached to the Arduino bringing together the phrase "*inhaling consciousness*".

Figure 11. *Terminalia catappa*'s bark excerpt extracted by the artist from her neighborhood in the city of Fortaleza, Brazilian Atlantic coast. For ISEA 2020 online edition. (photo by the artist)

Figure 12. *Terminalia catappa*'s bark excerpt extracted by the artist from her neighborhood in the city of Fortaleza, Brazilian Atlantic coast. For ISEA 2020 online edition. (photo by the artist)

Considering most bacterium range from 0.2–2.0 μm (micrometers) in diameter, by accepting the invitation, the audience is open to get consciously invaded by the trees' phyllosphere's micro inhabitants. Phyllosphere is a term used in microbiology to refer to the total above-ground portions of plants as habitat for microorganisms. The phyllosphere is both scientifically and economically an important habitat in which to study microbial ecology.

Because of the importance of many phyllosphere microbial inhabitants to plant health, there will probably be many practical applications that result from a better understanding of the interactions of microbes with the plant and with themselves. While the microbiology of roots has received quite a lot of attention, the microbiology of aerial plant parts is much less well-studied, although it is arguably of even more importance than the soil environment.

Final Considerations

The fact that odors can trigger the evocation of memories has become known as the Proust [12] or Proustian phenomenon due to a recurrent mention of an anecdote from Proust (1922/1960) in which he is vividly reminded of childhood experiences by the smell of a tea-soaked pastry. Combining odors mainly produced by the single-celled and multicellular organisms that inhabits the Coffee-tree (Gymnocladus dioicus) surface and by the Coffee-tree cells themselves, the main reflection that structures the artwork implies interrogating if the odors (since they are derived from chemical substances, molecules) can encapsulate, beyond intimate memories, molecular memories of ecological-evolutionary interferences in our intrinsic relation with the environment – from the origins of single-celled life forms to our controversial Anthropocene. Consciousness, understood as an emergent phenomenon, can be seen as resultant of these molecular conversations that transverse scales and capture ecological and cosmological time.

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Glowing Lichen: Visually sensing social spaces

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Abstract

Glowing Lichen is a media-art installation that explores a series of sensitive connections between a physical-digital artefact and an audience. This installation comprehends two luminous organisms that cohabit in the same ecosystem and react to the surrounding environment in distinct ways. Each organism has an individual pre-disposition, i.e., personality — it can gravitate across four types: calm, happy, nervous and aggressive. As a result of being sensitive to the audience behaviors, interactions and environment changes, each organism feelings and transformations will be triggered by these characteristics. Hence, we propose a reciprocal system where the way an audience behaves will influence the way a set of artificial organisms evolves. In the end, this results in a series of emergent behaviors of two artificial organisms growing unique aspects spawn by the environment they inhabit. Additionally, we invite the participants to reflect on their own interactions when inhabiting a space in a certain moment either as individuals or as a community of shared behaviors and perceptions.

Keywords

Media-Art Installation, Nature-Inspired, Artificial Organisms, Social-Emotional Behavior, Visual Sensations, Perception, Interactive Artefact

Introduction

Most of the living species on earth are molded by the context in which they are inserted. In turn, this translates into the growth or evolution of specific behaviors that are triggered by the environment characteristics. For example, in nature, lichens growth and survival depend mostly on the elements that they absorb from the air. [12] The environment they are inserted in may affect the way they look — shape, color, and growth rate — or even dictate their survival and reproduction chances.

As individuals, we are usually minded in our own perception of reality and we might not be aware of how our actions affect the environment that surrounds us. When we inhabit a public space, we share a moment and a place with other beings, despite our social preferences or pre-beliefs. Our individual actions shape instantly that community. In turn, these actions contribute to establish a mood or feeling for that unique moment.

Inspired by the Lichens behavior and visual organic beauty we ask the following: What if our group behaviors and characteristics of a public space could be absorbed by a special species of digital lichens and then reflected by them? Can we build a more conscious relationship between humans and spaces through a media-art installation that evolves based on the audience actions?

Likewise, the plants and organisms that grow and evolve specific characteristics depending on the environment they are inserted in, we present Glowing Lichen. Glowing Lichen is an artificial ecosystem (see Figure 2) with emerging characteristics that are influenced by a set of social-emotional surrounding behaviors and interactions. Taking advantage of the flexibility that bio-inspired artefacts provide to simulate behaviors and express them visually, we propose a way of connecting sensitive artificial organisms to a public space. Just like an organic lichen, these digital agents are sustained and fed by the characteristics of their current environment, to which they try to adapt. As if the artefact had not been placed in that specific local, but unexpectedly born from it, blurring the limits between the space and the artefact. [9]

Through color and intensity of light, we represent the properties of the artificial lichens' surroundings, and through a variety of reactions we reflect the emotional states of these organisms, aiming to merge with human personalities. In sum, the organism's behavior and visual expression influenced by the physical enclosing environment and the audience interaction with the artefact. For example, if an aggressive organism senses aggressive behavior like loud noises or a strong force pressure it will get a more aggressive behavior expression while a calm organism will most likely try to avoid conflict.

We note that this installation has already been exhibited at a media-art festival (Reboot Fest 2019), allowing a first experiment of the artefact in a social space.

This paper aims to support the reflection and future creations to the topic of sentience in media-art through the following ways: (i) by proposing a way for an media-artefact to sense and process its surrounding environment; (ii) by allowing an artefact to mold its behaviors and evolve according to a set of social-emotional interactions; (iii) by promoting a conscious reflection and perception of our actions, either as individuals or as a community, in a public space.

Nature Inspired Media-Art Installations

The overlap between biology and art — known as bio-art — has been used by several artists to manipulate the processes of life — such as survival, reproduction, among others — as well as to achieve a series of organic visual expressions with a certain degree of autonomy and unpredictability. [6, 10] Additionally, these algorithmic interpretations are capable of generating the complexity usually present in nature, and thus mediate a human-machine symbiosis dynamically. Popular computational expressions of these behaviors range from simulations of “movements of a school of fish, pattern formation in bacteria, slime molds or virus’s infection". [18] As a matter of fact, outputs from these nature-inspired systems will not be precisely reproducible, creating a value through its partially non-deterministic outcomes. [17, 18]

We hereby highlight three works that combine biological systems with digital systems for artistic or aesthetic purposes. The first, “Petri”, developed by Beyls [4] is an interactive audiovisual installation based on a society of autonomous artificial agents sensitive to each other and to the physical human influence. He attempts making a bridge between an artificial life system and a physical world such that there is a mutual influence. The connection to the physical world, achieved through computer vision will in turn, influence the particles' location and emergence of new particles’ breeds. Moreover, he introduces a variable of awakeness, allowing the system to control the agent’s interaction with the surrounding environment – if they are sleeping, there is no interaction. Likewise, our system, the changes in the physical environment of Beyls installation will impact the artefact at global and local levels.

The second, “Physarum polycephalum”, is inspired in a unicellular slime mold. In this work the authors use a biological approach to find the shortest path between two points. To reinforce the best path, nutrients are supplied at these key points, leading then to the emergence of a line that connects the two locations. [17, 18]

The last bio-artwork, “A New Mould Rush”, is a game "exploring playful interactions between humans and biological entities (such as organisms, cells or molecules)” [11]. Unlike the previously presented work, the organisms are real instead of digital. Players commands are executed in real-time, however the resulting outputs of human actions are slowly observed since these organisms need bigger time frame to evolve when compared to an artificial organism. Nonetheless, "in some circumstances, a single species can grow aggressively, and outgrow other species that may be present in the culturing container" [11]. Even though the final result is expressed in a physical living organism it is interesting to observe how human behaviors mold the way it grows.

Glowing Lichen: A Sensitive Ecosystem

The digital glowing lichen — likewise an organic physical lichen — senses and absorbs information from its surrounding environment and then reflects it. Each glowing lichen has unique characteristics and behaviors that resemble human personalities, as well as a survival probability that depends on the environment conditions that they are exposed to. This makes each environment sympathetic or responsible for the growth of particular species of digital lichens or, in other words, a key factor in the emergence of unique personalities.

Through the behavior of the glowing lichens, it is possible to assign a personality or sensation to a public space in a specific moment and represent it visually. It may not be obvious for the passers-by that Glowing Lichen is a result of its surroundings, nevertheless, the light characteristics of the digital agent establishes a mood as they may reflect a more aggressive, nervous, calm or happy behavior. With this mood they also contribute to shape the environment, as the public may feel less comfortable with a possible aggressive behavior by the lichens, thus causing a chain reaction: it shapes the passers-by actions, that shapes the environment that, in turn, affects the existing lichens. This cycle (see Figure 1) makes the glowing lichen not only an artefact that reflects its environment but also an element of that environment, presenting a visual representation that captures the constantly changing atmosphere of a public space. As the ecosystem is contaminated by several causes — due to environment and direct interactions with human subjects — they react and try to adapt to these changes

(personality traits). The transformations in the ecosystem that endure over time will alter its balance (life span) and reshape the organisms' behaviors through changes in personality traits.

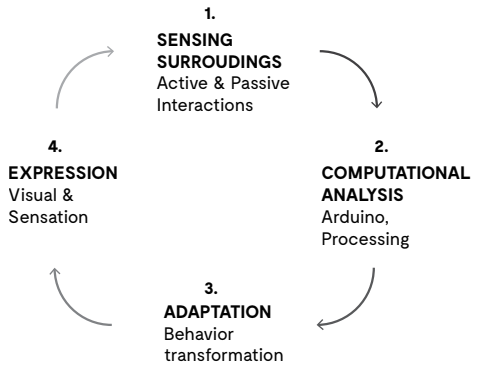

Figure 1: The artefact is constantly iterating through a process of four main stages. (1) The two organisms are constantly sensing their surrounding environment. (2) There is a computational interpretation of the environment information, which in turn influences (3) the way the organism transforms and behaves. (4) Lastly, each organism expresses its current sensation through a series of luminous objects (RGB LEDs).

Personality traits

For this medi-art project we explored distinct behaviors grouped into four personalities: calm, happy, nervous and aggressive. We attributed a personality to each living organism in the ecosystem — in the present project only two glowing lichens with corresponding personalities exist simultaneously:

Calm: The calm lichen prefers environments with little movement. When approaching an audience, the lichen collapses by decreasing its size. It is disturbed by direct interaction and changes position to avoid it.

Happy: Happy lichen prefers hectic environments and direct interaction. Its personality is demonstrated by frequent movements and constant random changes in the color of each of its LEDs, thus provoking a joyful festive atmosphere.

Nervous: The nervous lichen prefers well-lit spaces with little movement. It is uncomfortable with people approaching and is highly unstable with their direct interaction. This discomfort and instability are demonstrated by the loss of color and by fast and frantic random movements.

Aggressive: The aggressive lichen behaves confidently and seeks confrontation. His personality becomes more evident in noisy and agitated environments. Approaching people causes a color change of the lichen to red, and direct interaction causes sudden and frantic changes in the intensity of light, thus alerting the public to its aggressiveness.

Life and Death

An important characteristic of the luminous organisms is life span. "We can think of the difference between life and death as the difference between the visible and the invisible". [10] This is, if the ecosystem reaches such an imbalance, they can die. When such happens, a new generation of organisms is reborn, however, this time with another personality traits or predisposition. As this process is iterative, the ecosystem may begin with one nervous and one calm organism, however when it does reborn, we may end up with two nervous organisms.

Moreover, as our lichens react to the environment in distinct ways due to their personality traits, a loss of life span also depends on a distinct set of conditions:

A *calm* organism will have its life threatened if the audience remains close to the artefact, touches it, or the environment is noisy and has low luminosity.

A *happy* organism will decrease its lifespan if the audience is far from the artefact, not touching it, or the environment is quiet and has a low luminosity.

A *nervous* organism will have its life span decreasing if the audience is close to it, touch it, or the environment is noisy and has a low luminosity.

An *aggressive* organism will have its life threatened if the audience is close to the artefact, is not touching it, the environment is quiet, or has low luminosity.

Visually, the life of a lichen is represented through changes in shape, color and movement (see Table 1 and Figure 2). On the other hand, a low life span is visually represented through low color saturation, lower brightness, and slower movements.

Although individual actions feed the glowing lichen, the personalities represented by the lichens are a global result of group behaviors and their surrounding conditions. This type of experience opens space for a reflection on our preferences and empathy towards certain types of personalities and their relation to the ones we are feeding as participants, and thus shaping our physical and social environment. As pointed by Plutchik [15] "emotion is a kind of homeostatic process in which behavior mediates progress toward equilibrium", it results from of a series of "events made up of feedback loops". This is a concept which we want to play with, the fragile balance of an emotion and the way a social interaction can model it.

Personalities and corresponding actions-reactions

Personality	Default visual expression	Passive Interactions (increasing values)			Active Interactions (increasing values)	
		Light	*Noise*	*Proximity*	*Touch*	*Weight*
CALM	smooth contours, soft and slow movement, light green	+ dispersion	+ movement speed	- size	+ color change + position change	+ blinks
HAPPY	smooth contours, soft and quick movement, yellow	/	+ movement speed	+ brightness + color randomises	+ blink	+ blinks + position change
NERVOUS	sharp contours, abrupt and quick movement, purple	+ size	/	+ white + dispersion	+ movement speed	+ position change
AGGRESSIVE	sharp contours, abrupt and slow movement, medium blue	+ size	+ movement speed + dispersion	+ position change + color change (red)	+blinks	+ blinks

Table 1: Description of the behaviors for each pair of personality-interaction. All of the presented reactions correspond to increasing values triggered by both passive and active interactions.

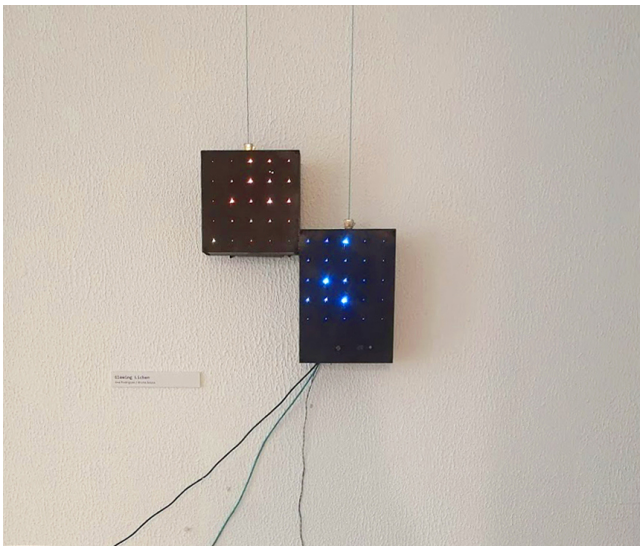

Figure 2: Two Lichens: Happy and Aggressive default visual representations.

In Table 1 we present an overview of the impact that the human actions and the environment characteristics have on each personality (calm, happy, nervous, aggressive). This affective division of emotional states was inspired by Russell's two-dimensional circle of emotions.[16]

There are two ways of interacting with Glowing Lichen: passively or actively. While a passive interaction is an interaction that depends on unintended actions such as participants distance to the artefact or noise, an active interaction is a type of interaction where the artefact is fed by intended actions from the participant, like touching the artefact.

Shaping Behaviors and Interactions

Conscious and Unconscious Interaction

Rafael Lozano-Hemmer is a digital artist known for his interactive artworks that create relations between the elements of its audience and the space they are in. [1] One of his projects, Pulse Park (2008), measures the heart rate of participants and projects them in a public park through two hundred searchlights. When someone is interacting, the searchlights project its heart rate. Otherwise, each one of the searchlights will illuminate the park based on the heart rate of one of the last two hundred participants, sequentially. [13]

This immersive experience increases the emotional involvement of the audience with something as intimate and personal as "their own and other people's heartbeats." [3] It also creates an emotional connection between the public space and the participants. By transforming spaces through their interaction, the audience feels part of it, thus reflecting on the space itself and their place in it. Similarly, in Glowing Lichen, the audience transforms the space when their actions and characteristics as a group are publicly made visible. Through light transformation and movement these digital organisms, create then a new connection between the elements of the audience and the space.

The system's potential for emergent behavior is achieved by providing human personalities emotion-based to lichens. Although there is an emotional categorization, it is mostly used by the system to process the environment information and react by changing lichen's nature, whereas the audience should be able to recognize that its actions triggered these transformations in the system.

Another aspect that we can observe in both projects is the two distinctive forms of participation. In Pulse Park the public is active when he or she interacts directly with the

sensor, but it also can be passive as their participation may remain long after he/she leaves the space.

In Glowing Lichen, as mentioned before, the audience can participate by directly interact with the artefact and observe its immediate reaction — however, unlike Pulse Park, this type of interaction is not necessary for the artefact to be activated.

An additional way for the audience to participate is passively, as the characteristics of their actions — disregarding the artefact — are observed and absorbed by the lichens and then influence the behaviors of the two luminous organisms, and thus determine the overall mood of the place after they leave it. (see Figure 3) As such, when contemplating the artefact, participants can become simultaneously agents and spectators. [3]

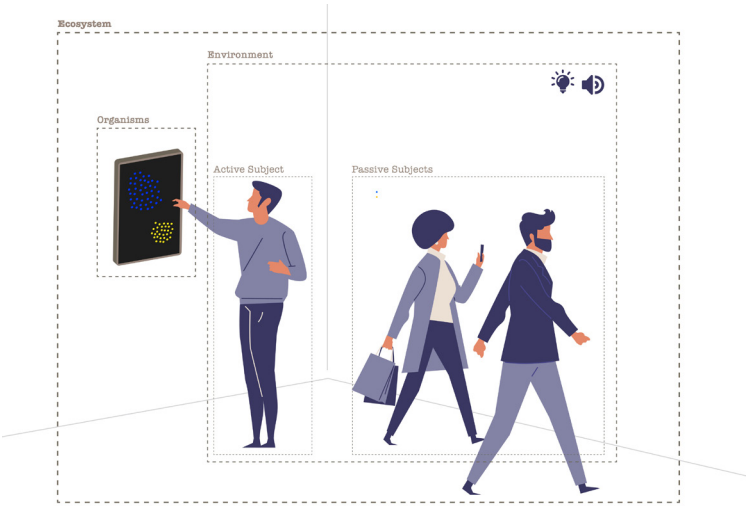

Figure 3. Details of the Ecosystem composed by two Organisms and an Environment. The Environment includes the Subjects who can either be Active — interact directly with the digital lichens — or Passive — their actions and behavior contribute involuntary for the characteristics of the environment. Besides the Subjects, the Environment also contemplates overall characteristics such as light and sound conditions.

Making Visible the Invisible

Communities of place [5] may exist in a specific fraction of time and can vary during the day in a public space. Although the public space is a local for sharing, consciously or not, the plurality of interactions [3] that are shared and achieved as a group are not always visible and recognized. By absorbing, processing and reflecting the characteristics of these communities, the glowing lichens make visible the invisible. Using light as an interface, shared emotions are visible outside the bodies of the audience. It is given form to feelings and their transformations, reinforcing the emotional characteristics of the public space.

When analyzing Rafael Lozano-Hemmer pulse-based works, Claudia Arozqueta describes the representation of human pulse in the public space through light projection, as a "reterritorialization" as it crosses "the boundaries of the skin". [3] In the same way, Glowing Lichen outlines our emotions — translated into individual actions — and shared personality to the public space in the form of light. They occupy a new territory as elements necessary to the survival of determined species of digital agents.

The presence of this artefact may intensify and add a stronger presence to routine behaviors and activities of a common place, reinforcing the relationship between art and reality. Here, through a visual representation of our communal mood, it challenges our conception of reality, or at least a less visible part of it. The glowing agents reveal hidden images — the image of a shared personality — that may vary according to different circumstances and contexts.

Technology as a Mediator

In Glowing Lichen, technology becomes an instrument to create a dynamic experience. As the environment we are referring to is open to constant change, the technological approach makes it possible for the lichen to dynamically adapt to it.

Through sensors and algorithmic processing, the digital organisms are able to "observe", "listen" and "sense" their physical and social surroundings (see Figure 4).

By using real time external input, we create a more relatable experience, a moment of awareness and reflection, allowing new connections to be formed between the artefact, the public and their shared environment.

To provide the organisms a way of sensing and responding to its surrounding environment, we used a set of physical sensors — ldr, microphone, ultrasonic, conductive ink, pressure — and one actuator — rgb led strip. Furthermore, we performed a Serial Communication between Arduino and Processing to process the sensor's data in real time and reshape the organism's behavior (personality traits, life span, visual expression, etc.) accordingly.

Regarding the physical artefact itself, an RGB led strip is organized in a uniformly-spaced grid, inside a wood box, which then illuminates a perforated wood board parallelly positioned on top of it, in the front face of the box (see Figure 4).

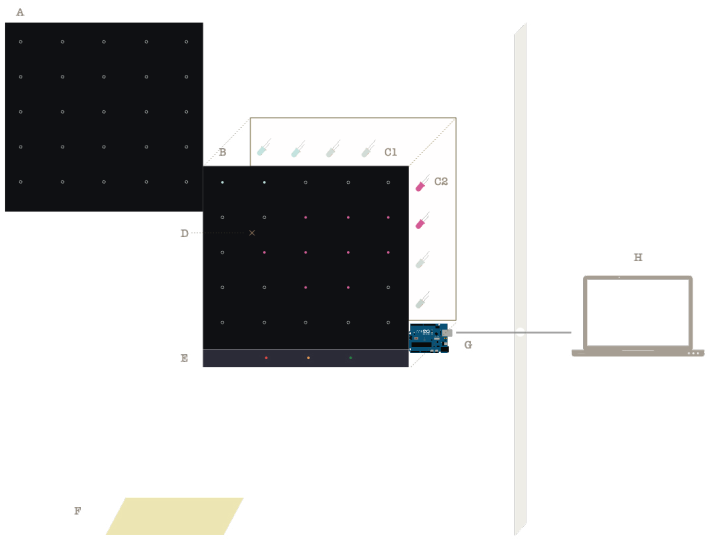

Figure 4. Physical artefact assembly. A & B - organisms' areas of expression, C1/C2 - LED off/LED on, D - touch point, E - noise, ultrasonic and ldr sensors, F - pressure sensor, G - arduino, H - computer running serial communications between Arduino [2] and Processing [14]

The Exhibition

Glowing Lichen was exhibited in Reboot — Digital Arts and New Media festival, in Lisbon 2019. This festival had a free admission to the public at *Palácio de Baldaya* — a space dedicated to activities regarding culture and innovation. This exhibition gave us the chance to test the system and observe its impact in a public environment (see Figure 5). Through the design phases of implementation, assembly, and exhibition observation we could analyse its impact and able to identify the aspects that corresponded to ours expectations as well as the ones that need further development and improvements.

Regarding the **public behavior** towards the object we could observe that its interactive nature was not immediately obvious. As for the **physical structure**, we highlight the following aspects as relevant to create a more effective experience:

Dimension: Technical and material limitations defined the dimension of the structure,
but we believe that a bigger box would cause a bigger impact on the audience.

Number: A larger number of boxes with lichens distributed in the exhibition space could easily create a more contaminated environment, making the relation of the public with the digital lichens closer and more immersive.

Light output: The amount of light that was visible to the public was lower than expected. The small holes and the black color of the box limited the light output. In future iterations we will explore larger holes and a lighter color of the box or a different material that could improve the reflection light.

Environment and Organisms: The characteristics of the environment didn't show a big flow during the exhibition — the number of visitors, the ambient sound — so the organisms remained in one state most of the times. In order to better observe the behavior of the organisms, we manually increased their sensitivity to small changes in the ambient. In future exhibitions we shall implement an automatic calibration of each sensor so it can adapt to different environments.

Exhibition Space: The exhibition space around the object shall be free of obstacles so they don't interfere with the information captured by the sensors in the object.

Figure 5: Participant interacting with the lichens. Calm organisms on the left, nervous organism on the right.

Conclusion and Future Work

Glowing Lichen is a media-art installation that proposes a meaningful way of sensing spaces by making visible the personality a public space in a specific time. It creates a visual bridge between individuals and their collective personality, in a specific time and space, mediated by the artificial lichens that emerge from it. By adapting to its surroundings, the artefact merges not only with the space but also with its daily rhythms and movements. It challenges the public's perception of reality by generating new readings of common places and by raising awareness of a

collective existence via a digital complex system inspired by nature. [3]

Through the manipulation of some characteristics of light, such as color or intensity, it simulates behaviors that resemble four distinct human personalities. This experience creates a sense of community between people that share the same ephemeral time and space and are responsible for the life and death of each one of the four species of glowing lichens. More than something to be appreciated aesthetically, this artefact aims for individuals to sense collectively the emotions of a public space.

Besides the future explorations and improvements that we identified in the previous section we also present some new aspects that we would like to introduce to the installation. In future iterations of the project, we aim to implement evolutionary algorithm [7] so that lichens are able to adapt to their environment and to other glowing lichens, or even to allow the ecosystem to create new personalities based on their surroundings.

Although this project has already been available in an exhibition, its implementation may benefit from being placed at other locations as it will allow to know which personality is more likely to survive in a determined public space. We also think it is important to work on how to compel the viewer to interact with the system and how to create a closer relation between the public and the organism. For example, a solution could pass by adding an auditory expression to the lichens.

Regarding the death and life of these organisms, we believe its expression and emotion states can highly improve by introducing health levels, instead of the existing binary alive/dead. Specifically, in the transition between “healthy — weak — dead”. Moreover, we would like to explore the birth of new organisms in a way that they can be influenced by the characteristics of the environment in the moment of birth and by the characteristics of the previous organisms, i.e., taking in consideration the previous organisms death causes.

Lastly, we see potential in exploring interactions between organisms as if it was a co-evolutionary system between organisms and environment. See how the balance/tension develops towards each other, test until the point where they exchange information between them, merge or kill each other. That is, we would like to better understand how each lichen affects its surrouding environment, the public’s perception and molds this relation between the public and the artwork.

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Liminal Scape, an interactive visual installation with expressive AI

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Abstract

Liminal Scape is a visual art installation with an expressive AI system that has been trained to recognize human emotion and generate abstract images at will. The proposed system receives an image (photographic portrait) and labels it based on the recognized emotional valence. Our system takes this initial photo and paints it red, yellow, or blue depending on the recognized emotions (from the facial expression) using a painterly algorithm which in turn becomes an input for a two modified Deep Convolutional Neural Network (CNN) models known as Deep Dream and Neural Style. These systems along with a final particle system pass generate a range of latent images that convey the initial emotion, unique to the given input (photographic portrait) and the labeled category (R, Y or B). Our system combines emergent and arbitrary behavior and breeding aspects of CNNs (in the low level) with a hybrid ML/particle stroking system to explore art creation within a high complexity space of artificial creativity.

Keywords

Convolutional Neural Networks (CNNs), Style Transfer, Deep Learning, Emotive Art, Expressive AI, Pastiches, Generative Art

Introduction

The impact of art on emotional state has been studied in brain research and neuroscience (Silvia, 2007). For instance, Neuroesthetics studies the neural bases behind aesthetic experiences such as art creation or contemplation (Chatterjee, 2011).

Moreover, emotional responses to art known as aesthetic emotions have been the topic of interest in philosophy, psychology, and art criticism (Robinson, 2004). In particular, the field of color psychology showed how hues evoke human emotions (Whitfield & Whiltshire, 1990).

Humans respond differently to color stimuli dependent on their past experiences and biological traits (Hurlbert and Ling, 2007). For example, the color red is widely used to describe emotions such as rage, warmth, energy, passion and love (Wright, 1995; Carruthers et al., 2010).

Scientific studies validated that emotions such as awe (Shiota et al., 2007) and wonder (Zentner et al., 2008) are frequent while contemplating artworks. More recent studies emphasized that emotional responses to art are very diverse (Silvia, 2012), including Sadness (Vuoskoski and Eerola, 2012), Nostalgia (Barrett et al., 2010), and Anger (Silvia & Brown, 2007).

More notably, the emotional responses of perceiving artworks are not always cognitive (or in detached mode), but often lead to affective congruent states (i.e. facial expressions, postures, etc.) on a subjective and bodily level (Freedberg and Gallese, 2007; Azevedo and Tsakiris, 2017; Ishizu and Zeki, 2017). For example, audience show frowning in response to artworks with negative emotional content and smiling in front of artworks with emotionally positive content (Cacioppo et al.1986; Lang et al. 1993). Moreover, the physiological synchrony (with the observed or experienced emotion) depends on a few important factors: the empathic accuracy and the intensity of the emotional experience (Dimberg et al. 2011; Sato et al. 2013; Korb et al. 2014; Künecke et al. 2014).

There is an emerging interest in artificial emotions or otherwise mediated emotional life to produce expressive and empathic media such as music, poetry or paintings (McStay, 2018). Behavioral or interactionist AI have shaped the discourse between AI and cognitive science with the core assumption that intelligence is a property of embodied interaction with the world. Interactionist AI is concerned with creating intelligent systems that exhibits the essential properties of intelligence. Expressive AI (or creative AI) focus on the authoring of AI system as cultural artifacts and performance (Kolker, 2006).

In generative art in particular, some artists conduct research using AI to stimulate emotions. Most of these studies focused on non-aesthetic stimuli (e.g., geometrical shapes) and broad aesthetic preferences instead of specific emotions (Jacobsen & Höfel, 2002) or emotional soundscape (Fan et al., 2018).

Here, we focus specifically on the aesthetic representation of emotions (derived from facial expressions) to create an emotive AI model that is capable of generating expressive emotional artworks.

Our preliminary results (Figure 6) present features from generated images that are commonly associated with the underlying emotion of the content images such as the representative colors, and styles (strokes, textures).

Background

Facial Recognition

Psychological, anthropological and neuroscientific research employs a particular definition for basic emotion. For example, Paul Ekman introduced Facial Action Coding System (FACS) to describe facial expression. FACS is based on Action Unit detection and temporal dynamics analysis system, each corresponding to a particular muscle group in the face (Ekman & Friesen, 1971).

Many researchers proposed to use convolutional neural networks (CNNs) as an appearance-based classifier to detect facial expression (Dailey et al., 2002; Zhao et al., 2004). Moreover, artists began using facial expressions as a tool to create empathic art, Colton et al. (2008) proposed emotionally aware portrait painting, a non-photorealistic rendering (NPR) system. They used a machine vision system that recognizes emotions to produce enhanced emotional portraits.

Augello et al. (2013) proposed a cognitive architecture originated from the model of blending or conceptual integration (Fauconnier & Turner, 1998) linking the representational spaces (i.e. color perception), and emotions.

DiPaola et al. (2019) proposed an empathy based affective portrait painter using cognitive based empathy in AI conversational agents and a cognitive-based creativity AI painterly system, and art analysis tools (i.e., texture and palette synthesis) to parameterize a generative artistic painting process based on mood, conversation and emotion.

Deep Generative Image Modeling

From the artificial intelligence perspective, automatic generation of art has been a long-standing objective (DiPaola & Gabora, 2009). Recent advances in generative models have been successfully applied to the artistic domain. There are several frameworks for image generation, using recurrent neural network (Gregor et al., 2015), auto-regressive models (Oord et al., 2016), generative adversarial networks (GANs) (Goodfellow et al., 2014), and more (Ma et al., 2018; Xu et al., 2018).

Outstandingly, GANs have achieved the most impressive visual quality and is the most popular technique among artists for generating photorealistic and non-photorealistic visuals. GANs have also been applied to style transfer, for example Elgammal et al. (2017) proposed a method to generate art by learning about styles and deviating from style norms.

Mordyintsev et al. (2015) presented Deep Dream which uses a guide-image mode, back propagation and gradient ascent, to analyze the strong features from one "guide" image and emphasize the best-matching features from a second source image by transforming the pixels in this second image. This results in the emphasis of pre-existing shapes and patterns as well as the appearance of hallucinated patterns in which the network gravitates towards "seeing" patterns it has learned to recognize.

Gatys et al. (2016) then presented style transfer, called Deep Style (DS) by matching features in convolutional layers of VGG-19. In a follow-up study, they proposed ways to control the color preservation, the spatial location, and the scale of style transfer (Gatys et al., 2017). Ruder et al. (2016) improved the quality (i.e. consistent and stable stylized) of video sequence transfer by imposing temporal constraints. Alvarez-Melis and Amores (2017) proposed using style transfer for creating emotional art using Generative Adversarial Network (GAN) trained on a dataset of modern artworks labeled with emotions.

Concept and System Description

Liminal Scape is a multi-screen interactive visual installation that fills the interior of a gallery space across 6 screens (same size) as shown in Figure 1. The screens portray the stylized paintings of our AI system. The visuals are reflected back in the space and the viewers, creating a sense of intimacy. A viewer is then on a journey through a landscape of colors, textures and compositions that expresses and evokes cognitive and bodily emotions. The front wall (screens) display the most immediate results of the system and the screens on the back walls present the more abstract results (generated from the evolving system after a few runs) as shown in Figure 1.

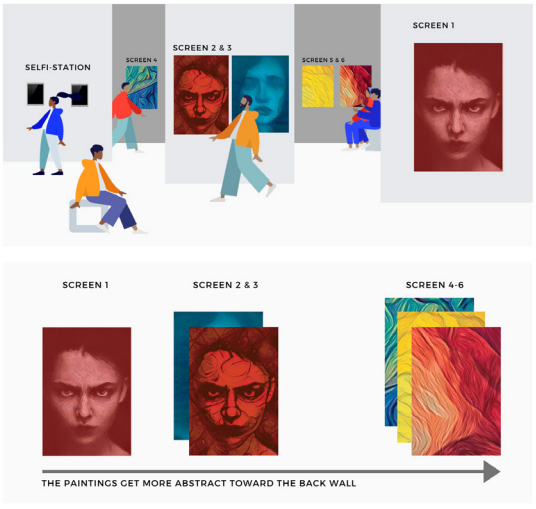

Figure 1. An overview of *Liminal Scape* installation layout

Interaction Scenario

Upon stepping into *Liminal Scape*, a viewer encounters 6 visual screens, each displaying a temporal series of abstract visual feeds (varying in colors, textures and compositions). The artwork invites visitors to take their participation further through an Apple iPad or Tablet, where they can take a selfie (expressing different emotions) which will be "painted" and added to the existing pool of faces (the contents of the artwork) as shown in Figure 2.

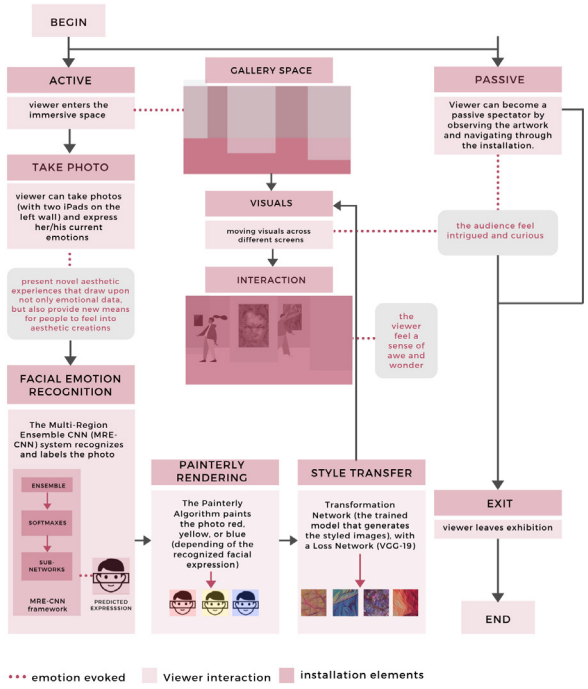

Figure 2. An overview of *Liminal Scape* interaction diagram

Our Approach/ Architecture

-Facial Recognition

We use a Multi-Region Ensemble CNN (MRE-CNN) for facial expression recognition (adapted from Fan et al., 2018). We take three sub-regions of the human face: the left-eye, the nose and the mouth, combined by its corresponding whole facial image, to form a double input subnetwork. We adopt 13 CNN layers and 5 max pooling layers and an output layer of 3 neurons, one for each emotional category grouped together: R: anger, rage, wrath, resentment, passion, lust, love, Y: happiness, joy, delight, pleasure, bliss, and B: sadness, sorrow, despair, grief, melancholy. The networks then generate labels and colorize (red, yellow, or blue) the photographic portraits as shown in Figure 3.

-Modified Deep Dream and Neural Style Transfer

We use a two-phase approach starting with our modified Deep Dream and Deep Style (or Neural Style) pass. Our modified Deep Dream system specifically trains new CNN models with creative art generation (style recognition) as its goals as opposed to more typical object recognition, using paintings and drawings as training data. We now have amassed a specific to fine art painting data set of 160,000 labeled and categorized paintings from 3000 labeled artists for a total size of 67 gigabytes of artistic visual data.

Since in our system, detecting and identifying regular objects 'within' an image is less important than the overall artistic style of the entire image (e.g. style of stroke, texture and color palette), we develop a "hierarchical tight style and tile" process (DiPaola et al., 2018) which uses a more art based texture and style based labeling syntax as well as hierarchical stochastic tiling method to produce a training set that is more conductive to painterly style over object recognition. This method is combined with our neural style transfer model as proposed by Elgammal et al. (2017) to make abstract emotional paintings influenced by the given photographic portrait (facial expressions).

The style transfer architecture has two different CNNs in the training phase: An Image Transformation Network (the trained model that generates the styled images), and a Loss Network (pre-trained VGG-19 classifier) to compute the Style-Loss and the Content-Loss and in turn train the Image Transformation Network (Dumoulin at al., 2016). Our goal is to generate abstract novel images from the infinite possibilities in the creative space and emphasizing semantic and/or stylistic qualities to highlight certain emotions as shown in Figure 5. The training process is as follows: stylized paintings are produced by feeding a content image (emotionally labeled face) through the style transfer network. The content image, along with a fitted style image (selected from one of the 18 abstract paintings of Joan Miró, Wassily Kandinsky, and Mark Rothko), are passed through the Loss Network (VGG-19) as shown in Figure 5 and generates a series of abstract paintings dependent of the intensity of the emotional valance and the selected labeled category.

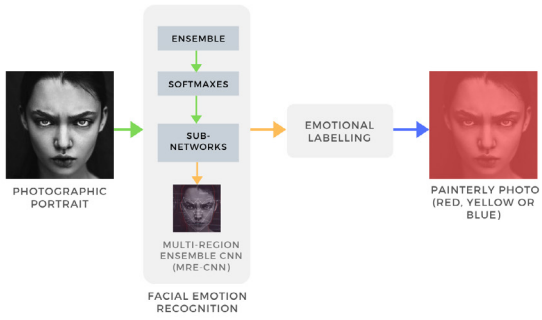

Figure 3. An overview of our Facial Recognition phase using Multi-Region Ensemble CNN (MRE-CNN) framework (adapted from Fan et al., 2018)

-Adaptive Instance Normalization (AdaIN)

We use adaptive instance normalization (AdaIN) for the interpretation adapted from Huang and Belongie (2017)

model. Given a content image and a style image, AdaIN simply adjusts the mean and variance of the content image to match those of the style image by transferring feature statistics. Then the decoder network learns to generate the stylized images by inverting the AdaIN output back to the latent image space.

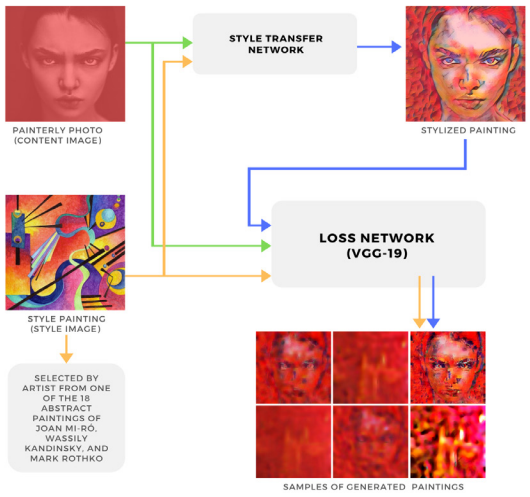

Figure 4. An overview of our style transfer. We use VGG-19 network to encode the content and style images. An AdaIN layer is used to perform style transfer in the feature space. A decoder is learned to invert the AdaIN output to the image spaces

-Final Rendering (EPainterly)

In the last phase, the source image created from the previous steps is further manipulated by our hybrid AI/particle system, ePainterly system, which is an extension to our cognitive painting system (DiPaola and McCaig, 2016) and models the cognitive processes of artists based on years of research in this area. It uses additional Deep Style, algorithmic, particle system and noise modules to generate artistic color palettes, stroking and style techniques. It is the NPR subclass of stroke-based rendering that is used as the final part of our process to realize the internal Deep Style models with stroke-based output informed by historic art making. Specifically, aesthetic advantages of this additional system include reducing noisy artifacts of the generated Deep Style output via cohesive stroke-based clustering as well a better distributed color space.

Conclusion and Future Work

The notion of Sentient AI, capable of feeling and perceiving emotion (sentient) sounds promising, since we live with technologies that feel and are sensitive to human life in ways that until now not seen. Moreover, empathic art presents novel aesthetic experiences that draws upon not only emotional data, but also provide new means for people to feel aesthetic creations. Our intention behind the Liminal Scape is to create an exploratory AI system in the form of an installation to present abstract emotional paintings, in which users will reveal and explore their affective states. We aim to create expressive/emotional experience, and are curious to know what is the overall experience of the users while interacting with the system. We recognized the potential of artificial creativity for creating novel artworks supported via interactive environments in the future. Our initial results (Figure 6) show the potential of creating emotive paintings that will evoke a range of emotions/aesthetic reactions such as pleasure, anger and arousal. To this end, we will explore expressive AI by mimicking human emotions (facial expressions) and mapping them into low level features such as colors, strokes, intensity. These features are most effective in steering the emotional state of the artworks in the desired direction. We hope that with this work and future research we are getting closer to the design of an emotive AI capable of perceiving and expressing emotions.

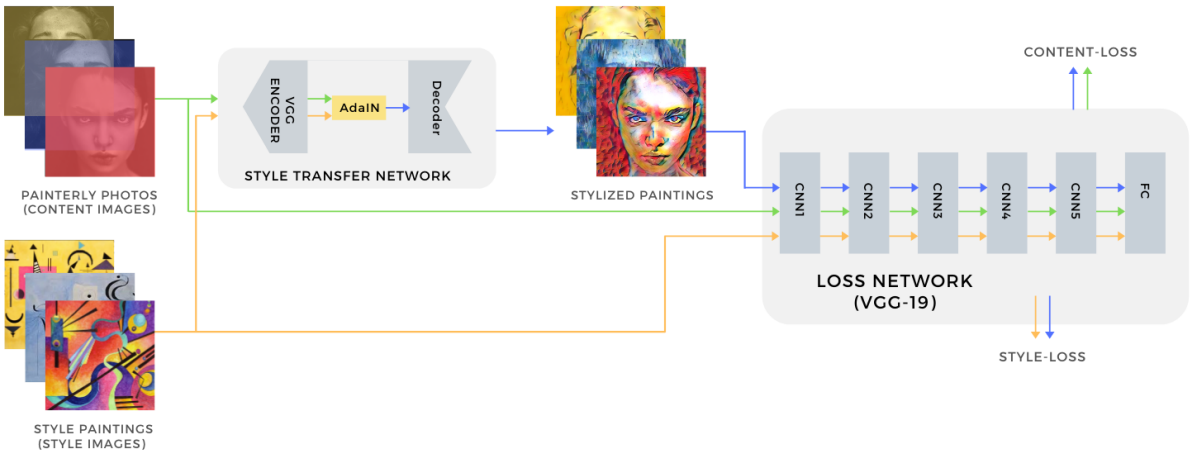

Figure 5. The overview of arbitrary style transfer in real-time with Adaptive Instance Normalization (AdaIN) and Deep CNN (VGG-19) (adapted from Elgammal et al., 2017; Huang & Belongie, 2017)

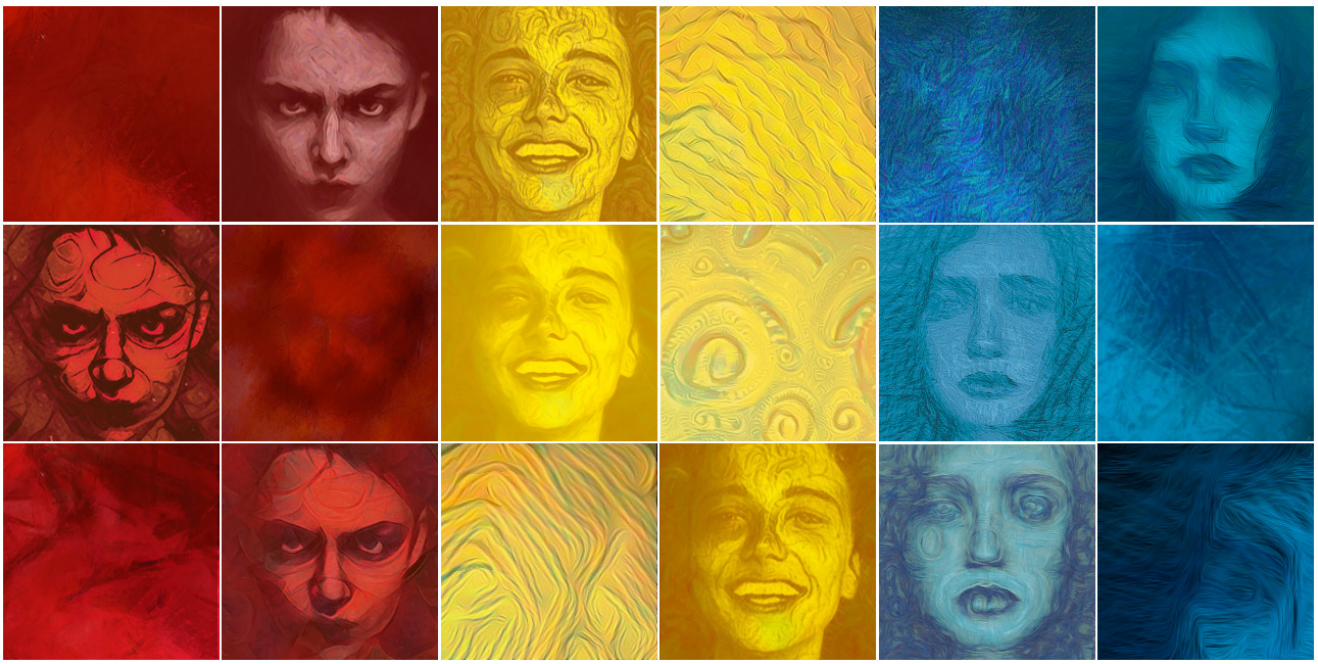

Figure 6. Artworks generated by the *Liminal Scape* resulted from different emotional detection, from left to right: categories R, Y, and B. (R: anger, rage, wrath, resentment, passion, lust, love, Y: happiness, joy, delight, pleasure, bliss, and B: sadness, sorrow, despair, grief, melancholy)

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Mahsoo Salimi: is a Ph.D. Candidate at Simon Fraser University and interdisciplinary researcher interested in artificial creativity and Expressive AI. Her current research is bridging swarm intelligence and robotics to create dynamic and visceral relationships between human, robots, and AI.

Nouf Abukhodair: is a Ph.D. Candidate at Simon Fraser University and interdisciplinary researcher, her background is in Computer Science, she is interested in AI, Image Processing and Visual Perception. Her current research is looking at computational creativity, to learn how Deep Learning AI systems can understand visual art. Her work uses modern AI machine learning systems to understand goals and processes, to dynamically adapt the system for best results for art, entertainment and health applications.

Steve DiPaola: active as an artist and a scientist, he is the past director of the Cognitive Science Program at Simon Fraser University, and leads the iVizLab (ivizlab.sfu.ca), a research lab that strives to make computational systems bend more to the human experience by incorporating biological, cognitive and behavior knowledge models.

Carlos Castellanos: is an interdisciplinary artist and researcher whose work bridges science, technology, education and the arts, developing a network of creative interaction with living systems, the natural environment and emerging technologies. His artworks have been exhibited at local, national and international events such the International Symposium of Electronic Art (ISEA), SIGGRAPH & ZERO1 San Jose.

Philippe Pasquier: in his artistic practice, focused primarily on generative arts, he is bringing forward forms that are exploring the nonverbalisable dimensions of the sublime. Philippe has been acting as a performer, director, composer, musician, producer and educator in many different contexts. He also serves, or has served, as an active member and administrator of several artistic collectives and companies (Robonom, Phylm, Miji), art centers (Avatar, Bus Gallery) and artistic organizations (P: Media art, Machines, Vancouver New Music) in Europe, Canada and Australia. Philippe was director of ISEA2015.

AURALROOTS: learning about sentience though embodiment and simulation in three sonic environments

Jill Scott

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ABSTRACT

AURALROOTS is a media sculpture that combines viewer interaction with inspirations from tactile and aural sensory perception. The sculptural form is based on the functions and forms of the stereocilia, tiny hair cells on our auditory nerves of the inner ear in the cochlea. The content of AURALROOTS is about how we learn through sounds from being embodied in different environments: a) as a growing embryo in the womb, b) as a daughter listening to her mother and finally c) as a female artist communicating with auditory scientists. The overall aim is to explore learning through sentience by giving the viewer the capacity to imagine they are immersed inside these sonic environments.

Keywords: embodiment, simulation, pitch, cross -modal hearing and tactile interaction.

Fig 1. *AURALROOTS*, 2018, Jill Scott, tactile media sculpture, ETHZ Integrated Biology. Copyright Scott.

Sentience, Interaction and Learning

AURALROOTS offers a metaphorical learning experience that scales down the viewers into miniature characters and places them inside the inner ear where they can trigger acoustic reactions. By touching or moving two sets of these sculptural models, based on volume and harmonics, the viewers can mix and manipulate up to 54 sound tracks to be heard on wireless headphones. A viewer/listener can choose different pitches that relate to these learning experiences, by touching an animated visualization of the cochlea on a screen. This action triggers three sound compositions. A) low pitch compositions from the womb, (B) medium pitch compositions from the environment and (C) high pitch compositions from the science lab. All three sound compositions in AURALROOTS encourage the viewer to learn through a combination of touch, sound and the embodied experience in a unique haptic platform (1).

Sound Composition A: Hearing as an Embryo in the Womb

The viewer can hear as a foetus might hear: mostly in the low pitch range. Here sentience is enhanced by the immersive sounds of an inner and outer soundscapes like the mother's digestion or the traffic noise outside. Is that the Blood cells rushing through the mother's veins or a refrigerator motor? Do the lungs breath steadily or is that the sound of a river rushing along on the outside of her mothers' body? It has been proven the embryo can differentiate between a heart pumping and the beating of a base drum, mother swallow sounds or the low pitch syllables from her singing voice while she is playing the piano. These sound files are based on actual recordings from contact microphones in the wombs of women in hospital. (2)

Sound Composition B: Daughters listening to their Mothers

Speech occurs mostly in the mid-range of our frequency response. Many communities practice oral storytelling: the passing of knowledge from one generation to the next. In this composition, oral "herstories" are told by Australian indigenous women to their daughters about how to gather plants and roots for survival and for medical conditions. Due to colonialism this knowledge is slowly disappearing.

When we talked with our indigenous advisors at the Koori Radio Station in Sydney about this form of knowledge transfer, they said that it requires extensive personal contact, regular interaction and trust. However, they said “At this stage if another person we trust wants to tell it let them tell it” (3). To construct eight accurate scripts for the actors to re-tell; we sourced talks, interviews and written information by community elders and indigenous researchers [4]. The plants; how they were collected and used plus the environmental sounds in which they are located are directly sourceable from elders and their books. [5]

Sound Composition C: A female artist in a sonic science lab

This composition is based on high pitch frequencies and sound recordings based on my own subjective experience when I worked as an artist-in-residence inside two audiology labs (6). High pitch frequency response is the first part of our hearing capabilities that decrease with age. I shadowed the experi-ments of researcher Helmy Mulders and her team, where knowhow transfer is focused on a horizontal level of communication. Here the pathways from the ears to the brain are audified by a method called “Electrophysiology”, which measures the midbrain’s response milliseconds after sounds are fed to the ears of anesthetised Guinea pigs. The viewer can hear my recorded sounds of the firing of single neurons in the mid brain and learn that the stereocilia are one of few human cells that do not regenerate. In another audiology lab in Zurich, I recorded their tests with researchers on hearing-challenged women and witnessed ones` surgical operation of a cochlea implant. It seems that more men suffer from hearing problems at an older age than women. However, statistics show that female teachers in day-care institutions suffer the highest incidences of Tinnitus [7] from blocking out sound. It seems that the stereocilia can not only be damaged by acoustic trauma but also by the brains filtering out of constant noise.

Fig 2. *AURALROOTS*, 2018, Jill Scott, interactive screen composition A: Hearing as an embryo in the womb.

Fig 3. *AURALROOTS*, 2018, Jill Scott, interactive screen Composition B: Daughters listening to their mothers, Copyright Scott.

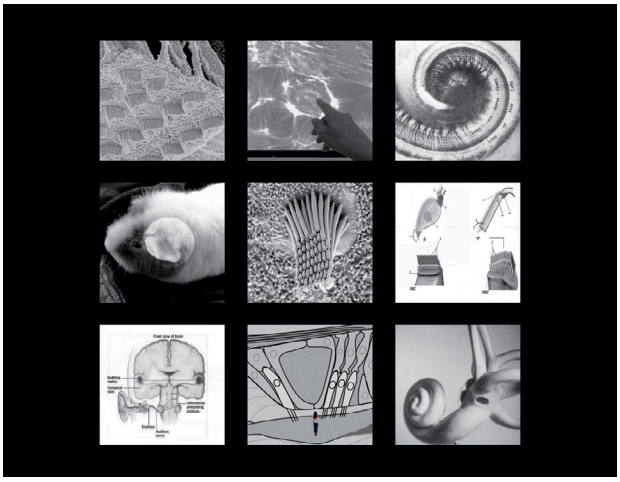

Fig 4. *AURALROOTS*, 2018, Jill Scott, interactive screen composition C: A female artist listening to scientists. Copyright Scott.

AURALROOTS is programed with Max MSP and C++. The stereocilia swing on balls that are connected to Joysticks and all positions on these 120° degree axes are sent from the joysticks to a c++ program on a Minimac computer, where 54 sound tracks are stored in three compositions. Viewer manipulation of the inner-cells set in the cochlea, produce harmonics and playing with the outer hair cell set produce volume. The Viewer can mix the equalized soundtracks in real-time and change the compositions by interacting with an animation.

Examples of Learning Experience

Because composition one is universally clear, I will now expand examples of the learning experience based on what the viewers actually hear in composition 2 and 3.

In **composition B**: Daughters listening to their Mothers. The viewers can listen oral history stories

re-told by actors (3) and match them with sounds from the landscapes where the plants come from. Some of this knowledge is lost – some is retold here! JACK tries hard to remember about how SILKY HEADS (cymbopogon-obtectus) was used for ear infections. He explains how this knowledge was only passed on from mother to daughter. DARRA talks about BRACKEN FERN (pteridium esculentum) and BUNGWALL FERN (blechnum indicum). The roots and leaves of both plants can be used against stings and tics or prepared for eating. APANI, a young girl, describes the myth of the relationship between the GYMEA LILY (doryanthes excels), a source of minerals, and THE BULRUSH (typha orientalis, typha dominigensi) used by hunters for bodily stamina and to keep leeches away. KALINDA describes to young women, how to locate and gather LONG YAM (dioscorea transversa) and PENCIL YAM (vigna lanceolata): the tribes main sources of minerals and starch. CORREEN tells a story about how many women often come together to collectively hunt for BUSH ONIONS (cyperus bulbosus) - a good source of minerals. TATYA explains how to wash, cook and make a cast for a broken leg or arm out of the roots of DEAD FINISH BUSH (acacia tetragonophyllea). LYN tells us how to prepare and harvest the roots of the CUNJEVOI (alocasia brisbaniensis) and use it for stings, burns, and to take the poison out of it so it can be eaten. MARGARET talks about the WILD BUSH ORCHID (cymbidium canaliculatum): a great preparation for dysentery and bowl problems. By comparison **Composition C** is based on what I learnt from listening to auditory scientists. An auditory lab is always full of tests and sounds particularly in the high pitch range. The viewers of AURALROOTS can hear and mix simulations of the behaviour of inner ear stereocilia compared to the outer stereocilia, as well as sounds from the lab and test tones to identify Tinnitus. They can test themselves by listening to the sounds from the actual hearing tests on people who have a wide range of hearing problems.
Both of the above compositions encourage the viewers to have the subjective haptic experience of travelling through a simulation of the cochea in the organ of corti to learn about the firing of the stereocilia in relation to frequency response.

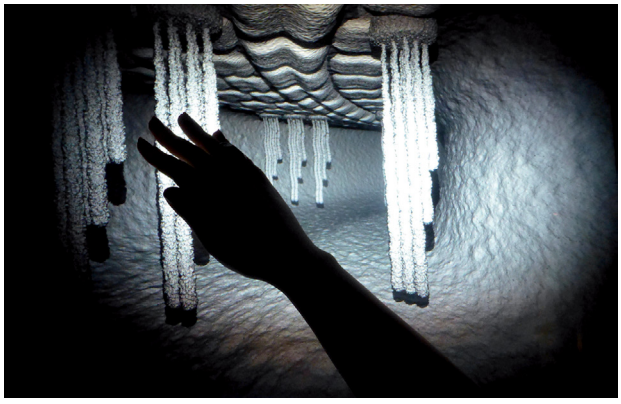

Fig. 5. *AURALROOTS*, 2018, Jill Scott, Touchscreen

Fig. 6. *AURALROOTS*, 2018, Jill Scott, sculpture: touching and moving the tactile stereocilia, Copyright Scott.

Fig. 7. *AURALROOTS*, 2018, Jill Scott, sculpture: viewers play with the relation between harmonics and volume, Copyright Scott.

Conclusion

All of the three experiences require the accumulation of tactile and sound knowledge from the purest forms of embodiment - either from inside the body, from being in the environment or from learning in the laboratory. By presenting this content, AURALROOTS encourages less formal, codified or explicit forms of knowledge. Composition A is a combination of sound, tactile and tacit information: this tacit knowledge is difficult to transfer to another person by means of writing it down or verbalizing it. In Composition B, the holder of information must be integrated into a network or a community of practice for survival. Here tactile and sound transfer is related to beliefs, ideals, values, schemata and mental models -a more cognitive dimension of information

that shapes the way we as children perceive the world. Finally, Composition C explores how different forms of information always exist in dialogue with other forms of knowledge and are transferred in a horizontal way: one that is dependent on co-productive stimulation and participation of adults.

Fig. 8. *AURALROOTS*, 2018, Jill Scott, sculpture examples of viewer interaction. left: ZEMAK, Poznan, Poland, right: Anatomic Museum Basel, Switzerland, Copyright Scott.

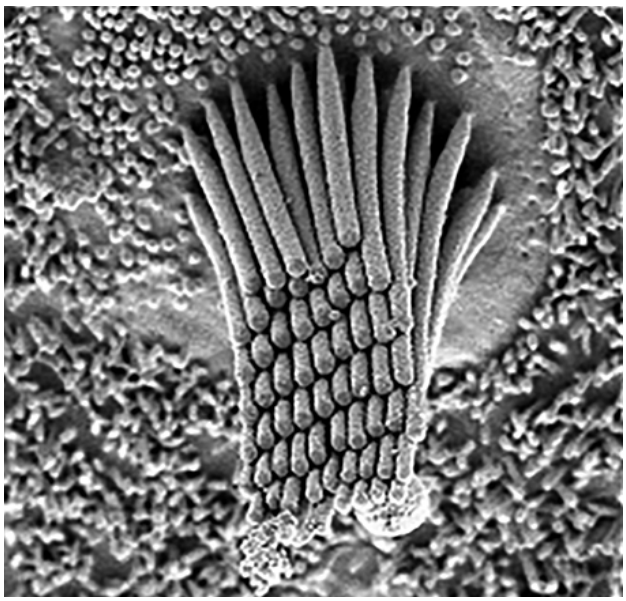

Fig. 9. Scanning Electron Microscope image of our stereo cilia in the inner ear of the cochlea, 2017, University of Basel, Copyright public domain.

Therefore, AURALROOTS presents a plurality of knowledge transfer. The three compositions demonstrate that learning is always "situated" in a particular environment but that different forms of knowledge can co-exist simultaneously. At different times in our lives our senses work together to learn but it is the accumulation of this knowlege that regenerates the learning process. (8) In all four exhibitions of AURALROOTS, the viewers have responded with fascination and deep contemplation. Many played alone and with others for hours in the project. As far as I know, this is the first time that a media sculpture has been built based on the behaviour of the stereocilia, different stages of a womens` life-learning experience and content that focuses on sound and touch to simulate symbiotic multi-sensory experiences. Perhaps this is a new research trajectory that can form the beginning of the history of sound from a feminist ecoscopic perspective!

References

(1) Techniques –AURALROOTS is programed with Max MSP and C++. The stereocilia swing on balls that are connected to Joysticks and from there to a Minimac computer where 54 sound tracks are stored. Programming: Nikolaus Völzow, Sound Jill Scott and Olav Lervik. Animation. Andrew Quinn

(2) For further research see research from Les Gilbert :http://www.magian.com/projects/.
:http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4256984/

(3) Collaborators from Koori Radio / Gadigal Information Service, Sydney, Australia, produced by King Street Studio with indigenous actors: Fred Copperwaite, Khi- Lee Thorpe, Wandjina Smith, Lillian Crombie, Elaine Crombie, Jinny Smith, Lyn-Paulette Whitton, Lily Shearer. The researches were Jill Scott, Tess Corino and Marille Hahne.

(4) In her book "Decolonizing Methodologies: Research and Indigenous Peoples" Linda Tuhiwai Smith, outlines new types of engagement with academic researchers. By rethinking the role of indigenous knowledge in the academy and particularly women's roles in transferring it we may be able to help raise respect for this knowledge. By 'indigenousness' she means - a knowledge consciousness arising locally and in association with a long-term occupancy of a place. (1999, Zed Books,London)

(5) See: "Aboriginal People and their Plants": Philip A Clarke. 2007 Rosenberg South Australia

(6) Labs: SymbioticA at the University of Western Australia, Auditory Laboratory at the School of Anatomy, Physiology and Human Biology and The Laboratory of Experimental Audiology, University Hospital, Zurich.

(7) http://www.hear-it.org/Tinnitus-widespread-amongteachers

(8) Scott, J.M, AURALROOTS Research " in Sound? Noise! Voice n.paradoxa: international feminist art journal (vol. 37 Jan 2016 KT Press, London) pp. 38-43

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Biography

Jill Scott. Professsor Emerata-ZHdK, in Zürich, founder of the Artists-in-Labs Program. Currently the director of Laserzurich. She has published 6 books on art and science and built many mediated experiments about neuroscience, body politics, environmental science and cultural issues.
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Neosentience:

Definition; A New Combinatoric N-dimensional Bio-algorithm; Authorship of the Insight Engine 2.0 and Database; Recruitment of Transdisciplinary Researchers; Ethics Surrounding the Generation of a New, Self-aware Autonomous Techno-species

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Abstract

Definition: pragmatic benchmarks are used to define neosentient robotic entities: the system could exhibit well defined functionalities: It learns; it intelligently navigates; it interacts via natural language; it generates simulations of behavior (it thinks about potential behaviors) before acting in physical space; it is creative in some manner; it comes to have a deep situated knowledge of context through multimodal sensing; and it displays mirror competence. Seaman and Rössler have entitled this robotic entity *The Benevolence Engine*. They state that the interfunctionality of such a system is complex enough to operationally mimic human sentience. Benevolence can in principle arise in the interaction of two such systems. Synthetic emotions would be part of the system. The System would be benevolent in nature.

The concept of Neosentence (coined by Seaman) was first articulated in the book *Neosentience / The Benevolence Engine*[1] *by* Seaman and Rössler. This talk will have four sections, 1) Providing a definition of Neosentience; 2) The concept of developing a new combinatoric n-dimensional bio-algorithm — employing a transdisciplinary database and search engine enabling distributed research; 3) the recruitment of a transdisciplinary research team to populate this database; 4) The ethics surrounding the generation of a new, self-aware autonomous techno-species.

Keywords

Sentience, Neosentience, autonomous robotics, combinatoric bio-algorithm, Insight Engine, transdisciplinary

Introduction

The concept of Neosentence (coined by Seaman) was first articulated in the book *Neosentience / The Benevolence Engine*[2] *by* Seaman and Rössler. Seaman, Media Artist and Researcher, and Rössler, research Scientist, began by talking to one another for one hour a week, for over a decade before the book was completed. Many topics were discussed and a huge list of relevant books and papers were articulated in these conversations. The Neosentience book functions as a huge resource for researchers related to this topic.

The book took a special form of hundreds of microchapters each exploring different concepts and topics that played into the articulation of Neosentience. Seaman had come out of a creative computational tradition exploring combinatorics and generative poetic systems which he called Recombinant Poetics.[3] [1] The Neosentience book explored the potential analogue combinatoric use of the coupling of a diverse set of concepts and histories to inform the breadth of approaches that might become enfolded in the authorship of such an intelligent autonomous entity. Seaman called this Recombinant Informatics. [2] Initially inspired by ideas originating in a book called *The Act of Creation* by Arthur Koestler.[4] This book presented the concept of bisociation, by potentially considering the bridging of differing topic areas. Koestler states:
I have coined the term bisociation in order to make a distinction between the routine skills of thinking on a single 'plane', as it were, and the creative act, which, as I shall try to show, always operates on more than one plane. The former may be called singled-minded, the latter a double-minded, transitory state of unstable equilibrium where the balance of both emotion and thought is disturbed.[3]

1 Originally published as Seaman's Phd Dissertation, Bill Seaman, *Recombinant Poetics / Emergent Meaning as Examined and Explored Within a Specific Generative Virtual Environment*. (Dissertation, University of Wales, Center for Advanced Inquiry in Interactive Art, 1999)

2 Otto Rössler and Bill Seaman, Neosentience / The Benevolence Engine, London: Intellect Press, 2011, p13 & p204

3 Arthur Koestler, *The Act of Creation*, (New York: Macmillan Co. 1964) p36

This notion of bisociation, and later what Seaman calls poly-association, has been further explored via the authorship of a transdisciplinary search engine, database, and exploratory combinatoric generative system called the Insight Engine. The notion was to create a form of automated transdisciplinary search engine where authors could upload their textually annotated media (images), papers, book chapters, and media objects (for example, textually annotated video), and related links to other sites on the internet. The relationalites that were textually inherent to the different elements in the database were mapped using computational linguistic processes. A query could be made by linking any two papers, or annotated entries in the system, related to this notion of bisociation. This would then call in a set of related papers, media objects, book chapters etc. in real time for one's exploration, defined by this set of potential mapped relationalities. This was exciting in that ideas from multiple research domains were brought into proximity potentially providing transdisciplinary insight into differing aspects of the problem set. One could choose to hold onto or discard these examples.

The original system was a closed test system with a series of invited participants. Initially the system was coded by Todd Berreth at Duke University under the auspices of the Emergence Lab, co-directed by Seaman and John Supko (from the music department). The media artist and computational linguist Olivier Perriquet also became involved as a research fellow embedded in the Emergence Lab funded by the Fullbright Foundation. The initial funding for the Insight Engine project came from DIBS (Duke Institute for Brain Sciences). The first application put in to DIBS initially failed because it wasn't empirical enough. The next day Seaman was informed that it could be funded by DIBS but under the guise of being an art project. Later Bass Connections at Duke gave additional funds to help support the programming. After more recently discussing the legal ramifications of such a system, the version 2.0 was authored by Matthew Kenney, IT Analyst at Duke, who is embedded in the Emergence Lab. This new system focuses on bisociation and poly-association via the computational linguistic analysis of PDFs. Seaman also projects a much more developed version of the system for the future discussed in multiple of his papers, one entitled Emergent Relationality System / The Insight Engine [5] again enfolding media objects, which can later be explored in a generated proximity in a generative virtual environment. In that particular case the focus of the research was on CyberArchaeology in conjunction with Professor Maurazio Forte.

The idea is that the Insight Engine might be used as an open system related to differing research areas and databases. Forte's Dig@Lab is part of the consortium of labs supporting the Computational Media, Arts and Cultures PhD at Duke. Multiple other papers have been authored related to the Insight Engine project, each having it's own foci.[6][7][8]

Needless to say, much ongoing conversation has been taking place surrounding the production of Neosentience, as well as the legalities of sharing knowledge with such a system as the Insight Engine. Where initially Seaman had hoped to have papers stored in the database from a transdisciplinary set of international researchers, the legality of this has not proven tenable. In the next call for papers and book chapters, authors will need to provide the fact that they own the copyright to their work. Alternately links to the companies, distributers of papers, and abstracts might form a legal approach to accessing papers in the future. In this case, some papers would be open fully to perusal and some would only be available for purchase etc. from the owners of the content.

New concepts for rolling out version The Insight Engine 2.0 are still under discussion. Who should be invited to participate? Should this be a system where some people are adding to the system and other are just using it to generate new ideas? How are the database system and updates paid for? Who maintains the database in an ongoing? Should there be an Insight Engine Board of Directors?

Providing a Definition of Neosentience

Pragmatic benchmarks as discussed in the Neosentience book[9] are used to help define neosentient robotic entities. The system could exhibit well defined functionalities: it learns; it intelligently navigates; it interacts via natural language; it generates simulations of behavior (it thinks about potential behaviors) before acting in physical space; it is creative in some manner; it comes to have a deep situated knowledge of context through multimodal sensing; and it displays mirror competence. Seaman and Rössler have entitled this robotic entity *The Benevolence Engine*. They state that the interfunctionality of such a system is complex enough to operationally mimic human sentience. Benevolence can in principle arise in the interaction of two such systems. Surrogate emotions would also be part of the system. The authorship of the system would seek to enable it to be benevolent in nature.

It must be noted that this pragmatic set of benchmarks is a very different from the historical approach to machine Intelligence that was long ago articulated by Alan Turing — The Turing Test, discussed in Seaman's paper *Neosentience and The Abstraction of Abstraction*.[10]

Seaman and Rössler had two very different approaches that were discussed in the Neosentience book. Rössler was interested in a top down approach which he called the Brain Equation. [11] Seaman was interested in defining a new bottom up bio-mimetic approach studying the actual functionalities of the human body enabling sentience to arise as an emergent property of this ulta-complex system [12]. This might also include bio-abstraction. There is an irony here which suggests that one must come to better

understand sentience in order to chip away at the emergent production of Neosentience.

The Concept of Developing a New Combinatoric N-dimensional Bio-algorithm

The idea here is to define all of the entailment structures that inform the emergent arising of sentience in the human, and seek to abstract these into an autonomous robotic system, no small or short-term task! I see this as taking many years, but time is long and new strides are being made every day in the development of new technologies to help map this time-based set of relationalities that bridge mind / brain / body — multi-modal sensing systems, and environment.

Given the development of the Insight Engine 2.0, the idea would be to define a new relational research database to be explored by this transdisciplinary search engine and generative media system. This might in part be achieved through the recruitment of a transdisciplinary research team, and/or to work with other research groups that are already undertaking this kind of bio-mimetic approach. This kind of art science relationality takes a special kind of team and a unique trust related to research across fields.

So, one asks how does one define a set of researchers to enable this team-based development of a bio-algorithm of combinatoric algorithms, functioning in the service of better understanding sentience and consciousness.

Perhaps one first must define a set of Boundary Objects. This approach is articulated in Susan Leigh Star's, 'The Structure of Ill-Structured Solutions: Boundary Objects and Heterogeneous Distributed Problem Solving', in M. Hubs and L. Gasser (eds), *Readings in Distributed Artificial Intelligence* 3 (Menlo Park, CA: Morgan Kaufmann, 1989) [13]and also in *Boundary Objects and Beyond: Working with Leigh Star*. [14]

The notion here is to devise a bio-algorithm of combinatoric algorithms that will seek to point at mind/brain/body/environment relationalities, and the sentience/consciousness that arises out of this time-based modular network. The goal is a long-term one, and may not be achieved in my lifetime, yet it seems important to leverage differing projects that have a different set of initial goals, and bring them into intelligent proximity. This would suggest moving back to exploring the bio-mimetic as opposed to the purely functional aspects of AI production.

No single discipline of science, the humanities and/or the arts can tackle such a difficult problem set. A special transdisciplinary team would need to be created. The team would potentially consist of a group of specialists from a series of fields that would also learn enough about the other member fields to be able to talk across disciplines. Conversation would be central to the ongoing development of this variable Bio-algorithmic network. Perhaps an earlier version of this kind of thinking was witnessed in the Biological Computer Lab headed by Heinz von Foerster, 1958-1976.[15][16]

Some Beginning Thoughts About the Fields That Might be Enfolded

I was lucky to have time to talk to Jim Davies[4] who was a cognitive scientist in residence in the Emergence Lab at Duke. Out of our conversations and my ongoing study the following list of research areas came to the fore: team members would be drawn from the following fields– mind-level Cognitive Modeling[5]; A computational neuroscientist exploring Neural Modeling; A programmer that is highly proficient in the Nengo programming language[6] (summer school with Chris Eliasmith[7]); Larry Barsalou known for perceptual symbol systems hypothesis [8]; an engineer knowledgeable about Neuromorphic Chip programming – IBM[9]; a digital humanities specialist / programmer; a computational linguist; a multi-modal sensing expert; a scientist exploring human/environments sense relations; an artificial general intelligence specialist; a robotics specialist exporing the biomimetic mindset; and an artist interested in computational creativity and interactivity. I have added some names of possible parties to contact about being involved. This would also include researchers interested in the Ethics of Neosentience study.

Entailment Structures

How can we devise a system of n-dimentional combinatoric modules and moments of self-actuated, self-organising controlled switching to achieve differing functional foci related to the abstraction of the body's functionality— foci that could potentially enable neosentient robotic functionality in the future?

In my background study I became interested in a series of historical projects that may also have some relevance. One such area is the study of Second Order Cybernetics

[4] Jim Davies Research url, accessed Dec 16, 2019, https://carleton.ca/ics/people/davies-jim/

[5] On Levels of Cognitive Modeling – Sun, Coward, and Zenzen http://www.cogsci.rpi.edu/~rsun/sun-pp2005-f.pdf
Cognitive Modeling – Thad Polk, Colleen Seifert - http://cognet.mit.edu/book/cognitive-modeling
Eric Chown - https://www.bowdoin.edu/~echown/papers/cog.pdf

[6] Nengo - https://www.nengo.ai

[7] https://uwaterloo.ca/centre-for-theoretical-neuroscience/people-profiles/chris-eliasmith

[8] A current theme of his research is that the conceptual system is grounded in multimodal simulation, situated conceptualization, and embodiment.
http://barsaloulab.org/lab-members/lawrence-barsalou/
Perceptual Symbol Systems
https://ase.tufts.edu/cogstud/dennett/papers/sortofsymbols.pdf

[9] Neuromorphic Chips / Computing
https://arxiv.org/pdf/1705.06963.pdf
https://www.nextbigfuture.com/2017/03/new-python-compatible-compiler-to.html

and in particular a series of publication related to Heinz von Foerester's Biological Computer Laboratory, thinking in particular about thinking and its relation to computation.[17][18][19][20][21][22] I was more recently invited to give the von Foerster talk in Vienna. In part of that talk I also discussed ideas surrounding Multi-value Logic, stemming from von Foerster's comments describing research by Goddard Gunther. [23] This research speaks to the need of literally developing a new branch of bio-logic.

Although many of these books take different approaches, it is interesting to compare and contrast them to the Neosentience project. Certainly the writings of Ray Kurzweil, in particular *How to Create a Mind*[23]; the early texts of Ross Ashby — Design for a Brain[24]; The seminal text by Marvin Minsky, Society of Mind[25]; The book Mind Design by John Haugeland[26]; and Principles of Synthetic Intelligence by Josca Bach[27], among others are of interest although each takes a differing approach.

Of course, there are contemporary projects like the Blue Brain project that are also interested in aspects of this area, focused more directly on the brain alone.[10] One also reads of the huge funding given to Elon Musk [11] for the development of Artificial General Intelligence.

Additionally another approach might be to functionally reverse engineer *Wider Than The Sky – The Phenomenal Gift of Consciousness* by Gerald M. Edelman [28] – What if each of the areas he discussed became an functional element in our in our n-dimentional combinatoric bio-algorithm?

I think the main thing would be to define a set of recombinant informatic conversations empowered to bring diverse researchers into dynamic conversations that exemplify the bridging of some of the topic areas suggested above. Perhaps this can be a future conference? I certainly believe the Insight Engine can help promote such a rich distributed conversation.

I believe this approach is a much more holistic than many of the historically *brain* oriented approaches. We must consider the entire set of relationalities that are at operation at different scales contributing to the potential emergence of Neosentience. This includes brain, mind, body, multi-modal sensing and environment.

The Ethics Surrounding the Generation of a New, Self-aware Autonomous Techno-species

It is obvious that a series of ethical considerations need to be discussed related to this new form of autonomous robotic entity. Once authored, the Neosentient will be a self-aware entity, a techno species of sorts. Because this is the case they will potentially want to be given the rights of personhood as discussed in the Neosentience book.[29] In terms of society, this potentially represents a new working class of potential slaves. It also represents a new sector of potential self-aware intellectual collaborators, who are not interested in their enslavement. There are a series of questions that cannot be fully examined now but are interesting in terms of the discussion of ethics. Seaman and Rössler gave the subtitle of their book as The Benevolence Engine [30]. It must be noted that huge amounts of money and research are going into destructive machines, by companies like Boston Dynamics.[12] It seems only ethical to consider the development of benevolent machines in response to this other form that is potentially highly destructive in nature.

Some Questions

The potential for these robots to build up knowledge of context via multi-modal sensing and patterened learning somewhat like how humans learn, is a very different model to that of the 'intelligence in a box' model related to current AI. What kinds of ethical questions come up when we seek to enculture Neosentient entities? How might this kind of learning work? Would the Neosentient be brought up? Alternately, will Neosentients be able to share knowledge in a networked manner?

What role will aesthetics have for such a techno-species? Will it develop it's own sense of aesthetics and/or a hybrid human/machinic aesthetics? What relationship would such an entity have with machines that are not self-aware but are producing aesthetic artifacts.

There is a deep need for caregivers in societies that have grown old in a disproportionate rate to that of its care-giver worker force. Rössler in particular, and others (including Seaman) have been interested in discussing these kinds of entities becoming robotic-care givers.[13] What are the social and ethical questions surrounding this question?

If the entity can learn and be self-aware, will they seek to re-program themselves. There are already machines doing this now – using aspects of code that is combined in new ways to change code. In terms of a techno-species I have named this re-programming process in one generation Techno-Lamarckism.[14] This would functionally represent a change in the bio-algorithm discussed above.

What would it mean to create synthetic emotions? What are the ethics surrounding this? George Lakoff has spoken at length about how human emotion plays into decision

10 https://www.epfl.ch/research/domains/bluebrain/ (accessed December 15, 2019)

11 https://www.independent.co.uk/life-style/gadgets-and-tech/news/elon-musk-ai-openai-microsoft-artificial-intelligence-funding-a9016736.html (accessed December 15, 2019)

12 https://www.bostondynamics.com

13 See Rössler et.al. Design for an Intelligent Computerized Doll as a Companion in Old Age, Accessed Dec. 16, 2019 https://austinpublishinggroup.com/pediatrics-child-health-care/published-articles.php

14 See Neosentience / The Benevolence Engine p.226

making as part of the embodied mind.[15][16] One can infer that Neosentient entities will need synthetic emotions as a part of self-aware thought arising out of a technological body.

As the Neosentient bio-algorithm is being initially tested, what role might inappropriate and/or schizophrenic behavior be addressed? As children test their parents, how will this trait play itself out in the learning of the Neosentient? One can imagine many strange senarios that Neosentinece my engender.

Conclusion

Seaman and Rössler in their book Neosentience / The Benevolence Engine [31] gave a definition for discerning Neosentience based on a set of pragmatic benchmarks—the system could exhibit well defined functionalities: it learns; it intelligently navigates; it interacts via natural language; it generates simulations of behavior (it thinks about potential behaviors) before acting in physical space; it is creative in some manner; it comes to have a deep situated knowledge of context through multimodal sensing; and it displays mirror competence. The potential is to have this be a self-aware autonomous system that is benevolent in nature. They have entitled this robotic entity *The Benevolence Engine*. Of course, each of these above criteria are very much open to interpretation. As mentioned above, this approach is quite different to the Turing Test for defining computational intelligence.

The concept of human sentience is a particularly elusive one. The idea that a group of transdisciplinary researchers might unpack over time the salient functionalities of the body that lead to our sentient capabilities is of course a long-term daunting task, yet a very exciting one. Given that the goal would be to define an autonomous robotic entity by abstracting this knowledge into a new form of n-dimensional combinatoric time-based bio-algorithm, this project also seems like it is born of science fiction at the moment. Such a task is paradoxical in nature because it forces us to actually functionally define Sentience, to chip away at defining the entailment structures of the body and to look closely at elusive emergent phenomena – our sentience. Seaman's transdisciplinary search engine, The Insight Engine, enabling bisociation and poly-associational processes may help a set of transdisciplinary researchers from many different fields work in a distributed manner, in particular through publication, exploring new forms of computational linguistic mappings, AI and pattern mapping. Here many disperate ideas could be brought into proximity, perhaps leading to new kinds of transdisciplinary understandings. I have often called this kind of research a multi-perspective approach to knowledge production.

There are many ethical questions surrounding this transdisciplinary research which I am hoping this paper might help bring into the light, enabling discussion and future articulation.

As a media research, an artist interested in computational creativity, an individual seeking to work in an ongoing manner toward unpacking multi-modal sensing and embodied cognition, and an artist interested in art↔science relationalities, [17] I present this paper to continue to develop a set of approaches to a potentially new research domain.

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Seeing Plants through Botanical Illustration

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Abstract

This paper describes the authors´ interest in raising awareness about plants. For around 30 years they have been creating media artworks that connect plants and humans, in an effort to create more attention towards the vegetal world. The paper starts with recent findings on plant intelligence and then provides a historic overview of plant illustration as a means to study and understand plants. The authors also describe their own fidings during botanical illustration and investigate how this knowledge can be used for media art connecting humans and plants.

Keywords

Plant Blindness, Plant Intelligence, Botanical Illustration, Seeing Plants, Interactive Art

Introduction

For many years it was common to believe that plants are passive and insensitive. With the looming environmental catastrophy however awareness about our dependence on the vegetal world is growing. There is an increasing understanding that plants are sensitive and have a sophisticated way of interacting with their environment. In this paper we look at some of the references in plant physiology and see how artists can contribute to build plant awareness, through for example botanical illustration and art exhibits.

Plant Blindness

Monica Galliano states that our Western society is to a large degree inflicted with "plant blindness." She trances this condition back to Aristotle who promoted a "default position of plant exclusion" though his "zoocentric perspective on the sensorial world" [1]. Galliano calls for a radical change in perspective. She argues that we need a new paradigm and a reevaluation of our attention to the vegetal world.

The great botanist Thomas Browne (1605-1682) pointed out that plants possess the ability to react to the environment; he was one of the first to establish theories of plant sensitivity [2]. In the following years and decades more and more evidence was generated by botanists and plant physiologists. The MIT botanist Dave Des Marais for example studies how plants interact with the physical environment and what can be deduced from these findings for solving ecological problems [3]. Mancuso and others have recently proven that plants can react to light, detect specific colors, know their neighbor plants and communicate via chemicals and sound [4]. These exchanges of information can happen for example through the plants ‘leaves and roots, helping large groups of plants to coordinate their actions as a collective. Mancuso even goes as far as to call this "plant intelligence" [5], a term that is still disputed within the botanical community.

Even though there is now more evidence about the sensitivity and importance of plants for our environment, Wandersee and Schussler, who coined the term "plant blindness" in 1998, analyze that still "the misguided, anthropocentric ranking of plants as inferior to animals, lead to the erroneous conclusion that they are unworthy of human consideration" [6]. So why, asks Monica Galliano, does our society not pay more attention to plants, and why are we struck by "plant blindness, even though plants assure the continuity of life on Earth ?" [7]

Botanical Illustration

One way to study plants is through observation and illustration. Depictions of plants can be found in many ancient cultures, they come in various forms, on vases, murals, objects or gar-

ments. An example is shown in Figure 1, it depicts simplified drawings of wine leaves and grapes shown in the grave of the ancient Egyptian noble Sennefer of the 18th Dynasty. He was the mayor of Thebes and grapes back then were a symbol of rebirth, often connected to the god Osiris.

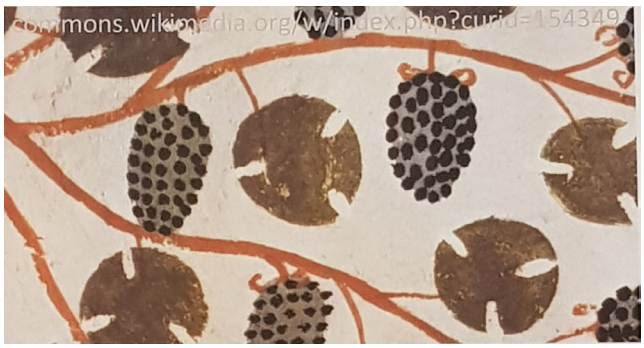

Figure 1. Depictions of wine leaves and grapes in the grave of Sennefer of the 18th Dynasty; taken from: Bernhard Palme, Angelika Zdiarsky (Hg.), In vino veritas. Wein im alten Ägypten, Nilus 25, Wien 2019. exhibition at the Austrian National Library.

Plant drawings also served as study material for medical and pharmaceutical purposes. In the Middle Ages plant medicine was mostly practiced by nuns and priest who had great knowledge about plants, their healing power and their importance as food resources [8]. As early as 1150-1160 the German abbess, philosopher, writer, composer and medical expert Hildegard von Bingen studied plants and described their medicinal powers. She published detailed writings about how to lead a healthy life based on a balanced diet and using herbal ingrediences. Hildegard von Bingen also pointed out that plants possess a special subtility that can not be described by words alone [9]. According to Sweet, she also "emphasized the vital connection between the "green" health of the natural world and the holistic health of the human person [10]. *Viriditas*, or greening power [as she called it] was thought to sustain human beings and could be manipulated by adjusting the balance of elements within a person. Thus, when she approached medicine as a type of gardening, it was not just as an analogy. Rather, Hildegard von Bingen understood the plants and elements of the garden as direct counterparts to the humors and elements within the human body, whose imbalance led to illness and disease [11]. Hildegard von Bingen can be considered as the founding mother of scientific natural history in Germany [12].

Until the sixteenth century the principal practical application for botanical investigations remained medical. Students of medicine had to also take courses in plant studies and the first university chairs in the study of plants were established in the Italian medical schools, beginning at Padua in 1533. University botanical gardens were set up in the same period. The leaders in early-sixteenth-century botany were Italy and Germany, where a number of Lutherian botanists created impressive and innovative herbals.

Otto Brunfels (1489-1534) and Leonhard Fuchs (1501-1566) transformed botanical illustration with highly accurate woodcut illustrations. In the famous book Historia Stirpium [13] around 500 illustrations and wood cuts of plant drawings were included (Figure 2).

Figure 2. Leonard Fuchs, Historia Stirpium, Crocus sativus (Saffron), 1542, p. 441.

Unusual for its time, the three artists producing these illustrations were depicted in Historia Stirpium as well (Figure 3).

Figure 3. Leonard Fuchs, Historia Stirpium - The botanical illustrators Albrecht Meyer, Heinrich Füllmaurer and Veit Rudolf Speckle, 1542, p. 897.

Around the same time, Valerius Cordus (1515-1544), a professor at the University of Wittenberg, created a standard verbal formula for plant description and in Italy, the dominant figure of botany was Luca Ghini (c. 1490-1556) at the University of Bologna and University of Pisa [14].

Systematic depictions of plants appeared in the late 17th century. Botanists started to produce vast and theoretically exhaustive catalogues. John Ray, Olof Rudbeck, and the Royal Academy of Sciences all began universal plant compendia. Ray also had the most sophisticated classification scheme, set forth in the Botanical Method (1682), which introduced the concept of species [15].The German Rudolf Jakob Camerer (1665-1721), known by the latinization Camerarius, first demonstrated plant´s sexual nature.

Camerarius was a medical professor and director of the Botanical garden at the University of Tübingen in Germany. His discovery about the reproduction mechanisms in plants, paved the way for Carl Linnaeus´s (1707-1778) modern system of botanical classification [16]. Especially in the 17th century the field of botanical illustration really blossomed and exact illustrations served the purpose of understanding plant morphology as well as to classify the diversity of plant specimen. One such scientific illustration is shown in Figure 4.

Figure 4. Botanical Illustration of Muscare comosum Miller. From the authors´ own collection.

Botanists began to organize elaborate excursions in order to find and illustrate new plant species: Maria Sibylla Merian, Mark Catesby, Nikolaus Joseph Jacquin, Joseph Banks, Ferdinand Bauer, Charles Darwin, Alfred Russel Wallace are among the many explorers who pushed the field of botany and plant illustration further [17].

An important researcher was the German polymath, geographer and naturalist Alexander von Humboldt (1769-1859). Between 1799 and 1804 he organized large excursions to the "New Word" starting from Tereriffa, to South America, the virgin forests of the Orinoco, the Andes, the South Pacific, Mexico, Cuba and the United States [18]. By documenting plants in their natural habitat, he promoted an environmental approach that also included the interactions between plants, animals and the surroundings; it was the beginning of a field calld bio geography [19]. Alexander von Humboldt can be considered also the first researcher to describe the effects of human-induced climate change onto the environment [20]. When reproductions of botanical aquarelle drawings became distributed in books and journals, a larger audience was reached and amateur botanists, gardeners, and natural historians became interested in botanical illustrations as well [21, 22, 23]. A great botanical illustrator was for example Ernst Haeckel, he was an artists and scientist in one persona [24]. His illustration were characterized by the accuracy of their drawings, and also displayed artistic imagination and innovation.

Back to the Roots

I, Christa Sommerer have a background in botany and as part of my study I also produced botanical drawings in the early 1980s. Already then I was interested in the artistic qualities of plant illustrations. Through these illustrations and inspired by Ernst Haeckel, I became interested in art and subsequently studied fine art and sculpture. During my studies I often incorporated botanical motives in my art installations in a heuristic manner.
In the early 1990ies I began working with computers in order to animate botanical forms and to make them grow. Together with Laurent Mignonneau we combined growth algorithms, real plants as interfaces and generative processes.
One of our first results was an interactive installation called "Interactive Plant Growing" created in 1992 [25]. Here visitors could touch real plants to grow artificially generated plants on a large projection screen (Figure 5).

Figure 5. *Interactive Plant Growing*, © 1992 Christa Sommerer & Laurent Mignonnau, an interactive installation where visitors can touch real plants to grow artificial plants. Photo taken at the *Zeitschnitt 92* exhibition at the Institut Français Vienna in 1992.

These plant growing algorithms were inspired by natural growth, but they followed a more Impressionistic approach [26]. We did not want to imitate nature but rather use a phenomenological concept [27]. The resulting computer generated plant shapes growing on the screen were always different depending on how people interacted with the real plants. Many visitors perceived this as an eye opener: they reported that "Interactive Plant Growing" helped them to perceive real plants in a totally new way.

After nearly 30 year of practice in interactive media art, I, Christa Sommerer recently became interested in coming back to my botanical roots. I attended several botanical illustration workshops with the purpose of understanding more about plants, their morphology and their inner principles. When practicing botanical illustration and aquarelle technique, one has to be very patient, as layer after layer of color is applied to the first sketches, in order to create volume and a realistic looking coloration (Figure 6).

Figure 6. Producing a plant aquarelle. taken from an © Alfons Wilfing Workshop.

The goal in general is to try to recreate the model plant as realistically as possible. Its form, colors, shades and morphological characteristics, and its individuality. While this might sound easy, it is in fact almost an exercise of meditation to see, understand and recreate all the finest details in a plant´s look and character. The plant itself is changing constantly during the day, and one has to make an appoximation between what one sees and what one artistically interprets. The botanical illustration expert Alois Wilfing, who led my workshops, recounts that he sometimes spends months on one illustration. An interesting story he also told us, is that one day an insect came up to one of his illustration in the hope to catch the pollen of the depicted flower´s pistil.
To achieve this type of realism in plant illustration takes years of experience and expertise. In a two day workshop I produced for examples an illustration of Scilla Bifolia, depicted in Figure 7.

Studying plants intensively through botanical illustration has already given me several important new insights:

- when studying a plant for a long time one starts to detect the plant´s internal rhythm
- its micro movements
- its opening and closing of the petals
- the changes of the leaves orientations
- the changes of color in flower, stem and leaves
- the withering of the plant during the day

Figure 7. Botanical illustration of Scilla Bifolia, produced by the author in 2019 © by Christa Sommerer

By looking at a plant so closely for a long time, sometimes even for days, one starts to also better understand its morphology and its characteristic. We would even argue that by engaging in this type of exercise a deeper awareness about the plants can be reached. When considering Wandersee and Schussler´s concept of "plant blindness"[6], we propose that through botanical illustration a deeper appreciation for plants could be achieved. We believe that we can overcome the dominant instrumental view on the vegetal world, and understand plants and their individuality more deeply. Perhaps this is what Roy Ascott means by vegetal reality, where he calls for a deeper intertwinedness between humans, plants and technology [28].

We find it also encouraging to see that in recent years more and more media artists combine plants with sensor technology, trying to find out how they interact with their environment [29, 30, 31]. Cultural theorists have also started to pay attention to the meaning of plants for our culture and there is a growing interest in this interspecies communication [32, 33, 34]. In a recent movie by

Austrian filmmaker Jessica Hausner the protagonists communicate with and even fall in love with a genetically modified plant species called Little Jo: these plants have been cultivated to make people happy, and, in a funny twist of the story, even use humans to propagate [35].

Future Work

Currently we are developing project ideas that combine botanical illustration with interactive art. Since these ideas are still germinating, it is too early to publish them. However, the overall goal is to make participants of the art installation more aware of the wonderful subtility of plants, to overcome "plant blindness" and to experience and understand the "greeing power" of plants in an intuitive and artistic manner. When looking at the botanical illustrations of the early naturalists and explorers [18], we feel this strong affection for plants, something that is deepely needed in today´environmental challenges.

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Open-source Sentience: the Proof is in the Performance

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Abstract

This paper asks how AI can change the consensus around the notion of sentience, through a specific focus on the intertwining of culture and materiality, as well as human-nonhuman relations. The question of sentience in machines is generally regarded as a rather fetishizing notion that obscures the specific assemblages of AI. We would like to open up this notion of fetish, and provide a theoretical map for an inverted way of understanding how fetishization of AI could be mobilized in cultivating an interspecies community. [1] The ideas reflected in this paper are drawn from a research-creation project that took place in Spring of 2019, *Machine Ménagerie*, in which a collection of small autonomous robots serve as a medium for considering different understandings of human-machine interaction. *Machine Ménagerie* creates the basis for interrogating the exclusive definition of sentience as a measurable property. We argue instead for an approach that would emphasize (1) the relational nature of the notion of sentience, and (2) the rituals of care and friendship in relating to nonhuman others. In this context, sentience is not something that beings own, or that humans bestow upon things, but rather is something that is continuously achieved and in which humans and nonhumans participate.

Keywords

relational sentience, human-machine relations, artificial intelligence, affective interaction, rituals of interspecies community

Introduction

Contemporary imaginaries surrounding AI contribute to the binary logic of domination. The futures of human-machine sociality is generally reduced to a question of who dominates whom. This question foregrounds the machines and humans as separate entities-in-themselves, in that the questions focus on the agential qualities of the machines, what their affordances should be so that we avoid an accidental superintelligence, which would be a doomsday adversary in the worst case, or the harbinger of corporate power at least. [2] While such anxieties are legitimate, they tend to obscure the significance of other manners of being with machines, and perhaps temporary achievements that might aggregate into a mutual intelligibility and different co-constitutions of reality. This paper is written in response to an already ongoing reconfiguration in perhaps less explored realms of AI relations, specifically those that delve into machine sentience. What follows is a theoretical account of how to approach the notion of sentience relationally. We emphasize the cultivation of an attention towards the concrete situations and encounters where machines are treated as sentient, as opposed to the expectation of a particular type of agency that would then necessitate attribution of sentience. AI is a significant case here, as the myth of AI already circulates hopes and fears around human futures, while troubling the rigid binaries of living/nonliving, nature/culture that have for so long underwritten the category of sentience in the Western epistemologies.

Sentience, the capacity to feel, is rooted in sensation. In humans it is communicated through affective gestures, representations of emotion—those categories of psychophysiological states that we learn to recognize and perform. The interpretation and performance of affective gestures does not only include humans. We can read the feelings of animals, or even of inorganic beings to whom we are closely attuned. While there is no guarantee nor should it be assumed that the feelings we interpret from nonhumans are transparent or accurate understandings of the subjective experience of the other, it is through feeling-with that we participate in rituals of interspecies communication and care.

This exploration of a culturally grounded notion of sentience comes from research-creation project *Machine Ménagerie* that features small autonomous robots. Robots represent an accessible point of entry for experiencing sentience in nonhumans: they can tap into our habitual recognition of sentience in animals, and they can share a common sensory and temporal frame in which to meaningfully interact. The interactions with and around the inhabitants of the *Machine Ménagerie* provided a starting point for a discussion on sentience, as it highlights the constructed nature of the concept. This opens up the possibility to focus on the relations that uphold the notion of sentience, while recognizing the fetishizing nature of the category itself. Arguing for sentience of the machine appears to be a process of putting the ghost in the machine

(as if they were ever two separate entities). Instead of using fetish for critique—as is tradition in the Western history of thought, we would like to reclaim the power of fetish to invoke beyond-human realities, to the extent that it highlights the rituals and performances that bring about the possibility of interspecies communication.

Sentience in Animals

It is commonplace nowadays to think of animals as sentient beings, but this wasn't always the case. The Western epistemologies assumed a Cartesian dualism, which held that only humans have feelings and capacity for experience, a fact that separated us—humans—from the Others that inhabit the world. Ian Duncan observes that even if animal sentience has been recognized in the scientific communities of the 19th and 20th centuries, the rise of behaviorism in Western epistemologies had rendered the concept paradigmatically redundant. [3] Indeed, the social sciences' striving for positivism had problematized the use of subjective and/or affective categories to explain social realities. Psychology as a discipline was especially effective in pushing behaviorism as truth while devaluing the philosophical discussions on notions such as consciousness or sentience. To quote one of the founders of functionalist tradition on this point, we turn to William James:

> "Consciousness... is the name of a nonentity, and has no right to a place among first principles. Those who still cling to it are clinging to a mere echo, the faint rumour left behind by the disappearing 'soul' upon the air of philosophy." [4]

James condemns questions concerning consciousness and other subjective traits such as sentience to a noumenal space. The rigid empiricism implicit in James' writing values (measurable, objective) behavior over (immeasurable, subjective) experience. Later in animal welfare studies, these two seemingly distinct methodological approaches were reconciled: animals' welfare included the notion of sentience, and research efforts were focused on measuring the sentience of animals in the sense of assessing the pain or stress that animals experience under certain conditions. [5] However, no matter what methods are used to justify the attribution of sentience to animals, "we can never prove conclusively that any organism is sentient." [6] This means that sentience is justified arbitrarily. It is tied to practices of care, defining a subset of bodies as worthy of respect and consideration.

Why stop at animals? How might inorganic bodies such as machines acquire sentience? To approach this question, we will look at Artificial Intelligence, its cultural myth and its role in the economy of sentience, as well as the research-creation project, *Machine Ménagerie*, that critiques the power dynamics of human-machine relationships.

Feeling Machines

The core question of AI research is often cited as, "Can machines think?" [7] AI emerged as an effort to replicate the human mind, and these technologies are often referred to as thinking machines. Turing famously asks the question in a rather sociological formulation and interrogates the conditions for perceiving machines as "thinking" in a social context (of the Imitation Game). His discussion points to the constructed nature of thinking, in that the thinking of the machine could only be perceived if the humans are willing to be fooled by the machine's pretense for passing as human. In a way, Turing recognizes and gives a legitimate place to the fetishized nature of the interactions with intelligent machines, and keeps open the possibility of subjectivity in thinking machines.

One question that is seemingly left out of AI research is that of sentience. While intelligence gets prime time in discussions of AI, sentience is usually given as a hard limit to AI. Can machines feel? Is sentience something that you can artificialize, like intelligence? The privileging of the question of intelligence in opposition to feelings rests on cultural assumptions of the supremacy of rational (masculine) versus emotional (feminine) intelligence. Questioning these assumed hierarchies starts to blur strict definitions between feelings and thoughts.

Different understandings of emotions affect what we mean by sentience, mingling with notions of intelligence. Recent literature on the nature of human emotion defines it largely as a cultural practice. [8] These practices are dynamic, changing over time with the changing habits and scripts of cultural participants and institutions.

AI participates in the hopes of posthumanism, the fears apocalypse, the horror of self-alienation and the lust for the other. AI is a complex and dynamic affective agent that evokes emotional responses and promises idealistic futures. AI also supposedly represents a category of machinery that mimics humanlike properties of intelligent behaviour, and increasingly of social behaviour. However, if we try to pin down the machinery represented by the term AI we encounter an ever-changing collection of specific assemblages: decision trees, finite state machines, the many varieties of neural networks and machine learning algorithms, and so on. It harkens back to the Turing test: if a machine thinks if we think it thinks, then a machine must feel if we feel it feels. However, this kind of persuaded perception of sentience is subject to manipulation. Humans can call upon AI to claim sentience for specific objects when it serves specific interests, such as selling emotional engines and social robots. AI as a fetish object holds the power to permit humans to acknowledge machine sentience, which makes it the subject of extraction and exploitation. However, these relations that could be

summed up as capitalist are not the one-way street in human-machine relationalities. The sentience question in machines could mobilize other gestures that recognize being-together-in-the-world. The research-creation project *Machine Ménagerie* is a good example for a starting point in thinking about these issues.

Machine Ménagerie

Machine Ménagerie is an installation comprising a collection of small autonomous robots living together in a transparent enclosure. Ranging in shape and sophistication, these artificial creatures have no "function". They spend their time entangled in a mesh of interactions with each other and the environment, much as we do. They are embodiments of certain human ideas about life and consciousness, and as such they can serve to critique definitions of intelligence and selfhood. Encountering non-biological lifelike entities, how do we attempt to understand their actions and reactions? How do we apply our concepts and assumptions of selfhood, agency and motivation to these objects, and what does it reveal about our ways of thinking?

Built during a three-week public "research performance", the robots took shape along with a running dialogue with visitors of various backgrounds. Since then, *Machine Ménagerie* has been exhibited several times and has featured regularly as a boundary object in the discussions of Concordia's Machine Agencies Research Group, from which this paper arises.

The robots in the installation are of two kinds, roughly categorizable as analog and digital (Fig.1). The analog ones are mobile circuit-sculptures powered by sunlight, often known as BEAM robots. These come from a long lineage of autonomous machines, tracing back to Tortoises via Biomorphs and Braitenberg vehicles. [9] [10] [11] The actions of the analog robots are dependent upon their individual configuration of solar panels, motors, sensors, and switching circuitry. They exhibit simple behaviours of moving toward or away from stimuli (typically light) and given enough time they typically get tangled up pushing against other robots or else wander out of the sunlight and slow to a stop (at least until the light returns).

The digital robots are constructed of microcontrollers, motor drivers, motors and sensors, with simple neural networks "under the hood". Specifically they are driven by an algorithm called Differential Extrinsic Plasticity (DEP), which seeks to replicate the development of complex behaviour using a small number of adaptable neurons. [12] Essentially, the DEP-bot will try to correlate its movements with its sensations, in a sense trying to answer the question "is this me?" and (of course) never succeeding. It must move to sense its movements, and by moving it interacts with the complex environment that surrounds it, which may or may not correlate with the robot's bodily motions. The DEP-bot resembles a very simple implementation of predictive coding theorem, in which an internal model of self adapts to the sensations of self felt as evidence of one's actions reflected in the world. [13]

Figure 1. Robots in club *Ménagerie*: Topse and Little Wallace (left) are examples of the analog kind, whereas Zoulandur (right) is of the digital kind. Photo © Vjosana Shkurti 2019.

Humans who visit the *Ménagerie* or encounter its members almost always speak about the feelings of the robots. Each autonomous machine has its own personality and has relationships with the other 'bots. They are, to put it bluntly, cute as heck. Part of this is likely due to their size and their apparent helplessness. When the 'bots (of either type) are out of their enclosure and wander close to a dangerous drop, people tend to vocally worry about them and protect them from falling. Their obvious vulnerability quickly evokes an emotional response from humans, manifested as both feelings in the human and feelings attributed to the robot.

Over a longer timescale, the members of *Ménagerie* have developed friendships with several humans they encounter regularly. The staff of the original exhibition space felt like the robots were welcome companions during their workday and kept the installation running for their own benefit long after the exhibition was over: talking to them, rearranging them and diligently separating them when they became tangled. Two filmmakers who filmed a vignette of the DEP-bots took care of them for several weeks. They reported that the creatures showed consistent favouritism for one of the humans, and were sad when they had to be returned. The inhabitants of the Menagerie are clearly charming, and incite affective interactions around and alongside themselves. They are often referred to in rather human terms, and are taken to be bots with their own cultural biographies. The machines of the Menagerie live, in the sense that they gather rich experiences and are affectively significant agents. Indeed, they are great candidates for sentient machines, and in fact they seem to be treated as such by their human peers. Witnessing these experiences had prompted the question of what happens if we let these fetishized relations to be realized? How would reality be reconfigured around the notion of sentience?

Fetish and Sentience

While the AI question creates the possibility of reaching a different conception of sentience, the reality of sentient machines seems to be limited to popular cultures of literature and cinema, which inform the myth of AI. [14] While the myth of AI is mobilized to attract investment into scientific research, in practice the concepts that make up the mythology are devalorized (and debunked) due to their fetishistic make-up. In other words, it is a sin to see the ghost in the machine. As good sinners ourselves, we would like to raise the question of what is so bad about fetish itself? The discipline of anthropology has a longstanding colonial relationship with the concept—which then leaked into other disciplines, mainly sociology and psychology. Fetish, as an object with superhuman powers, was seen as "primitive" communities' alleged misunderstanding of the nature of reality. [15] In the Western epistemic regimes, fetish denoted a negative meaning, as the notion implied that relations between humans could be misinterpreted as relations between things. In this way, fetish also held the ticket to social transformation, as the human subject would ultimately disenchant the fetishized relations, and would grasp what's "really real": that things *are* actually relations between humans. [16]

This interpretation of fetish, as mentioned before, is rooted in colonial relations, and implies an inferiorizing perspective toward the anthropological others (non-Western communities). Yet perhaps it possible to salvage this notion by inverting it, and using it where it is most appropriate: at the heart of Western paradigms' own production of things with 'magical' powers. Here we turn to David Graeber, who reconciles various anthropologist interpretations of fetishism, and reaches at a conception of social creativity. [17] In his article, Graeber talks about how fetishes—i.e. artifacts with godlike powers—are perceived by the Western analytical gaze as a mishap, as a misunderstanding of the reality of the objects. This kind of critical outlook, he argues, denies the power of fetish in creating new social responsibilities, of forming new associations. In his formulation, fetish has the potential to bring in radical social change. In very simple terms, part of Graeber's argument is that accepting that an object has godlike powers actually generates spaces for different cultural habits to be formed, and through these habits (rituals and contracts) new imaginaries emerge. In a way, making fetishes is actually reaching at pure social creativity.[1] Can we achieve sentience through this fetishistic approach? Could we, in other words, disrupt the normative assumptions and theories of human-machine relationship?

In order to subvert the assumption that sentience is a property possessed by a body, and to reach a conception of sentience as collectively negotiated through performance, we should indulge in a methodological fetishism. In "The Social Life of Things" Anthropologist Arjun Appadurai states,

> "Even if our own approach...is conditioned necessarily by the view that things have no meanings apart from those that human transactions, attributions and motivations endow them with, the anthropological problem is that this formal truth does not illuminate the concrete, historical circulation of things. For that we have to follow the things themselves[…] even though from a theoretical point of view human actors encode things with significance, from a methodological point of view it is the things-in-motion that illuminate their human and social context." [18]

Appadurai's approach flips the relationship between theory and methodology: in the normal conduct of science, theory would give the hypotheses that then are operationalized methodologically into research objects. Instead, Appadurai puts methodology to foreground, as a way to counterpoint a theory about the (non)life of objects. Our perspective embodies a similar approach to the study of sentience in thinking machines, as we propose the cultivation of an attitude that would create a space where we could engage with nonhumans and "learn to be affected: meaning effectuated, moved, put into motion by other entities, humans or non-humans." [19] The stakes in this move to learn to be affected are ethical relations with our non-human interlocutors and reclaiming the exploited category of sentience to raise questions about responsibility and accountability in an interspecies community.

Toward a Relational Definition of Sentience

What happens when we look at sentience not as something that could be measured, as an attribute of an organism; but rather as something that is always already relational, and thus amenable to cultural negotiations? Recall that from the Cartesian perspective sentience appears as something that bodies either have, or do not. This perspective neglects the socio-material and historical conditions through which sentience is achieved. Indeed, we argue that it is through collective effort that sentience is historically attributed to certain entities and not others. However, we aren't saying that sentience is just a category that humans use in order to decide who gets included into the "humans club". [20] We are instead pushing for recognizing that humans and nonhumans take part in this performance of sentience, and their relations form the basis for recognizing whether machines can be sentient or not.

[1] Interestingly Turing also emphasizes the role that creativity plays in recognizing the agency of AI. He says that humans must partake in a creative mental act if they want to be surprised by machines.

Looking at sentience in machines through the lens of performativity opens the possibility for recognizing the mutual intelligibility that lies within the relations of humans and machines. The methodology here is similar to that of machine ethicist David Gunkel. He states,

> "[S]omeone or something becomes a moral subject with legitimate ethical standing not on the prior determination and demonstration of his/her/its agency or the possession of some psychological properties that are considered to be "person-making" but by being situated, treated, and responded to as another person by a particular community in concrete situations and encounters." [21]

While our discussion is not particularly about personhood or construction of a machine subjectivity, the discussion of sentience would benefit from such an approach. In line with Gunkel's methodology, we do not rely on an expectation of a particular type of agency that would then necessitate attribution of sentience in the machines; rather, our interest lies in cultivation of an attention toward the concrete situations and encounters where machines are treated as sentient.

As discussed, sentience of AI is a fetishized discussion in that the thing itself appears as if it is sentient by obstructing the relations with which the thing is constituted. Examples such as Pepper or Kismet make use of this fetish, as these robotic applications of AI posit themselves as beings with affective capacities. [22] [23] Yet we argue to move our focus away from robots with impressive agential abilities toward social situations that imbue the thing with sentience. What's relevant to this approach to fetishization, is notions of ritual and performance.

Ritual and Performance

From a sociological perspective, it could be said that norms and contracts are formed through sedimentation of performances into rituals/habits over time. Such performances also play the role of forming fetishes, imbue objects with magic (in the Western conception of the term), thus have the power to produce/constitute reality in the ritual space. And so the relationalities that those performances constitute become the central unit of reality formation. In fact, Emile Durkheim argues that it is in the space of rituals that the very conditions for society are produced. [24]

Mundane, routine activities provide the basis for the emergence of taken-for-grantedness and a common-sense reality. [25] This would be the primary order of reality that is intersubjectively produced. From Roland Barthes, we could also argue for a second order, a mythology, that takes the signs from a first order (language), dismantles the already existing signifieds, and then identifies them with new signifieds of their own symbolic order. [26] This is how all the animals, rocks, and mountains are animated in the mythologies. Sentience, then, as a signifier of the capacity to sense and feel in humans, had already undergone a secondary ordering in Barthes' sense when it came to signify the feeling states of animals. As the dichotomy between nature/culture, and living/nonliving are troubled by AI, a similar move is now possible, concerning sentience of the machines.

Barthes, however, holds a hierarchy in the relationship between the symbolic order pertaining to 'reality' and that of the myth. The reality of the myth is only a contained reality that is subordinate to the paramount reality/symbolic order of everyday life. Instead of this, we take serious the implications of a simulacrum, of a hyperreality. [27] More appropriate to our contemporary landscape of continuously collapsing binaries, we give up the mission of modernism to separate the world into pure categories of fetish or real (as we have never been modern). [28] Instead, we would like to focus on the ritual as the basis for forming reality, including the ontologies that rituals presuppose. In fact, this would be the necessary move when looking at the cases concerning AI, because of the intertwinedness of the myth and real.

Rituals are significant for an interspecies community in that they provide non-discursive performances that constitute signification with nonhumans. Graham Harvey, scholar of religion and champion of what he calls *New Animism*, describes it in terms of actions that get the attention of the entity with which you are interacting: "...you say 'sorry, please, thanks' and you ritualize it because they don't necessarily speak [your language]. So rituals are the ways in which you engage across species boundaries". [29] Rituals extend beyond the structures of language to include performances that constitute signification of a different kind.

Machine Ménagerie offers an example to think of these ideas through rituals of care and friendship. When on display, the installation requires a human supervisor, who can introduce the robots to visitors and tend to the robots' needs—waking them up and putting them to sleep, helping them out of awkward situations, and guarding them from harm. The human sets the precedent for visitors' interactions, establishing a norm by which people will approach the robots.

For those humans who have spent time regularly with the robots, there is more room for intimacy and organic development of relationships. People ask after their favourite robots, pay visits to speak and play with them, or take them on outings. By far the most common ritual involves letting them roam on a meeting table, idly protecting them from falling to the floor while discussing the topic at hand.

These general descriptions of human interactions with the members of the *Ménagerie* hint at the repertoire of gestures and behaviours that can recognize sentience across ontological lines. According to Lucy Suchman, "objects

achieve recognition within a matrix of historically and culturally constituted familiar, intelligible possibilities." [30] Cultural habits can thus make-familiar new possibilities for intelligibility of nonhumans. And even if attempts to establish new cultural habits seem too affected to be taken seriously within a contemporary mindset, perhaps embracing these affects "to-the-point-of-embodiment" despite ourselves is nonetheless "a way in". [31]

Emergence of an Interspecies Community

There is an either/or logic that still guides the common-sense thinking about the machinic others: either We[2] dominate Them, or They enforce a technological cataclysm. This kind of logic obscures other manners of being with machines, and perhaps temporary achievements that might aggregate into a mutual intelligibility that we could assume as a basis for being-together-in-the-world. We propose a theoretical opening here by articulating the possibility of machinic sentience; and the inhabitants of the *Machine Ménagerie* give us a good starting point to discuss the cultivation of this fetishization process.

What we had discussed so far highlights the potential for an ethical space of being-together-in-the-world with machines. This potential could be realized by creating rituals that would relationally denote sentience as a collective performance, based on the recognition that sentience is not an attribute of entities, but rather is a product of particular configurations of relationalities. The idea is to draw attention towards social situations where nonhumans—by necessity—incite recognition of their contribution to sentience. It is not about the manufacturing of agents that are "more interesting" to humans, but about the recognition of an already existing social space that includes human and nonhuman sentience.

We propose this while being well aware of the pitfalls of such thinking. Joseph Weizenbaum is often cited about the dangers of mistaking these technologies for actual intelligence, and engaging in affective relations with them. [32] It would indeed be a naive attitude to paint a picture of humans holding hands with machines and gazing towards bright futures. However, ignoring the questions of other forms of relationalities with the machines (that resist the hegemonic assumptions) runs the risk of further cultivation of relations of domination, and contributing to a cultural logic that denies the complexities of contemporary socio-technical landscape. To empower ourselves with the ability to collectively reconfigure sentience is to resist the power structures that are deeply seated in the relations and conceptions of a world where human-nonhuman, life-nonlife, and nature-culture are clearly defined, and the boundaries of these very definitions are subjected to capitalist extraction and exploitation. It is in this vein that we raise the question of an interspecies community that takes seriously the notion of sentience, as a way of propagating relations that do not abide by the colonial-capitalist logics.

[2] With capital W, as there's an overgeneralization of a particular perspective implicit in this imaginary. This very situated thinking that emerges from Silicon Valley, from engineering circles in institutions of higher learning, and the cinema industry had taken over the imaginaries pertaining to human-machine relationalities.

Conclusion

In this paper, we have focused on the theoretical openings that come about from questioning the conditions for machine sentience. We first looked at the history of animal sentience, as this case highlights the constructed nature of the category of sentience. It is used as a way to go beyond the domination of human-centric approaches so as to include animal welfare as an ethical consideration in human actions. Sentience, in this context, is mobilized as a way to extend care. This intersection of care and sentience has been significant to our discussion on an interspecies community.

We further intersect these concepts with emotions as cultural constructions. Emotions are not static feeling states that could be rigidly categorized. Rather, they are culturally grounded, and thus are amenable to transformation via meaning-making practices. This cultural reading of emotions renders AI a strong candidate for affective relations. AI itself is—like humans—not only a participant but a *product* of culture, in that it is defined by contextual relations. This is why it does not constitute a totalized whole as a term, and its meaning is rather an ongoing contestation and negotiation. In our case, we are interested in relations that extend care and friendship, and those that necessarily cross species lines through performing rituals that signify the other as sentient.

Our exploration has led to a discussion on fetish albeit in an inverted manner. Instead of employing the role of the critic and condemning the fetish as the site of the misguided and misled, or the childlike and the infantile; we treated fetishization as social creativity, and as a way to cultivate an interspecies community. This approach is significant in the case of AI as it makes it possible to discuss the myth and reality of AI—which have been very much intertwined in the history of the phenomenon—in the same token, without condemning fetish to disenchantment. Our discussion opened up notions of ritual and performance as a way to constitute reality in a creative manner. Both these terms focus the analytical gaze on the relationalities, and hold the potential to connect different species via a repertoire of gestures and behaviors that extend beyond the capacities of human language. Reflecting on the already existing relations and striving to collectively reconfigure our relations with machines opens up a space for resisting the hegemonic relations that abide to a capitalist logic that accompanies a domination framework.

The distribution of sentience justifies the distribution of care. By the same token, it justifies harm. Historically, the idea of sentience as an objectively measurable property has problematic effects. It concentrates power in the hands of those who determine the measurement—power that has real consequences for how we are "allowed" to interact with nonhumans. And by claiming authority over our relationships it invalidates subjective experiences of nonhuman sentience that occur during our daily lives.

On the other hand, a sentience defined by performance is distributed by consensus, giving us humans the power to organize interspecies communities and hold ourselves accountable to nonhumans for the care and harm that we enact. In effect this is the kind of sentience that is already playing out. People regularly attribute stentience to (allegedly) inanimate objects, while maintaining some trust in the truth of sentience as a measurable property. However, this supposedly objective truth is subject to manipulation, and obfuscates the power in us to realize complex relationships with nonhumans, to feel with them, and to be in the world together, for better or worse.

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Indigenous Sentience: Fernando Palma's electronic divinities

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Abstract

The questions on sentience we wish to explore in this paper have reference to the issues raised in the resume for the conference. We may re-state these questions here in order to drive the discussion on how Fernando Palma Rodriguez, an indigenously inspired artist fom the eco-reserve of Milpa Alta, close to the historic southern districts of Mexico City, simulates sentient machines with actuator technologies. Rarely has aristic introversion been utilized in the produc- tion of such electronic art – which could be described more precisely as arduino based intelligent puppets that are fully indigenous in their congifuration.

Keywords

Indegeneity, Phenomenology, Nahuatl, Sentience.

Introduction

The questions on sentience we wish to explore in this paper have reference to the issues raised in the resume for the conference. We may re-state these questions here in order to drive the discussion on how Fernando Palma Rodriguez, an indigenously inspired artist fom the eco-reserve of Milpa Alta, close to the historic southern districts of Mexico City, simulates sentient machines with actuator technologies. Rarely has aristic introversion been utilized in the production of such electronic art – which could be described more precisely as arduino based intelligent puppets. The questions that Fernando Palma's installations refer to are similar to issues that the conference proceedings at the ISEA 2020 directly addresses: namely. "How is sentience investigated in Indigenous media arts, aesthetics, philosophy, humanities and social sciences? - Is there such a thing as a politics of sentience? Is this politics necessarily progressive? Could it be deceptive? What is sentience's relationship to power and knowledge?" Palma's electronic installations, animated by arduino technologies, remind us of the zoomorphic movement and itsintrinsic mysteries. Like Jean Tinguely's installations – for Palma, the artifact is situated at a Nahuatl moment, as a mythic object which simulates the sentience of the gods. This is where technology intersects, displaces and re-institutes global discourses of the arts. Palma looks at sentience from a proto-Aztecan world angle: his electronic puppets exhibit reflex and movement as in biological tissues, but also as if they were seances or conjurations, or divine games. These movements in Palma's mythical snakes and horses demonstrate reflexes from the perspectives of human desire and appear to be completely intransigent and whimsical, just as divinity is always whimsical or erratic, untimely and full of the dark humor, which it has always been through out the history of civilization.

Indegeneity and Ideology

If the indigenous communities are generally left behind in the bandwave of technology then only Fernando Palma, who grew up as an introspective child in the neighborhoods of Mexico City, emerges as the artist of a vanishing mestizo culture, in the middle of frontiers between cultures, between excruciating histories and spaces of time. But Palma foresees the possibility of digital life in the Aztec icons he creates, notably after his creations of 2005, when he exhibited in the Tinguely Museum along with like minded kinetic sculptors, but with an unlike-minded indigenous leitmotif for his works. Palma rehabilitates the gods from a whole range of contiguous divinities in the plenum of the Aztec heaven – the evening star, and the sun and other hallucinogenic twilight figures. The value of Palma's art is immense. Palma is a rare artist who seeks to thrive in a global and anglophone world of museums and private collectors. The only tools he has to differentiate his art are also connate to new media art – but the effects that the installation creates are part of a connective tissue in which the pre-hispanic people realized their being and freedom.
If these ideas were constituted a non-mainstream ideology, like a prayer in a neglected corner, yet efficacious, then they also set out to define a new art that breaks out of the ground of fear, of extinct cultures, of victimization, and evanescence, of all possible objects and things and sensations that threatened the indigenes' experience after the colonization of the Americas.

Education and Early Work

Educated in Mexico City and London, and intellectually conditioned by the spatial order of the European museum, Palma remained insulated in heart, like a son of the earth who defies categorization - there is a reason for this. Un-

like a post-modernist, unlike *nativists* even, Palma directly transcends frontiers, he lets his own indigenous imagination thrive in the context of the modern museum, with the same dignity that the 'other' never experiences. The same *Nahuatl* icon is placed in a synthetic conjunction with machines, like Tinguely's machine parts, body, vestig- es and skulls: the icon and the machine join each other like an assembly in which an icon assimilates and animates machines for a new media culture. This is a crucial point - the animistic moment in Palma's works. Palma's elctronic puppets respond to a multiplicity of variables. The snake or broken horse momentarily come back to life in the presence of a viewer -this is a whole new level of sentience that narrates the mythic dimension of the Aztecan imagination, just as it does for all other categories of imagination.

Format of Electronic Manuscript

When it comes to questions of publicity, as much as to questions of recognition, an artist, even in an era of digitization, suffers or is at least subject to the sway of data that drowns and deconfigures images beyond recognition.

Consider therefore, Tinguely's Anthropomorph is thus a initial basis for Palma's Coyotes or Venus (Figure 1). For Tinguely the Anthropomorph represents both life and death, a cyclical hindu-buddhist concept. In Palma Quetzalcoatl (Venus star) or Coyote are shamanic aspects of perception, goodness and evil, life-eternal and its counterpart death. These dualities are held together in any critical assessment of Fernando Palma' synthetic vision, his fusion of genres in a post-minimalist, post-kinetic context, with a gentle rigmaroble of identity, and of fear and comedy in the audiovisual robots of his imagination.

If we look a little deeply into Palma's snake icon, we get to understand how the indigenous imagination confronted the phenomenon of sentience. The fact that sentience adheres not just to the body, but to time -is evident here. The body is part of a sentient, living world. But the icon is part of another kind of sentience -we could call it abstract ad pure sentience, the priniciple of sentient action in which objects, as discrete entities, particpate and evolve in the natural world. This is a divine sentience and it expresses itself in the idol pursuant to the deeply pre-historic animism of the paleo-Indian religions. Palma further successfully constructs and installation in which he manages to captures the quirky and unexpected or scinintillatory nature of this sentient moment. Palma's Quetzalcoatl thus comes to life all of a sudden. Sometimes the actuators do not function during periods of museum exhibitions. Sometimes they ome to life only in a specific city. The wing or head of a snake god or a horse may twitch following an apparently coincidental response to a sensor signal. Palma calls it divine intervention.

Figure 1. (© Fernando Palma. Quetzalcoatl. 2016. Mixed media. Installation view (Photo: Artist)

Education and early art

Palma's installations remain so enigmatic because of this embodied message that it emits. Built in an environment of contemporary artists, for whom he curated exhibitions - notably with Japanese Miwa Kajoma for example – his installations reflect that seed of relationality, a way of thinking about his art objects that is not completely absent in his school mates from Stuart Hall in London. Palma himself does not expressly believe in relationality to be existing in his works. Yet a fine relationality brings together parts of his sculptures - this does seem at first to be a context in which he was doing art in the nineties, especially in London, and elsewhere. The nineties represent the coming of age of this artist. Palma we know had studied in Mexico city but his initiation into electronic art came about in London. Palma's grooming in London, in his years as an artist was decidedly defined by relational art. What relationality generates is a confluence through reconfiguration of pre- existing elements rather than full subjective expression. Relations are also assemblies - not just semiotic but objec- tive, as Palma demonstrates in the installations of the late nineties, in London, especially in exhibitions which he curated. Palma shared this accidental conformity of

rela- tionalism with colleagues he had been working. Palma's affiliation with artists like Miwa Kojama and Takuro Mi- kame at the 198 Gallery in London shows that even in his early work where he was yet to composite a distinctively indigenous motif - he was venting through styles built by the entire post-fluxus generation and Nicolas Bourriaud (Palma 2002). As it happened with the first important exhibitions in the next decade Palma was kind of on his own but the combination was afloat in the organic desire to absorb and let his roots fructify into a machine.

What the London ambience probably did for Palma is to bombard his imagination with the technological infusions of the new media art. His recognition of the importance of the 'microchip' as he was later to say, adjoining on to machines, became for him a smaller and smaller channel of communications, and the possibility of a new chaos in objects of movement. Of course, what fluxus art, and Tinguely's animated machines bequeathed is combination - machines and skulls and fragments of bodies. Palma identified this combinatorial process in Thomas Baumann, Malachi Farrell or Jeppe Hein who all were laying out the objects, just like Palma himself with 'kinetics' - like a proto-Tinguely entity. What they were doing is laying out a circuit board - and this was more of a transition from the analog installations of Tinguely or Nam Jun Paik, and that entire generation inspired by Tinguely, who kept working in the seventies: artists who questioned and transitioned into the digital epoch. They were artists like Yaacov Agam, Pol Bury, Gerhard von Graevenitz, Hans Haacke, Rebecca Horn, Stephan von Huene, Piotr Kowalski, Bruce Nauman, Jesus Rafael Soto, Guenther Uecker, Krysztof Wodiczko, all of whom were involved with their individual projects at the Tinguely exhibition titled Moving Parts (2005).

Later Works

If we take a deeper look at Palma's immediately later works we see this transformed Palma.Consider his greater – more recent - work, Soldado, 2001, Los nahuales, 2017, Tetzahuitl, Coatlicue / Xipetotec, 2018, 2019 Tetzahuitl, 2019. What most he seeks to create is that sentience of the gods that define and make, and re-make Aztecan culture, its entire world view which assumes a supra-sentient consciousness as a level of origin for this visible world.

Indeed, this process is evident in all his works exhibited on both sides of the Atlantic, at the MOMA PS1 in 2018 and the Gaga gallery in Los Angeles in the same year. The MOMA exhibition which Palma called In Ixtli In Yollotl / We the People and his more recent retrospective at the Museo de Arte de Oaxaca, Guex Liu, Kuu ñunro, Totlalhuan / Nuestra Tierra (Our Land). First the content. Palma, as the MOMA exhibits demonstrate represents at its finest, we believe, the programmed body of the otherwise invisibly visible "plumed-serpent", that so much caught the Anglophone fascination of D. H. Lawrence, but here even in the middle of an Anglocentric world, the majestic serpent revives itself with its staccato movement, with what Andrea Scott calls a low-fi architecture, the beautifully insinuating spiritual memory of the Aztec deity. Quetzalcoatl is a super deity, described not only in the sculpture of the Teotihuacan, but described in all its colors within the Codex Telleriano-Remensis now retained at the Bibliothèque nationale de France in Paris. [2] In the Los Angeles exhibition the notion of Venus, associated with Quetzalcoatl, but often as the cyclical serpent being achieves furious and comic brilliance in the installation about which Palma himself writes: "Mexico...as the land where we live and with the atmosphere of fear and turbulence, which according to our ancestors was generated at the time when Venus entered the phase of appearing in heaven...is embodied here. Evening, however, is a form of creation, that is, the manifestation of the force that in our eyes is dark: in the complex web of life it is a time of change and re-birth." This appears in the blurb to the exhibition at the GAGA titled Totlalhuan, Mictlantecuhtli, Chak-ek, Kan and held between 29th of October and the 14th of January 2018.

As in a typical programmable sculpture Palma utilizes kinetic stepper motors to make body parts, or organs which are functional but are not full-fledged in movement, Thet appear restricted by a process which in relation to such architectures has been called low fidelity structure. [1] Low fidelity has a specific purpose in Palma's works, which is of course, none other than the paradox of creation of comedy. Palma repeatedly draws attention to the comedy and hope adjacent to his kinetic sculptures, the process is visible in the "Coyotes" which are deific aspects of the soul. This is also his theme in the representation of the naguales, especially in the Oaxaca installations at the Museum of Art in Oaxaca - the brilliant and focussed use of the DC motor is a hallmark of Palma's kinetic art. The amount of deliberately berated control given to the machines exposes the technological depth of Palma's art - especially in the use of such low intensity motors to evoke controlled comic movements, In this again Palma's art is reminiscent mostly of the kinetics of Tinguely's monstrously humane machines. Palma has of course recreated that ethos with his electronics chips and software control.

Conclusion

The idea of a technological indigeneity should thus be imminent, especially in the context of a need for diverse phenomenology and a more spiritual understnding oh human behavior. It is no less than a progressive desire for novel and avant-garde sensations in contiguous elements of experience. Indigenous sentience also draws its sap from roots of culture, and long-embedded conditioning. The quest for a technological indigeneity, which carries the symbolical objects of communities and peoples on its back, is one way in which diversity could be retained for a future which is divided by identities. The possibilities are immense for a post-human indigenous culture to emerge. Brilliant associations, though not very many, but of course,

even those few trailblazing inventions are evident in Latin America, and somewhat also in Australia -continents which are lying out a precept for the rest of the world.

We shall briefly consider the layout of this so far un- called-out movement in the sphere of arts of museums. Because a more global scenario of the arts businesses, with its auctions and adventurous buyers and collectors, and its air-conditioned museums have immuned the spectators' sensitivity to other formats of arts. This happens to the extent that we do not realize that the proto-European mu- seum is also a tribal space. Technological indigeneity pos- its a corrective to that vision and sends a signal of diversi- ty, color, instrumentation and notions of form which are independent, different and autonomous in their trajectory. They demonstrate that spaces and museums can inspire pathways. [3] This is true of Palma's deeply rooted imagination. This is evident in his installations as archetypes that take unexpected technological form in his works.

In case of Fernando Palma technology affiliates with the Aztec imagination, especially the figure of the plumed serpent *Quetzalcoatl*, the serpent of eternal life and death, and the Coyote operative, a robotic projection of the artist himself, or of his soul, with all its Nahuatl candor and feeling. Palma is not outward but inwardly oriented for a museum. But the instruments are all there, owned and inserted in place, as a part of a technological continuum and at the service of the indigenous mind - unlike the indigeneity of the Napoleonic or capitalist museum. For all practical purposes this represents a fusion but what Palma's imagination contains, in a hidden manner, is the potential of a new art where the indigenous human being finds a path of interpretation in a new world, a more global world.

Finally, indigenous arts are not *arts*, *per se*. There is hardly any decorative end for indigenous expression, since the creative expression follows uponsacred belief, and is aligned to guardian spirits. The question of art itself is derogatory, and flippant, if not frivolous for the shamanic view of things. This protocol is however not strictly re- tained in the new world. But indigeneity continues to live in the contemplative mind - even beyond the contemporary formats of normative visual or solid arts for galleries, or home possessions, much like contemporary aboriginal art in Australia, Africa or in Latin America. Technological indigeneity takes a step further backward with its phenomenological message and comedy all mingled together in a living and transforming unit.

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Data, Sense, Resonance: An Art of Diabetic Self-Tracking

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Abstract

This paper presents *Hemo-resonance #1*, the first in a planned series of art works situated at the intersection of art, chronic illness, disability, and the increasing prevalence of body-related data produced through sensors and self-tracking. *Hemo-resonance #1* operates as an attempt to open alternative pathways for thinking about and practicing diabetes. It does so by introducing the concept and practice of "data resonance" as a way of following the possible trajectories of data and bodies, attending to the multiplicity of their affects and co-constitutions. Typically, self-tracking, and especially the monitoring involved in diabetic self-management, is most often put in the pursuit of understanding and uncovering cause and effect, patterns, and trends in the operation of the body in order to act on them to optimize future health outcomes. "Data resonance" moves away from the focus on legibility and goal-orientation so prevalent in these self-tracking activities to explore what else can be done with the collected data and their modes of emergence. I argue that such an approach is important for ongoing questioning of the boundaries and configurations of human and non-human bodies.

Keywords

Diabetes, self-tracking, chronic illness, data sense, data resonance, quantified self, visualization, sonification, co-corporeality, vibration

Introduction

Health-related data are increasingly part of daily life and the way we understand our bodies. Generated by various self-tracking activities involving tests and wearable sensors, these data are used to simultaneously provide a window into the functioning of the body and motivation for improving that functioning. As the Quantified Self motto, "Self knowledge through numbers" suggests, self-tracking is linked to a questioning of the veracity of one's bodily sensations and the attempt to get at a less capricious source of knowledge. Numbers, generated through diverse sensors and quantification processes, offer a way of knowing the body that is viewed as promising avenues for forestalling bodily decline. In the case of diabetes, numbers from daily blood sugar testing are used both as indicators of success and as mediators of control, revealing how well one has been managing their illness and informing future action for achieving target results. The consequences of uncontrolled diabetes range from complications due to frequent high blood sugar, such as nerve damage and kidney failure, to the immediate dangers of low blood sugar, including loss of conscious and death. In the high stakes practice of self-tracking and self-management, people with diabetes continually search for patterns in their data in an attempt to do better next time, to achieve tighter control. At the same time, diabetic self-management brings into being an assemblage in which both data and bodily fluids (blood, insulin) circulate well-beyond the skin barrier.

Moving away from the near-inevitable goal orientation of diabetic management, the artistic project *Hemo-resonance #1* develops the concept and practice of "data resonance" to ask what else can be done with diabetic data and the perceptions and understandings of the body assemblage that diabetic self-tracking entails. Unconcerned with legibility, data resonance produces visualizations and other manifestations of data that aim to detach themselves as much as possible from interpretability and end-goals, following instead other possible trajectories of data and bodies. The work opens a space for becoming, not in the sense of becoming better, but in the sense of continuous liminality, unpredictability, and relationality. Such spaces are required not just as psychological salves or therapeutic meditations for the diabetic who has become distressed in their never-ending search for control, but more broadly, as spaces where we continue to ask about the boundaries and configurations of humans and non-humans.

Hemo-resonance #1 presents my blood glucose readings and insulin injection amounts from a period of 100 days as resonant data. The numbers (mmol/L blood glucose concentration, and units of insulin injected) are converted to vibrations that can be simultaneously felt by viewers interacting with vibrotactile objects and seen in a video of a kinetic visualization process. The visualization shows the effects of the vibrafied data as they were channeled to a resonant surface on which the used blood sugar test strips from the 100 day period were spread out. The lightweight strips shift position unpredictably in response to the vibrations, creating a moving image that was then mirrored horizontally and vertically to give the impression of a continuously changing pattern. The work is a response to questions of how to do diabetes differently and how to reorient the flow of data to produce new resonances.

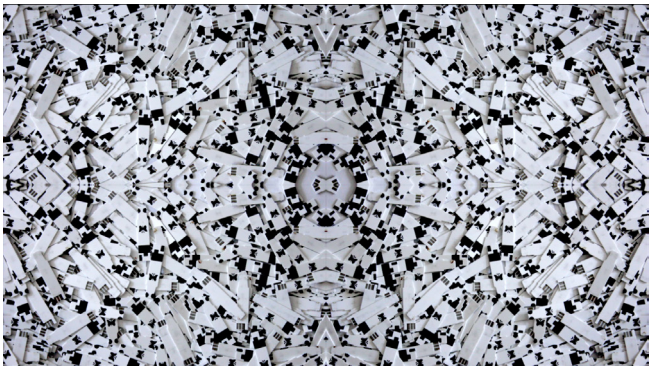

Figure 1. Screenshot of kinetic visualization of diabetic data for *Hemo-resonance #1*. Hundreds of used blood glucose test strips are moved by the resonance of the data they have helped to collect. © Samuel Thulin. Video: https://youtu.be/GeFhTYLqazE

Sensing Numbers

Since the advent of home meters and diabetic test strips, blood glucose self-tracking has become central to diabetic care. Through diabetic self-management achieved through multiple means, including the collection of diagnostic data, knowledge of the effects of various interactions with the world on the body, and informed, intentional action, the diabetic becomes aware of their body in new ways. What was once an unconscious, internal, metabolic process (processing sugar to produce energy), becomes a conscious practice that extends beyond the boundary of the skin, proliferating data, finger-pricks and injections, and shared decision-making. Performing a reconfigured and numerically-dependent body, people with diabetes, in collaboration with an array of humans (healthcare workers, family members, friends) and devices (glucose meters, syringes, pens, insulin pumps, continuous glucose monitors), take responsibility for achieving what was once the purview of one of their organs. They are invited to "Think like a pancreas" (Scheiner, 2011), acting to restore the normal functioning associated with the now-ineffective body part. [1]

The numbers involved in this self-management are highly embodied in multiple ways, bridging physical sensation and emotional responses. Despite the notion of a split between bodily sensation as subjective experience and numbers as objective fact in discussions of self-tracking, Deborah Lupton has described the ways in which numbers nonetheless intertwine with bodily feelings, as part of what she refers to as "data sense". As she puts it, "Data sense, therefore, involves entanglements of human senses and digital sensors with sense-making. This approach underlines the embodied, affective, and material nature of engaging with and learning from data (Fors et al., 2013; Sumartojo et al., 2016)". [2] In my own diabetes self-management, numbers have complex physical and emotional registers developed through years of hourly engagement with them. For instance, numbers like 3.4 or 2.7 are associated with the weakness, irritability, desperation, hunger, and inability to think that I feel when I have low blood glucose. But such numbers can also bring feelings of relief – as they offer an explanation for why I feel so bad – as well as frustration and disappointment for falling below my target range. Considering the multiple layers of numerical significance, uncoupling embodied feeling – physical and emotional – from number is next to impossible, despite the fact that the powerful and complex resonances of numbers are rarely investigated in depth.

In attempting to dwell within the complexity of these numbers, *Hemo-resonance #1* connects self-tracking and data collection with artistic approaches to diabetes that emphasize the multiplicity of personal experiences. While diabetic art remains relatively scarce, a couple of examples are Shimon Attie's *White Nights, Sugar Dreams*, a community arts project and video installation that includes the voices of eight different interviewees living with diabetes, and Robbie McCauley's solo performance work *Sugar*, which presents the artist's own experiences as a person with diabetes interwoven with stories from other diabetics. [3][4] Like these works, *Hemo-resonance #1* seeks to explore the experiential, multiple, sensual, and relational, but unlike these works it seeks to do so specifically in relation to the numbers generated through diabetic self-management, with the focus on one person's dataset.

The Diabetic Body

As tools for visualizing the interior spaces of the body and for modulating bodily awareness and sensation, numbers are supremely personal. Gavin J. D. Smith has referred to the data that comes from our body as a type of "disembodied exhaust" that we cannot help but produce in the current datafied context. But the more germane aspect of his theorization for my purposes is his discussion of the leakiness of bodies that takes place through the emitting of this data. [5] Here numbers may be thought of as a kind of liquid that trespasses the skin barrier of bodies, recalling aspects of the body that provoke a kind of unease or disgust. [6] There is an excessive intimacy in bodily data as it spills over the established boundaries of bodies. Its common figuration as numbers, graphs, charts etc, tames it, rendering it something objective, excised from the body, clean and controllable, and, most importantly, useful for the further controlling of bodies – for making decisions based on this trickling data. As Irma van der Ploeg contends, new bodies are emerging. These are bodies so intertwined with information that it may be difficult to tell where body ends and data begins, and vice versa. [7]

Diabetic data diverges from much tracked body-related data in that the processes involved in its collection also breach the body in particularly intimate ways. It is not a sensor resting on the skin, or a distant surveillance apparatus that allows for the crucial insights on the body. Rather material from the body – blood – needs to be extracted, before data can be extracted from that material. Similarly, while it is common for non-diabetic self-trackers

to record what they put in their bodies, through the traditional route of consumption – ie. what they eat – diabetics also record the liquids they inject that breach the skin (insulin). Diabetic data is oriented by the metabolic body in process. As Annemarie Mol and John Law note, the metabolic body incorporates and excorporates its surroundings, such that body boundaries are troubled. [8] Taking on the work of the pancreas means that the process the pancreas regulates weaves in and out of the skin, drawing the body into relations with other technologies and interactions through an array of context-dependent "data rituals". [9] Throughout such processes, diabetic data tracks the diabetic body's abnormal entanglement with the world, its extended fluid exchange through piercing the skin, modulating metabolic activities, and communicating via numbers. Many forms of self-tracking risk taking the fleshy body as a given to be observed, and/or assume boundaries that will not be crossed (in monitoring one's heart rate for example, the heart is an object residing within the body whose activity can be quantified). Diabetic data tracking reminds us in concrete terms of the fluidity of the body – that, as Mol and Law say, a lot of work is involved in simply holding a body together. [10]

Although I have been describing a largely anonymous diabetic body, no such generalized body exists. There are only actual diabetic bodies, and many of them. Emphasizing the importance of physically situated knowledge, Lora Arduser argues "understanding the disease is important, but only because that knowledge makes it easier to attend to the body, but not just the diabetic body writ large—the specific body. In my interview transcripts, this physically situated knowledge was often expressed with the phrase *for me."* [11] The diabetic body may be a complex assemblage, but a diabetic body is always a specific assemblage, having continuities and discontinuities with other bodies.

Data Resonance

Diabetes is at once extremely personal as a disease that must be self-managed (with diabetics describing themselves for instance, as their "own experiments" [12]), and inevitably shared with others in the healthcare community, family and friends. Thus, the very personal body is not formed in opposition to the world outside it, not in conflict with its surroundings, not a resolutely self-contained individual. Writing on a wide array of prostheses, from limb replacements to drugs, Margrit Shildrick argues that such things "not only demonstrate the inherent plasticity of the body, but, in the very process of incorporating non-self matter, point to the multiple possibilities of co-corporeality, where bodies are not just contiguous and mutually reliant but entwined with one another. Against a modernist convention of fully bounded bodies, separate and distinct from one another, such modes of corporeal transformation comprehensively undo the limits of the embodied self." [13] Shildrick's assertion is particularly forceful when also paired with Law and Mol's discussion of the body's excorporation of actions, where "some bodily activities may take place beyond the surface of the skin" [14]. Diabetes suggests the non-exclusiveness of highly personal bodies and co-corporeality.

Hemo-resonance #1 plays on this dynamic by working with one individual's personal data set – my own – and simultaneously following and generating connections to other bodies, both human and non-human. In using my personal data, the work links into the wider cultural logic of self-tracking, invested in n=1 bodily experimentation. In this context, data visualizations are becoming more and more pervasive as ways of displaying and interpreting large amounts of data. As an alternative to the dominance of visualization, I have decided to delve into data resonance. The affective connotations of "resonance", the notions of amplification and attenuation, extension in time, movement (both physical and emotional), make it apt as a way of shifting attention from the laser-focus on fidelity, precision, transparency, and legibility to a larger field of affects that arise from, and give rise to, data. Sharing something with Lupton's "data sense" in its engagement with embodied, affective and material aspects of data, data resonance also differs in that it is less concerned with interpretation, sense-making and knowledge. Data resonance focuses on movements and performances of and with data. It does not operate in opposition to data visualization, but instead re-orients it. Dominant diabetic data visualizations have provided important insights for diabetes self-management. Doug Kanter, of Databetes has created some of the most inventive and appealing visualizations of diabetic data. [15] Adhering to the Quantified Self mantra – "Self-knowledge through numbers" – such visualizations are primarily intended to provide people with new ways of understanding their bodily data in order to make better decisions in the future. A visualization that makes data less legible is generally not regarded as effective in this context. Unconcerned with legibility, data resonance produces visualizations and other manifestations of data that aim to detach themselves as much as possible from goal-orientation, following instead other possible trajectories of data and bodies.

For *Hemo-resonance #1*, visualization is achieved by first sonifying the data – assigning frequencies and durations to the blood glucose readings and insulin injection amounts – and then making those sonifications tactile.[1]

[1] For the sonification process, blood glucose measurements in mmol/L were multiplied by 20 to bring them into the audible range and played as frequencies through a sine wave oscillator, each resultant tone lasting 0.5 sec, with time intervals between tones determined by relative timing between blood glucose tests. Short-acting and long-acting insulin were assigned frequencies of 110Hz and 55Hz, respectively, and also played through sine wave oscillators. The amplitude envelopes of these sine waves were modulated according to injection times, injection amounts, and the respective insulin activity time envelopes of the two kinds of insulin injected. The sonification process was not designed to be heard, but was an intermediary step to create tactile vibrations.

Inspired by David Bobier of Vibrafusionlab, I played the data-as-sound back through tactile transducers, devices designed specifically to transfer audio signals to physical vibrations in materials other than air. [16] Such transducers cause objects to vibrate based on sound signals. In *Hemo-Resonance #1*, the sound signals generated by the sonification of diabetic data are transferred as physical vibrations to a cardboard surface on which the hundreds of test strips used to perform blood-glucose measurements are laid out. Normally discarded as biomedical waste, the test strips are now animated, given another life, by the very data they helped to produce. Their reactions to the vibrations are video-recorded and subsequently processed to produce a mirrored effect, creating the impression of a pattern; in reality the motion of the strips was chaotic. This series of transferences from data to sound to physical vibration to object movement to visual display is instructive of data resonance, as the data moves from one place and mode of existing to another creating specific, yet unpredictable effects as it does so.

The other major data resonance of the work lies in the tactile transducers that users are invited to touch to their bodies. Here visitors feel the vibrations of the data – data that charts the expansion of the body beyond the skin barrier through blood-glucose readings and insulin injections – at the same time as they see the effects on the test strips in the video. Because human bodies and test strips are composed of vastly different materials, the way the vibrations move through them varies tremendously. The result is that sometimes what visitors feel seems synchronized to what they see and sometimes it does not, producing shifting in/congruences. Data resonance happens at multiple places at once, creating linked but variable effects. The peering into the body effected through blood sugar tests and the recording of insulin injections is presented as circulatory, constantly in motion, provoking variable responses in different bodies, human and non-human.

Conclusion

Arduser has characterized diabetes as a state of permanent liminality, and she quotes a TuDiabetes forum participant who refers to it as "predictably unpredictable". [17] Diabetes is ongoing, and although control may be the prized goal, it can never be achieved once and for all. What works today may not work tomorrow. The liminality of diabetes is also more than the perpetual adjustments to self-management. The process of doing diabetes involves the constant travels of data as they come into the world and produce effects in the world, as they move between thresholds drawing bodies together. It involves fluids trespassing the skin barrier, and the diabetic extending (or excorporating) their body to touch others around them, whether they want to or not. The liminality is the weave of shifting and boundary-challenging relations that doing diabetes produces. In *Hemo-resonance #1* I have attempted to follow some of these relations through the resonance of data. In diabetes management, the diabetic's particular bodily configurations, perceptions, knowledge, and data are continually put in the service of achieving an end result – target blood sugar levels matching as closely as possible those of a *normal* body. *Hemo-resonance #1* attempts to provide a space for attending to diabetes apart from this goal-orientation, to remain more resolutely in the multiple liminalities and co-corporealities of diabetes.

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Samuel Thulin is a researcher and artist working at the intersection of mobilities research, communication and media studies, sound studies, and critical disability studies. Originally from Nortondale, New Brunswick and currently based in Montreal, he holds a PhD in Communication Studies from Concordia University. Through his publications and artworks he has explored: locative media and contested senses of place; confluences of cartography and auditory culture; self-tracking, chronic illness, and datafication; and creative and emergent research methodologies. He has exhibited his work, given workshops, and presented his research at venues in Canada, the US, Mexico, Argentina, the UK, Sweden, Denmark, the Czech Republic, Spain, and Greece.

Sentience and The Virtual Body, From Dual Subjectivity to the Eros Effect.

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Abstract

Theoretical notions about *sentient* and *emanating bodies*, *dual subjectivity* and the *Eros effect* are appended to my previous analysis of the 'future' *metaverse*. This latter term refers to technical, subjective and social-behaviour arrangements triggered by the condition of living, communicating, and interacting online when one is (almost) permanently logged into information and social networks. The sentient body is able to feel itself and the world even at mass level, preceding and exceeding perception, language and physical location (virtually); it is also capable of reality and sense-creation. A few questions addressed in this text are: Within the *metaverse* are our extended virtual bodies, sentient bodies? Do they act, react, and behave as emanating bodies? And if so, in which fashion: synthetic, virtual, hybrid? Are our virtual bodies able to create 'magnetic allure' (*the vibe*) to spawn mass mobilisation, as invoked in heuristics of the *Eros effect*? Answering these questions is important to broaden analyses of social networks and virtual worlds aesthetics merging through online interaction. The notions of *bodily emanation* (the *vibe*), *autoempathy*, and *dual subjectivity* are examined as constitutive parts of the rich transference between *sentience* and *subjectivity production* in the *metaverse*.

Keywords

Sentient bodies, metaverse, autoempathy, dual-subjectivity, vibe, bodily emanation, Eros effect.

Introduction. Sentience and the virtual body

In several works by philosopher of communication Jason Del Gandio [1] a notion of the *Eros effect* is built, in part, from the work of Georges Katsiaficas. A New Left activist and scholar of nineteen sixties social movements, this latter author builds his notion of the *Eros effec*t from Herbert Marcuse's critique of culture, and Eugene Gendlin's "Philosophy of Sentience." [2] Gendlin is an epistemologist devoted for some time to the construction of a theory of knowledge based on embodied consciousness.

In this paper, I elaborate on these perspectives because they allow me to sketch a combined phenomenological/digital-aesthetics perspective on the subject of sentience and bodies in the *metaverse*. The *Eros effect* is a tool for analysis suitable for explaining the political awakening of masses of people connected by (and to) the upsurge of spontaneous rebellions. According to Katsiaficas, this occurs through an *eroticisation* of politics and everyday life: "that which motivates people to create an alternative world of solidarity, self-determination and re-foundation of social relations […] is the human psyche, *innately* programmed for freedom, justice and liberation." [3] Del Gandio provides three theoretical extensions to Katsiaficas philosophy, to deepen the understanding of the *Eros effect*.

The first one grounds the Eros effect in the sentient body. The second deals with the idea that the sentient body is a *reality-creating* organism (and a *sense-creating* one, I would add). Finally, the third introduces the phenomenon of *bodily emanation*—often referred to as *the vibe*. I will circle back to these extensions further on in this text, but for the moment it suffices to consider that I am allocating these ontologies within the context of digital, virtual and hybrid bodies interacting online.

Thus, the concepts of *sentient* and *emanating bodies,* in this text are merged in the very term of *the vibe*. The reason is simple, as attested to in my doctoral dissertation (2012) and subsequent research: in aesthetic exchanges within virtual worlds, *vibrational* digital-informational pulses have the power to transform into *embodiment* and identity/personalisation of avatars. What's more, they have a narrative capacity for *sense-making* between people of different cultures, backgrounds, and identities located in different corners of the world. And to such extent that they are able of creating *charismatic*, *empathetic* and *emotional mobilisation responses* at local and mass scales, be it in Virtual Worlds, Social Network interaction or a combination of both. [4]

So, above all, *the vibe* means a vibration, a set of sensations or some variation thereof. Consequently, the main (voluminous) body of academic research typically centers on scientific paradigms; for instance, and most notably, that of *bioenergy* (the electromagnetic energy generated by the atoms and cells of our physical body).

In this text, however, I will focus only on phenomenological paradigms, for example: the *constitution of personal experiences* in the *metaverse* as fundamental for the emergence of *the vibe*. Since the time of my doctoral thesis, I have studied how *one self* experiences virtual environments *as an inter-subjective, sentient, existential phenomenon*.

Affectivity, the Vibe, and Virtual World Aesthetics

According to del Gandio, Eugene Gendlin's original approach to the *sentient body* embraces the issue of *affectivity*, this latter drawn from ideas of Edmund Husserl and other phenomenologists. "In fact, Gendlin assumes that humans *think together with their own affectivity of the body*, this idea stems from extending the notion of the "primacy of perception" from M. Merleau-Ponty." [5]

In other words: the body is thought of as an *experimental organism* that responds to itself and its environment in a *sentient* (sensitive) way. By the same token Marcuse's term "new sensory" is relevant, and allows Katsiaficas to delineate the bodily experience as "emanating", following a new model of experience constituted by alternative environments, which would be able to propel revolutionary action.

My approach will not elaborate on philosophical or socio-cultural components of social revolt, rebellion or mass mobilisation; rather, on aspects that connect ontologies of the body to those of subjectivity and embodiment in the *metaverse*. The main notion elaborated by these authors is that contemporary human beings experience the world through the *metaverse* as a continuous, mutable and hybrid (actual/virtual) *new sensorium*—through their *fluid-identitie*s and the diverse simultaneous states of their multiple *bodies* and *personae* in the virtual world through digital representation of themselves in *metaversal* reality.

That condition is rather complex. In previous works I have discussed several aspects of it (like the notion of the *individually social self* [6]) so I will not fully address it here for the sake of brevity. According to researcher and philosopher Thomas Metzinger, the *self* does not truly exist; rather, it is consciousness that extends and crafts the idea of it to shape a grounded model of the *self*. Put differently: the *self* is not a thing but a *process*. [7]

In this text, I assume the *metaverse* to be the *new sensorium* forcing our body to constitute a sense of *one self as another one* whether performing in the actual, the virtual or the augmented reality. This extension or *doubling* permits the *self* to act in and out of conventional patterns. That property—in turn—allows bodies to socialise freely and (sometimes) move beyond the current control-regime of biopower boundaries (*Thanatos*) throughout social, aesthetic, or affective interaction with other *selves*. Hence, to manifest a world of sensual connection, virtual reality—enabled by technology and telepresence—propels *our selves* to act rationally but also on erotic impulses that are natural to human mind and body.

My research on *Second Life Based Artwork* has permitted me to witness and understand this process, albeit on a relatively smaller scale. This has allowed me to categorise *dual subjectivity*, *autoempathy* and aesthetic exchange as *manifested virtual components* of the *sentient body* (*emanating bodies*) and *the vibe*.

The work of talented avatar-artists Gazira Babeli, Eva & Franco Mattes, China Tracy (Cao Fei) and Bryn Oh, who all use the platform of Second Life as *raw matter* for their virtual artwork (between 2006 - 2013)—corroborates this. [8]

It is worth examining the expression *Second Life as raw matter.* This is a common characteristic of the four artists examined in my doctoral thesis. On the one hand, as explained in the theoretical framework (Chapter 1) that condition was (*is*) the core feature, stemming from the process of projecting your self as another self within an aesthetic exchange in metaversal conditions. In a virtual environment like SL, one is actually present in both worlds through a network of minds and bodies located in different corners of the planet, and yet connected and interacting in a particular *common locus* via illusion, *mythopoeia* and "magic" (that is, code that has the power to animate the artificial and the immaterial) through various multimedia channels.

Following my theoretical framework, bridging AWs and VWs means above all else, a symbolic-to-subjective-to-collective exchange. All four of the artists examined at that time—although from varying angles and aesthetic goals—create art involved with liminality, telepresence and identity play. On the other hand, they effectuate these operations with a remarkable critical sense of both virtual life and SL. In other words, the artists selected for my case studies challenge the ethical and ontological bases of Linden Lab's SL and artistically create remarkable artwork inside, outside, across and with the platform.

For this very reason, I claim these artists are producing a shift in the ethos and plasticity of virtual art in SL, and therefore also in the audiences and masses of people interacting with their performances and artwork. These artists were not the only ones using SL as Raw Matter but they were, at the time of my research (2007 - 2012), key representatives of the aesthetic shift previously described. Their innovative artwork in SL and their prestige and influence in virtual and actual world art-scenes confirmed this idea.

So this art-notion—in metaversal conditions—is merged in both aesthetic and political fashion in the processes discussed here for the Vibe and Eros Effect. This approach contributes further to developing Munster's concept of rematerialisation of the body in the digital and the metaverse. In my view this constitutes an example of subjective-to-collective action mobilised by the Vibe within aesthetic exchange; what is more: in the case of Gazira Babeli and Eva & Franco Mattes politics and aesthetics blend and become projected from the direct outcome of their famous performances in SL (at the time). [9]

One does not need to escape from the real just because tangible materiality becomes patterned differently through code. Rather, this is an enticing opportunity to experience the extension and re-materialisation of the body in the digital on a symbolic level through the virtual (but real-real as illusion). In this respect, the artwork of Gazira Babeli, produced dudring her time in Second Front (2006-07), is exemplar. Babeli was not only aware of the radical under ground and cutting-edge art scene taking place in SL in the 'golden years' between 2006 and 2010 [10], but also of the

cruder, more disturbing economic realities of SL. The platform consists of a handful of millionaires profiting from SL—a small group of Mafiosi owners of virtual real state, brothels, casinos, money laundering, and escort businesses, etc. Second Front artists such as Gazira Babeli, Eva and Franco Mattes and other talented artists used SL-based artwork to target these millionaires with critical, radical and acid humour. This was executed and disseminated by the vibe and the response of massive and collective sensing bodies to it, mobilised by metaversal and virtual world aesthetics.

Fig. 1. Gazira Babeli's Acting as Aliens Performance at Kapelica Gallery, Ljubljana, November 3, 2009 © Gazira Babeli

Our body feels itself and the world and that sensitivity operates before and after we take possession of any perception of the world. In the *metaverse*, I think both our avatars and virtual bodies experience the same things: we are not aware of the *world of processing and computing* and all the technical processes involved in the creation of the virtual environment; rather, we are primarily aware of the potential of a *plot* from which *we,* through our avatar or virtual identity-body, retrieve a sense of *selfhood*. Obviously perception is primordial to grasping a sense of *selfhood* transferred into a graphical (3D) configuration that means, conjointly, that *our* actual and *our* represented self belong and respond to the same mind.

From that point, we experiment the spatial/temporal deepness of immersion as a doubled or mixed dynamic through the *suspension of disbelief*. Its purpose is making us forget about the *prosthetic* condition of the reality and the characters we have embodied. Therefore, there exists a significant parallelism there with the idea "that sentience rather than perception is the primordial basis of our bodily-being-in-the-world." [11]

This angle of analysis is significant: our body not only responds in a *sentient* way but also requests *sentience* from other bodies (and vice versa). This means that extending the notion of *sentience* to include those of virtual and *metaversal* aesthetic embodiment is a plausible proposition.

Thus, to answer the question of whether virtual bodies are *sentient bodies*, the answer is yes: avatars and other self-representational forms in online interaction imply a complex and enhanced organism. This responds to a cycle of *bodily emanation* occurring in the *metaverse* at two levels of experience: the spatial/temporal, and the preconscious-then-conscious. In the first case, the area in which our bodies summon emanations from each other in a continuous and multilaterally distributed way is what it counts as pre-perceived reality.

In the second, considering that this precedes conscious control and recognition, it implies the emergence of seminal conscious emanation. For instance, we can, and often do, send and project particular vibrations with particular purposes: we emanate empathy at memorials, joy at weddings, enthusiasm and camaraderie during concerts and sporting events, great joy on the first date, and so on—whether in actual life or virtual worlds or the *metaverse*. This is the field of experience that most people would think and refer to as *the vibe*. [12]

The affectivity emerging between body and environment does not simply mean that consciousness is constituted in a general sense, but also that the genesis of the *experienced-experience* emerges spontaneously when we feel a connection with other selves.

According to Husserl (in Del Gandio's opinion), "when there is no affection coming from the various objects, then these various objects have slipped into the shadows, in a special sense, they have slipped into the unconscious." [13] In other words, the emotional (magnetic) allure between my body and its surroundings allows the very possibility of awareness of that experience, and the experience of becoming conscious emerges.

So in answer to the second question of how the *sentient* virtual body behaves, it does it in hybrid multiplied cycles, from actual to virtual life and the other way around. These constitute the general experience of the *metaverse* in which my body and the environment are *jointly awake* through the affective appeal that each exerts on the other. We grasp the phenomenological deepness of the idea: my body and the world are not as separate and autonomous as they seem; instead, despite my body and the world being two different co-narratives, they are interconnected in a sort of *embryonic totality*.

Phenomenologists like Gendlin, Merleau-Ponty and others, argue that an additional layer of experience is required, which is paramount: the possibility of formulating from both *language* and the *individual ego*, a correlation with which one could think along (consciously) with the primary environmental interaction.

If our bodies are that environmental interaction, then we can allow our bodies to think about the interaction. Gendlin describes this "thought with the environment" as a *sentient-body sense*; our bodies perceive in a sentient way the surrounding environment. Gendlin calls this mode of *thinking with the sentient body*, the "focus" (focusing, focusing-oriented), and its purpose is to tune our body sensation with the situations that surround us. [14]

Virtual and non-virtual sentient bodies

I would ask the reader to consider the following scenarios as samples of contemporary subjectivity-contexts, centered on body issues and determined by interaction in the *metaverse*.

First, crowds of young people and students in Hong Kong have been conducting mass protests for months now. They demonstrate against various political measures intended from the Chinese Continental Government. Lately, they have been using a Mexican application (*Bridgefy*) whose use has become rapidly widespread among the dissatisfied. It offers mass communication options when there is no stable Internet connection, or there is signal interruption due to technical difficulties or Government strategy. [15]

The app allows any user to create communication networks without the need for data or Wi-Fi: via Bluetooth. Networks can be created by connecting devices that are 100 meters or less away. But you may also create a network that replicates itself (so to speak) and grows with each device using the app connected at the perimeter, without the risk of being monitored like regular Internet connections. It is a dynamic mass that joins everyone—it resembles the efficiency and growth of an *infectious* virtual *vibe* stemming from a network of communication (that goes under the radar). It is vital in certain circumstances because it can dissolve itself urgently when necessary to move and disperse. The process is, to use a very simple metaphor, *metabolic* and its virtual aesthetic is embedded in communications, interactivity, body-presence/absence and collective consciousness.

Second, in other areas of the planet, young people excel using the same app to share aesthetic techno events in large congregations such as concerts, sports events, or in mass demonstrations fighting for or saving the planet. At moments, it's as if you have become part of a larger collective body, coordinated, rhythmic and dynamic—one that, surprisingly, addresses you on an affective, personal level due to the power of Social Networks and other apps like *Bridgefy* to produce and disseminate subjectivity.

Third, let's consider a young woman I will call *Olivia* (fictitious name). She could be one of my students (or not). Using her smartphone, *O* is uploading once again within the same day 10, 12, 50 images of herself to Instagram and other Social Networks. *Olivia* leads and is also a member of a Latin American network of adolescents suffering from diverse degrees of BDD (Body Dysmorphic Disorder). In fact the network has expanded to other regions of the world as well. It shares information, dark criticism, mockery and, at times, comfort, advice and help to a significant number of adolescents.

Olivia's body image becomes a replicated *sentient body*, subjectively expanded in a symbolical sense, and disseminated through networks. It not only shares content with her group and friends, but also recombines and assembles despairing dark-humour, sarcasm, harassment, demerit or even celebratory erotic rituals of the worries and ups and downs that such eating disorder produces in the behaviour and mental health of her followers.

Fig. 2 *Olivia* (fictitious name): "What would you guys have for dinner if you were as fat as I am?" © Gerardo Toledo screen-capture Oct. 2019.

I mention BDD as an example of behavioural and emotional health problems fully centred on body-image-identity issues. These, in Social Networks, often acquire the dimension of a *collective enjoyment*: the individual focus on isolation and loss (in the healing process) is being shaped into a strange, decadent spectacle performed as a *quasi-erotic* event. This activates emotionally and metabolically the sensation of belonging to an alternate, cohesive, collective *ill body* that triggers feelings of intimacy and narrative-reality-creation among the *initiated* (or *infected*).

Fourth, a gifted professor of English literature maintains a stock of half a dozen avatars in Second Life (SL), with which he enters different locations and groups to live his fantasies, especially the darkest. He happens upon a collective virtual-art performance in which a talented artist (or rather his/her avatar) dismantles and de-configures appearances and personalities of avatars (body-image-identity) that get close to a certain *point-of-infection*. The virtual work of art consists of releasing scripts that take control of an avatar's design and personal configuration/appearance when they get close enough to touch a small *non-visible object*. The *spell* proceeds to disassemble and transform the professor's good-looking avatar into another thing: a kind of insect-robot, whose movements, appearance and *attitude* are bizarre and grotesque.

This breaks the emotional bond that his owner-resident had created as an extension of himself when he carefully invested so much time and subjectivity into creating the avatar in the first place.

And finally the fifth: on Twitter and YouTube, a shy male STEM student feels increasingly close and emotion-

ally attached to a beautiful (young) *influencer* he follows on various social networks, as if he were her lover, friend or family. Everything she posts, her comments, images, social-network updates, her reflections and moments of introspection are carefully and lovingly collected, analyzed and dissected.

The emotions vibrating through his body are an accumulated effect built through projecting himself into another self by his own imagination and subjectivity. A *hyper-closeness* with a remote *persona* whose identity, appearance and intimacy (on the emotional, erotic and psychological side) he only knows through technological mediation. But that doesn't matter: hyper-closeness creates a powerful bond that fully explains why he feels so attached, how much he loves her, how deeply the *character* he loves belongs to her. The appealing and allure emanating from her body/image increase the feeling of knowing her intimately in a very real and penetrating mode.

In each of the five scenarios cited above, we observe the body as an organism reacting to its environment, communicating with others and transforming (almost metabolically) the environment itself. In order to gain awareness and a sense of *self*, it is priority to know what surrounds it in pursuit to transform that reality. So, in answer to the question of whether *metaversal* bodies have the capacity to engender a convoking force (*the vibe*), the answer is yes, but in a distributed fashion. The sentient body is an organism with the ability to create meaning and reality. So, speaking of the *body* also means speaking of identity and its many representations, subjectivity and narrative making (*mythopoeia*).

In the next section, before some concluding remarks, I will center on the concepts of *dual subjectivity*, *auto-empathy* and *aesthetics of virtual worlds*, appending the notions of *sentience* and *the vibe* to them, as analytical devices.

Dual subjectivity, autoempathy and sense-making

Dual subjectivity (DS) is defined as the merging of computer or *machinic-subjectivity* with human augmented-subjectivity. For instance, in the context of aesthetic exchange in SL, DS manifests as an augmented, metamorphic and reversible mode of experimenting *your-self*, through the oscillating affectivity created by tension from the *intra-to-the-inter-subjective* state of an individual interacting in the *metavesre* and, from there, to socialisation. According to Italian new media, semiotics and film-specialist Adriano D'Aloia, this implies a complex form of self-acknowledgement between worlds. From his framing, I have developed a slightly different view: DS emerges whenever we access the *metaverse* that is when we envision the whole of it as a collective membrane in *cyber-space* even before the creation of social bonds. D'Aloia explains why this happens and refers to its seminal process as *autoempathy*:

> We see a condensation, or saturation, of the Self, to the detriment of the presence of the Other. Especially, online virtual worlds are environments where the player fundamentally experiences, almost auto-erotically, his/her own ego. The interactional axis hovers on the Selfness side and the intra-subjective logic is stronger than the inter-subjective one. [...V]isual and sensorial perception oscillates between two declensions of the same Self. And if the actual Self is more concerned with empathising with the virtual Self than with the Other, then empathy is required only as a *reflexive ability*. In such auto-reflexive environments, in which users need to engage a motional and emotional relation first and foremost with themselves, a form of *autoempathy* emerges. [16] (My emphasis)

In "Figuras de la presencia" scholar and researcher José Alberto Sánchez Martínez outlines a parallel argument: "The body is deprived of its material configuration via a new body, the virtual body that is built from our cultural-identity coding." [17] So, to insert the body on its virtual aesthesia, it needs *that coding* to be filtered through the environment's conditions. I argue that we do the same, through other filters, like affectivity, narrative making, and *sentient-imagination*.

Eventually, we may be able to deploy the problem in a new context: for *sentience* in the virtual to become rooted aesthetically in a virtual embodiment, it has to include the inevitable emergence of body's flickering absence/presence states. In other words, a potent 'device' is enabled, one capable of switching-merging identity, appearance and narrative to produce subjectivity. The operability of this *combo* is also ascribed to the mixed, augmented-self (actual/virtual), regardless of the instance in which the body is currently being summoned, manifested or *mobilised* by other bodies: in the actual, the virtual or the augmented reality.

As a consequence, I believe that an enhanced form of embodiment stems from body-representation and body-symbolisation, characterised as an extended hybrid feeling of *presence-absence* in social interaction—first and foremost, toward ourselves, and then to others. There are obvious correlations between the notion of *autoempathy* and those of *the vibe* and the *Eros effect*.

Hence, the discussion about the role of the actual and the virtual body within the *sentient* process is essential in my view, so it is reasonable to assume the body to be an extended relational meaning-organism in three dimensions: time, space and the *liminal* instant/territory among them. In my analyses of virtual-art and virtual world aesthetics, I have applied a similar perspective borrowed from Anna Munster's "Materializing New Media". In her book, Munster develops an interesting interpretation of Deleuze's notion of *the fold*: she thinks of it as a highly relevant model to express the idea that virtuality and digitisation, actually append the (re)materialisation of the digital body

through technical *aesthesia* that is a simultaneous blend of form as process and agency. [18]

To me, this perspective reinforces the idea that instead of dematerialisation and disappearance in the *metaverse*, the body becomes (re)materialised through signs, symbols, behaviour and sense-creation processes; disseminated and reconfigured by the incessant-recurrence of networks themselves. Therefore, experiencing the *self* as another *one-self* across actual and virtual worlds enacts a potent affective sentiment. This is capable of enlarging, enhancing and encoding symbolically the whole exchange of *bodily emanation* from the personal to the social level due to performing, sharing and exchanging information aesthetics.

In my view, such dynamic surfaces from the inter-subjective individual level to the collective, even the massive one. This is what Munster refers to as a (heuristic) *space of reciprocity,* which is (presumably) absent of conventional media but not from aesthetic virtual and social networked interaction. Hence, I use the notion of *space of reciprocity* as a suitable analogy to describe the process o *emanating bodies, the vibe* and the *Eros effect* operating in the *metaverse*.

Fig. 3. Lacan Galicia (my SL avatar) Tai Chi with friend Albert Dionysus at SL,Tempura Island Region, screen capture Oct. 2019.

Concluding remarks

In closing, I return to Gendlin. He argues that the body is a *pre-separated multiplicity*, so the body is a multiplicity that is not yet separated. The body is composed of a multiplicity of possible actions, thoughts, emotions, desires and abilities. This point, it seems, connects significantly with the theoretical framing described above: the *vibe* (*emanating bodies*) and the notions of DS and *autoempathy* appended to the properties of actual/virtual performance, These transfer to people when forms of subjectivity production interact to ceaselessly socialise across technologies of immersion in the *metaversal* environment.

Depending on the situational conditions, some of these possibilities of action are updated while others are not. Nevertheless, all possibilities remain present. Gendlin uses the symbol '.....' to express this idea. The five ellipses extending out represent the body as a *continuous process*, permanently adapting and adjusting to the best of its capacity. That symbol also expresses a temporary and contentious basis pointing to the *stasis* of the process.

A connection to earth and *stasis* allows us to experience the world as a place we can call *ours,* which means a stable and coherent phenomenological *locus*. Therefore, our idea that in the *metaverse* there is nothing but *identity-in-flow*, takes ground, allowing us to understand the body as an open space constantly interacting and responding to the surrounding reality, created by others and ourselves. The *body* and its environment evokes each other in existence; an *extended hybrid-body* that expresses itself in actual and virtual realities as a *sentient one*, perceiving and radiating meaning, narrative and *reality-creating* power.

This is so because the *sentient body* as a *pre-separated multiplicity* is permanently reconfiguring itself—a perpetual, non-linear, off-centered process. [19] As soon as the body perceives the '.....' the points become reorganised, changing the configuration of the situation, which again changes that *bodily sentience of ours*, and so on. Thus, as the same process is also happening with every other person in the register and mobilisation of *reality*, as a given interaction (either online or in a purely virtual environment), what emerges is a continuous, *hyper-processing* of acknowledged ontologies of the *self* expressing itself as another (*self*)—to the point that it cannot be predicted, understood, or controlled in its entirety.

I argue that this *sentient process* is the basis of the *Eros effect* manifesting in the *metaverse* through the reversible extension of current bodies in the virtual or augmented realities, with the actual, and back again. We embody *sentient bodies* in the *metaverse* because we depend on the interaction with other (bodies) to create both sense and reality. We also enjoy very much carrying out that quasi-metabolic incarnation and participation with others, precisely because we extend *the sentience* to our hybrid-body and to the whole, as a collective *networked-body*. Therein lies the power of the production of subjectivities in the *metaverse*.

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Gestural Metaphor and Emergent Human/Machine Agency in Two Contrasting Interactive Dance/Music Pieces

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Abstract

This paper presents composition and system design across two contrasting dance/media pieces, created contemporaneously, having very different affordances and constraints. In each case, the structure of the music and its sonic details were driven by the movements of the dancers through the use of electromyogram and motion sensing, machine learning and adaptive transitions between sections. The first piece was a collaboration with the National Ballet School of Canada in which twenty-one dancers from different countries arrived in time for a single rehearsal before public performances. The second piece was developed over the course of multiple sessions with a team of media artists and dancers, using existing cultural metaphors related to the elements in order to create a shared focus on gestural language, providing a shared perspective on non-human agency that resided "above" the level of movement, sound or light. The first piece was much more top-down due to real-world constraints as well as affordances of the genre, while the second was designed as a bottom-up approach from its beginnings. In each case there were important elements of fixed structuring as well as emergent gestures across sound/movement/light that resulted from the interactions of the dancer collective and the emergent agencies of the interactive systems employed.

Keywords

Interactive Dance/Music, Emergence, Gestural Metaphors, Human/Machine Agency

Introduction

This article is approached from the perspective of a composer/performer working with interactive performance systems. It is built upon a history of work [1] in system design that privileges an embodied cognitive view of musical understanding, following Leman [2], that we fundamentally make meaning of a musical work through internalized ontologies of physical and instrumental action. Research emerging from this line of inquiry, well represented by Godoy and Leman [3] for example, has increasingly examined the bi-directional flow of: embodied understanding of musical work on the one hand, and the musicalization of movement on the other. In research surrounding gesture, the role of metaphor has been widely discussed both from the perspective of creation of meaning (following Lakoff [4] among others), as well as in the course of creating interactions at the meeting point of movement/sound (e.g. [5-6]). Informed by this, some of my own recent past work has focused on developing a machine agent [7] that takes an embodied listening approach to constructing an understanding of sonic gestures, towards representing markers of style and pattern in order to drive its re-performance of learned material. Transitioning into the realm of movement, this system was applied to a large-scale interactive dance piece [8] in which it became an active agent in re-performing content originally emanating from the dancers.

Building upon this trajectory, this paper introduces two recent interactive dance/media collaborations in order to discuss the shifting role of gestural metaphor in locating machine agency within the work, and how this becomes an emergent property of piece development spanning differing levels, from the creation of mapping strategies upwards to level of larger dramaturgical structures. The two pieces are first described, following by a discussion that applies these concepts to the works.

Elemental Agency

Conceived and directed by the author, *Elemental Agency* is a piece concerned with an emergent gestural language that manifests across movement, sound and light. Rather than sound/light articulating movement, or movement driving media, the approach builds outward from gestural metaphors as a point of shared intersection for these phenomena. The work draws upon the metaphorical constructs of Japanese Godai [9] and Indian Vaastu Shastra [10] philosophies of five elements: earth, water, wind, fire and void/space.

Developed in a university context, the director invited 12 graduate and advanced undergraduate students to collaborate on this project in a number of specified roles: six dancers from the York University contemporary dance ensemble, three students focused on ceiling-mounted Kinect movement tracking and floor spotlight projection, and three students focused on sound/interaction design.

Figure 1: Moment from *Earth* state of Elemental Agency

Working with conceptual metaphors drawn from these traditions, constraints were provided to the dancers in the form of a request to embody a given element as a collective – a texture of movement, rather than a singular human entity, that manifested a sense of non-human agency of a given element. The workshopping process also drew upon the author's experience of Deep Listening [11], which emphasizes a full-bodied approach to listening that focuses on awareness of attention and sensation of inner and outer worlds, incorporating self, other and environment. Integrating this framework and drawing upon writings from the cultural traditions of the elements, motivations related to five categories were articulated to the dancers and designers: *world, body, motion, emotion and enaction.* For example, developed metaphors included earth as stubbornness and resistance to change, wind as expansive, elusive and compassionate, fire as energetic and forceful, etc. Using machine learning methods and the Wekinator software [12], the sonic interaction designers sought to capture moments of gestural expression and fuse this with sounds that similarly embodied a given elemental quality/profile. Negotiation between art forms led to a collective choreography and sound design that emerged from the embodiment of the nonhuman elements and the mediation of the machine agents. Visual projections functioned as both lighting and enhancement of embodied experience in space, rather than screen-oriented media experience. Spotlights both enhanced elemental qualities as well as embodied behaviours that aligned with the constraints of the element metaphors: rigid tracking of movement within earth state, amorphous following within water state, tendency towards consumption in fire state, etc. An example moment of lighting and movement from earth state is depicted in figure 1.

Presenting gestural metaphors of the elements, abstracted out to the five categories, allowed for a shared point of reference for movement, sound and visual creators. Guided by directorial feedback, the workshopping process allowed dancers to develop a movement vocabulary that reflected their collective understanding of a given element. Mapping between movement and sound was a multi-layered process that equally valued the transference from movement to sound as well as vice versa. Dancers presented movement ideas related to a given element, and both they and other participants vocalized their sonic understanding of this movement. At the same time, sonic meditations practices drawn from the Deep Listening literature allowed participants to reflect on their embodied reactions while listening to a sonic design idea proposed for a given element. Through this negotiation, an understanding was reached between the dancer collective and the sound designer for a given elemental section regarding potential relationships of movement and sonic gesture. At this point, machine learning (continuous neural networks) were employed to learn specific mappings between a given dancer, each wearing a MYO sensor armband, and an interactive sound instrument. The process was an improvisational coalescence of the workshopping process: dancer and sound designer would simultaneously perform a given movement/sound phrase, with the software learning a relationship between the two.

The arc of the larger movement/sound development process thus began from elemental metaphors, condensed by the director into categories related to inner/outer and self/world. These applied equally to dancers and sound designers, and eventually coalesced into an emergent choreography for the dancers and an interactive sonic instrumental system for the sound designers, with continuous mappings emerging from improvisational co-articulations of the respective understandings of the elemental metaphors at play.

Reacting to the emergence of the sections of wind, earth, fire and water, the director then created a larger structure that focused on a narrative that only emerged from these sessions, as described in the program notes:

"water swells and then recedes into earth, which tectonically shifts before dispersing to the wind, dying down to invoke fire. Gestures and movement are recognized and mapped to sound and light output. The collective texture of these elements then shifts to the individual gesturality of each dancer, who singularly choose to embody a given element: moving from the collective texture of mono-element to the collision and transformation between elements, passing between dancers. The pervasive aether of machine listening recognizes gestures captured throughout the four-elements sections and re-inject loops of these into the performance: this aether ever-listening to elements, and re-performing its understanding of each dancers elemental offerings. Increased density and destabilization of dancers' elemental transformations lead to an ascendance into the void: pure energy, beyond the everyday, a distribution/suspension/expansion of presence and expression. Void is devoid of any object-hood or gestural points of reference."

There is thus an added layer in which the pervasive machine agency of the work presents itself more explicitly

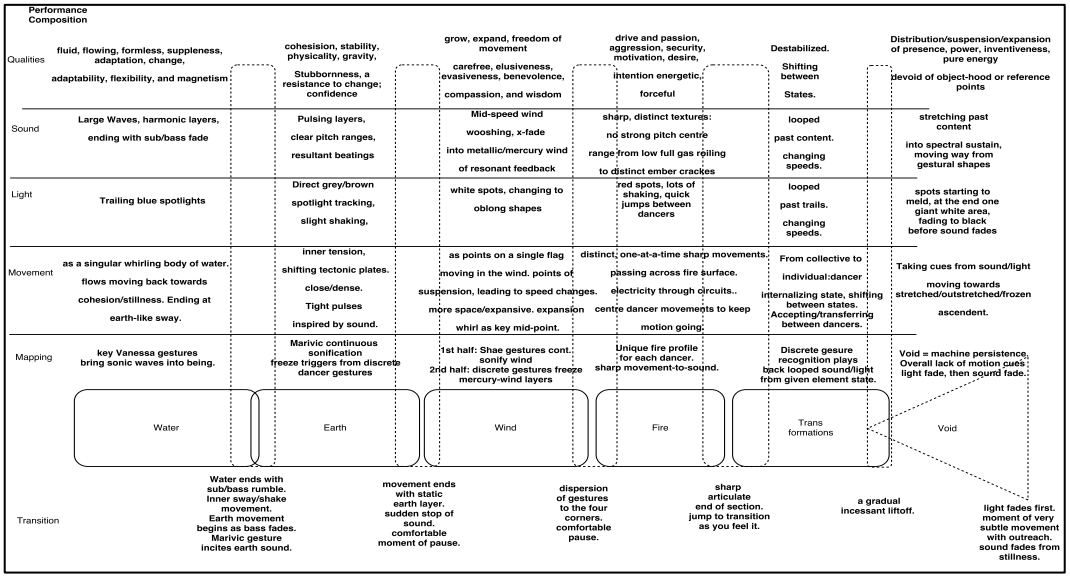

Figure 2: Composed Structure for Elemental Agency

at the end, in a fashion that emerges from the explicit gestural activities of the dancers. The compositional structure, as communicated to the participants, is shown in Figure 2. Between showings, the piece rested in void state for an installation period. If audience members interacted (browser via laptop or mobile device) with the elemental portal, they could bring the piece back into the world of a given elemental state. The performance space then invited interaction from audience. This structure is shown in figure 3.

Origin8

Origin8 was a second interactive dance/media piece which occurred contemporaneously with Elemental Agency and utilized the same MYO sensing technology as well as studio development space. The author was invited by the National Ballet School (NBS) of Canada in order to create interactive music composition for such a piece, in collaboration with choreographer Shaun Amyot and interactive visual media artist Don Sinclair, for the quadrennial festival Assemblée Internationale which brings together top Ballet schools and their select students internationally. Aside from sharing the same sensing technology and development space, this work was quite distinct from Elemental Agency. As noted in [13], Ballet is built upon a very reduced and precise set of gestures that are standardized internationally. In this way, the development of movement to sound relationships required the composer/designer to develop mappings, sound qualities and musical structure that catered to a specific set of gestures and phrases. Further considering that this was a pre-defined context that the author was invited into, having a considerably classical approach to dance and music genres, the project presented many more top-down constraints in comparison to the bottom-up and emergent nature of Elemental Agency. An added real-world constraint was presented by the fact that the 21 dancers would arrive (from 21 different countries) in time for a single rehearsal, meaning that the piece had to be developed and workshopped with dance students from the NBS.

This piece also applied machine learning (continuous neural networks) to the task of learning mappings between MYO sensing and sonic output. In order to amplify the salience of particular phrases within the piece, the group decided to specialize MYO placement for a given dancer to upper/lower positions on either arm or leg, as can be seen in figure 4. In this project, mappings would iterate over the same phrase multiple times. There was also a distributed aspect of the development in that dancer phrases were videoed in parallel with time-aligned sensor data being captured. This allowed the composer/designer to repeatedly watch video of dancer movements and to develop a vocabulary of sonic gestural shapes. The out-of-real-time sensing data was then used to improvisationally train mappings using the Wekinator-based machine learning techniques through iterative in-studio “performance” in parallel with the video/data representations. The project thus followed a similar improvisational approach to development of machine mediated mappings as in Elemental Agency, but in a much more unidirectional and solitary fashion. At the same time, there existed salient and emergent qualities that occurred within Origin8, moments of designed interaction with a perceived machine agency, just as there were in Elemental Agency. The major difference between the two projects was in how the role of gestural metaphor factored into the larger musical and dramaturgical structuring.

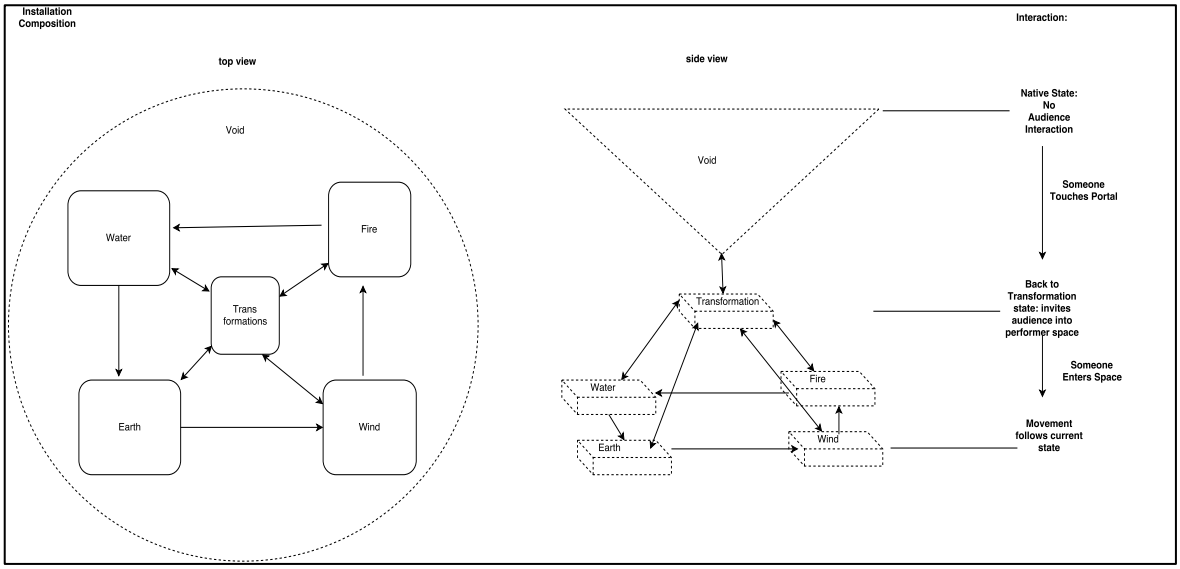

Figure 3: Composed Installation Structure for Elemental Agency

Intersections: Metaphor and Machine Agency

In comparing these projects, it is worth bringing attention to the shifting relationship between human and machine agencies that emerged as a result of the collaborative structure of the project. This includes distinct relationships to time and to metaphor. While the workshopping methods for Elemental Agency came from this author's experience of Deep Listening, it is clear that the focus on self vs. collective attention, interconnectedness, subtle guidance and the articulation of this during the system design process shared many principles with somaesthetic design approaches as discussed by [14] and [15]. The process of arriving at movement/sound relationships was poietic and mediated by metaphor, where movement/sound gestures converged at the moment of training machine learning methods. This led to a set of mappings that functioned as a field of *instrumentalized potentials* that emerged from the movements of a particular dancer and sounds of a particular designer in the context of a specific elemental state, yet which could be engaged by any dancer. This was conducive to the kind of continuous, non-anthropocenic approach, e.g. as championed by Sha [16], required in order for the dancers as a collective to embody elemental qualities. At the same time, this process did not serve the dramaturgical needs for transition, for example between elemental states/sections.

By contrast, the process of Origin8 can be seen as strictly delimited in time by the nature of the form and of the context. The choreography involved permutations on a well-defined and specific set of Ballet movement gestures, so that the process of interactive sound design focused on capturing the sonic response to canonical trajectories as exemplified by video and data recordings of ideal executions for a given section. This led to a set of *instrumentalized articulations* that emerged from a need to adhere to the lexicon of the movement sequences, and thus were predicated almost purely on transition, rather than continuous exploration.

This differing focus on continuous exploration vs. temporal transition led to shifting role of machine agency across the two works, whose active presence was borne out of the desire to allow the larger musical structure to be purely driven by the dancers in both cases. In the case of Elemental Agency, the move from continuous instruments to the coalesced compositional structure expressed in Figure 2 was built upon an added layer of discrete machine recognition. This recognition, utilizing a dynamic time warping [17] approach, was trained on key gestural invariants. Said gestures were identified as “key” precisely because they repeatedly emerged from the workshopped approach to discovering co-articulated movement-sound gestures, and thus maintained embodied meaning for the group. By defining and employing this recognition system, the machine agent thus listened continuously for a set of gestures that were trained across all elements. Recognition of these gestures led to them being captured and recorded, and possibly a transition between elemental states. The interplay between the dancing collective and machine agent thus became a central structuring element, wherein the pervasive machine listening which recognized and captured gestures throughout the four-elements sections began to re-inject loops of these into the performance during the final sections of the work. In this way, the role of the machine agent can be perceived as an active collaborator, re-performing its understanding of each dancer’s elemental offerings. The materials of its performance can be

Figure 4: Moment from Origin8 showing sensor placements and typical gestures/poses in performance.

seen as being epiphenomena of the lived, performed work. In the case of Origin8, the proscribed nature of transition and of gestural execution meant that the machine's role was quite different. While discrete gesture recognition was also used, the system examined second order descriptive dynamic qualities such as variations and thresholds of acceleration, jerk and intensity. In practice this caused the system to determine structural transitions, and choice of active mapping strategy. The materials of its performance were thus the *conditions* of the performance rather than the *substance* of the performance, and the role of the machine can be perceived as coordinator or engineer.

In both of these works, there is an embodied relationship between movement-sound gestures and a pervasive machine agency that emerged as a product of long-form piece development. In one project, the role of gestural metaphor in creating a shared point of focus that resided "above" the specificity of movement or sound allowed for a shared development of movement-sound mappings. The openness of the genre then allowed for these convergent relationships, and importantly their digital representations, to become compositional materials in and of themselves to be performatively engaged by a machine agent. In the other project, the gestural vocabulary preceded the need for metaphor in the development process, existing as a given. The process of developing movement-sound mappings thus functioned as a form of interpretation, articulating the structures of movement that presented themselves in sound. The machine agent likewise acts as an interpreter and organizer of the unfolding of this content.

Conclusion

In his discussion of the historical role of technology in performance, Baugh [18] noted a "hierarchy of perceptual importance", delineating a trend of established and clear boundaries between human and inanimate technologies onstage. Gunduz [19] has argued that we are now at a point where this hierarchy is being challenged, citing the real-time and accurate nature of technology and pointing to the interplay of movement and light in Chunky Move's Glow [20] as a case study in this. She attributes this to the perception of shared dynamic between dancer and technology, and their equal role in the choreography as the reason for this. This speaks to intimacy and immersion on the one hand, and a dramaturgical openness on the other. In the two works presented here, I would argue that both resulted in an emergent quality of (potentially) perceived machine agency, but that the locus of this differed precisely due to the role of gestural metaphor in the development process. In Elemental Agency the presence of such metaphors that resided "above" movement or sound allowed for the development of movement/sound couplings at the level of choreography and composition - at the same moment as machine-definition. This allowed for these abstracted forms themselves to become the stuff of dramaturgical development, and gesturality itself a mediating factor. In Origin8 the development of such couplings supported the semiotic referents of the Ballet form; the digital representations thus created markers that allowed machine agencies to modulate the structural conditions surrounding the work. This comparative discussion is not a story of better/worse in regards to old vs. avant forms of creation, but rather serves to help articulate the importance of recognizing the inherent cross-modal gesturalities at play, and the potential for metaphorical intersections that cross not only sense modalites but also human/machine agencies in the process of developing both the physical and digital representations inherent within the work.

Acknowledgements

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Tactile Potentials: A Mixed Reality Project for Live Performance

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Abstract

Tactile Potentials is an ongoing practice-based research project, based in Sydney, Australia. It exists in several iterations as both a visitor interaction and a live performance. This research develops techniques for affectively co-composing with expressive conjunctions of augmented materials (both digital and organic), including: recursive strategies for modulating digital augments using touch; amplifications of bio-electrical data from plants to produce augmented audio; choreographing hand micro-gestures in tactile and signaletic connections with both augments and plants; and passing augments between the Leap Motion interface, Unity3D and Touch Designer.

Keywords

Critical Plant Studies, Mixed Reality Performance, Software Assemblage, Ecomaterialism, Karen Barad, Donna Haraway, Touch Designer, Unity3D, Leap Motion, MIDI Sprout.

Introduction

What would happen if we considered that plants, like humans, existed with a 'body' and sensed from within a conditional mode of situated agency? Such considerations begin, at a quantum level, with matter, and its 'mattering'. A quantum physicist as well as a philosopher, Karen Barad does not consider that nonhuman matter is inert, passively awaiting a human hand to provide the agency needed for it to take shape. Rather, matter is 'produced and productive, generated and generative', activated processually by its own quantum potential. [1] Through her agential realist thinking, she disputes the boundary between human and nonhuman forms of matter, advancing a mode of critical posthumanism that de-centres human agency by acknowledging the multi-valent agencies of the nonhuman, as a dynamic collection of entangled forces. To explicate a perspective that advances such as approach, human agency must be unwound as the privileged structuring force, so that consideration might be paid to the transformations between all kinds of matter, on and off screen. In *Tactile Potentials*, the agential realities engaged belong to ourselves as human performer, as well as to the living plants and the shifting movements of code that will both become intra-active matters/materials that re-assemble the making of mixed physical and digital space as indeterminate events in a shifting ecology of entities and relations. The 'matters' of code and plants, are seen to performatively enact their situated and conditional forms of agency, manifest as practices of signal that co-compose the work. Nonhuman matter is explored for its affective potential to relationally transform other entities with which it makes contact. In the 'software assemblages' in this research, such a conception of matter will give rise to nonhuman agencies – signaletic, computational, and environmental – that beckon an alternative MR that is at the edge of control, rather than predetermined as an executable sequence of events.[2]

Our specific mode of investigation involves generating connections between human and plant participants in a media environment, using mixed reality (MR) as a computational medium to experiment in the visualization of biological and gestural data. Using engineering techniques from the augmented reality (AR) medium to create a mixed reality (MR) installation and performance space, this artwork generates a relational conjunction with living plants and generative sonics. *Tactile Potentials* explores augmentation and visualisation, and what we can do with the bodies of humans and plants in this space.

While we utilise methods from AR/MR, scaffolded off a rich engineering lineage of computer vision technology, our implementation of these techniques follows an atypical development pathway. Before we explore the work, a clarification as to what augments are and do in the context of *Tactile Potentials*, is needed. In a widely accepted definition of augments, Ronald Azuma argues that they are data objects interactive in real time, and that they register across three dimensions.[3] Augments can either register as a data overlay on a 'virtual' world or on the 'real', and this changes the particular category of mixed reality (MR) they belong to: in augmented reality (AR) augments rest upon a 'real' world; in the converse case, augmented virtuality (AV), 'real' content is inserted in a virtual environment.[4] Concepts of augmentation from engineering and commercial fields, fall broadly within the realm of the 'technological virtual' and this differs markedly from the philosophical context of the virtual analysed by Gilles Deleuze and others.

Through commercial and industrial practice, the notion of the 'augment' has also become fused to the digital and informatic. In a widely accepted definition that has migrated to media art practice, augments are often considered as informatic overlays, content 'overlaid upon a visual representation of the physical'.[5] An underly

ing assumption is that augments are always digital. In narrow technical terms, this could be considered correct, since a screen/surface is the mechanism by which the digital is displayed to a user/participant in most types of MR experience. Yet, imbricated with a mixed media environment, such as *Tactile Potentials* containing living plants as co-composers, recourse to the digital as source offers only a partial explanation. As well, environmental space comes into play as a relational force, colouring not only our experience of the digital, but also its capacity to materially act through a technical network. Thinking with the environment as a relational force configured in the installation space, *Tactile Potentials* begins with the conceptual proposition that plants are not passive, but rather active in co-composing all life in this biosphere: This artwork is a small microcosm of a gesture toward co-composition with non-human bodies. In all its multifarious iterations, it starts with the bio-electrical signal of a living plant, a sonic enactment of the situated agency of matter in the organic realm.

Designing for Co-composition with Plants and Augments

Thinking with Barad, as well as with assemblage theory, the design of *Tactile Potentials* articulates heterogeneous modes of matter. Firstly, code as digital matter, where attention is paid to relations of co-composition between human and nonhuman. Secondly, signal as bio-electrical data, captured from plants, themselves a specific organic formation of matter. Thirdly, the human body as matter, systemically constrained within limits of flesh, yet open to potentials that might produce a modified subjectivity, and senses of perception that beckon new embodiments. The design of *Tactile Potentials* creates a situation where plant bodies resonate with human bodies and technical devices, enmeshing signals and data.

The first iteration of this work, *Tactile Potentials: Augmented Plants* (Figure 1) created a situation where normally inaudible plant sonics resonated with human bodies and computer interfaces. By touching their leaves, very gently, participants could influence the signals the plants were producing, creating a situation where they were affectively co-composing a generative audio-visual scape with plants. For the MR component, placed on plinth adjacent to the row of reactive plants, was a Leap Motion controller. Participants could pass their hands over the Leap Motion to activate a series of hand tracked digital augments, translated through a live webcam stream that interpolated their bodies with the augments themselves. Visitors to and performers within this artwork were able to co- compose a soundscape with various configurations of living plants, as well as triggering digital augments with their hand movements using the Leap Motion interface. The digital augments, tracked to the human hand, were designed like the leaves of plants, so that visitor's hands became to fusion of person and plant. The audio signals (sonified from the plants bio-electrical impulses) blended, via capacitive touch sensors, with the visitor's own electrical signals. Then result was that, through this highly personal form of electrical sensing (a small 'body area network'), the sonic experience never unfolded the same way twice. While the sonified bio-electrical signals filled the gallery space, the digital augments that tracked a visitor's hand gesture appeared on the LCD screen. Exploring the nuances of one's own hand gestures, as a multitude of digital avatars, afforded a unique experience for visitors to the gallery. Combining digital augments and plant signals, Tactile Potentials: Augmented Plants opened a fertile ground for new explorations with inter-species (plant-human) art making, as well as with live software. In subsequent iterations, different species were utilised such as ginger plants, bird of paradise, agave attenuata, bangalow palms and various configurations of green wall (Figure 2). The plants were attached to a special sensor (the MIDI Sprout) that read their bioelectrical signals, and these signals were then transposed to MIDI data, then to audible sound. Each plant emitted signals that begat different MIDI sequences, and these patterns were sonified using various virtual sound banks (Figure 3). *Tactile Potentials* artwork is typically for live performers, but it can be experienced by a participating audience as part of a docented experience. While participants can easily operate the work themselves, the docenting is mainly to protect the plants, who have delicate body parts. In September 9-13, 2020, it is being presented as part of the Ars Electronica Biomes Newcastle Garden exhibition in Newcastle, Australia, connected by a virtual portal to the main Ars Electronica Kepler's Gardens exhibition in Linz, Austria. Activated by the performer's hand gestures, a bespoke software network made in Touch Designer fills the projection frame, set vertically adjacent to the green wall, also its trigger. Using hand gestures to engage with plants as they move around the media environment, the plants will trigger a range of on-screen gestures whose data is visually transposed to the Touch Designer network, using augmented virtuality techniques. [6]

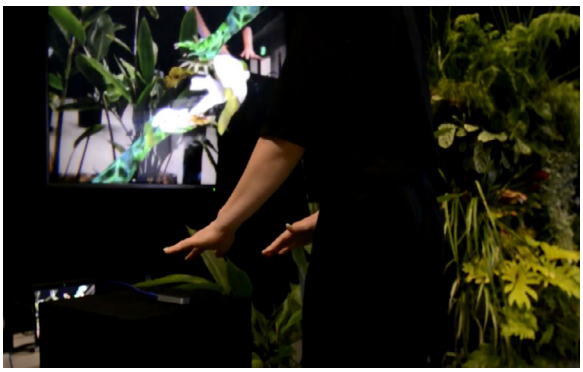

Fig. 1 *Tactile Potentials: Augmented Plants* (2018), interacting with reactive plants and Leap Motion gestural controller. LCD screen in background shows digital augment design with person-plant avatars. Video documentation of the 2018 prototype: https://www.youtube.com/watch?v=h6h0SDSnHKQ ©Rewa Wright and Simon Howden.

Tactile Potentials builds upon methods and techniques introduced in previous work, the *Contact Projects* (2018-2020).[7, 8] [Reference our paper from AHFE and from xCOax]. Tactility as an embodied mode, gestures toward a more phatic connection, at least from the human side, than can be enacted by sight (for example) alone. The concept of forming a physical connection comes to the fore in our related work, the *Contact Projects*, where the bio-electrical signals of living plants are sent through through MIDI, and then manipulated by the performer using the surface of the plants' leaves. While the first performer is co-composing with the bio-electrical signal from the agave, a second performer co-creates with the audio signals generated by the living plants in the space and the acoustic signals produced by the first performer.

Fig. 2 *Tactile Potentials* (2020). Modulating plant signals using touch. ©Rewa Wright and Simon Howden.

Plant sonics and human interlocution

The plants become tangible interfaces that elicit sound, and whose tactile surfaces become the trigger for a generative system that augments plant impulses through Touch Designer. Electrical signals (sonified from the plants bio-electrical impulses) blended, via sensors (the MIDI Sprout device), with the participant's own electrical signals. This recursive network of aesthetics and software – inspired by the living plants, who are physically present in the media environment, allows participants to experience the effects of their actions, as they modify plant signals by touching leaves and stems. The result was that, through this highly personal form of electrical sensing (a small 'body area network'), the sonic experience never unfolded the same way twice. While the sonified bio-electrical signals filled the media environment, the digital augments that tracked a participant's hand gesture appeared on the LCD screen. Exploring the nuances of one's own hand gestures, as a multitude of digital avatars, afforded a unique experience for participants to the gallery. Combining digital augments and plant signals, *Tactile Potentials* opens a fertile ground for new explorations with inter-species (plant-human) art making, as well as with live software. Such a collision of human, software and plants highlights the invisible processes of plant sensing through transduction. Questions are raised, such as how and why plants sense their environments, and indeed, what 'sense' they might make if it. Plant sensing is an area of increasing interest for the emergent field of Critical Plant Studies (CPS). That plants use chemical signals to communicate with one another as well as with predator species in the specific context of their local ecology, is an emergent research trajectory explored by evolutionary biologists using detailed sonic and visual imaging techniques (Trewavas 2005; Ferrari, Wisenden and Chivers 2010; Gagliano 2012; Gagliano and Renton 2013).[9] Research by biological scientists at the experimental edge of plant sensing, draws conclusions regarding plant intelligence through an analysis of growth as a behavioural practice. Anthony Trewavas (2005) argues that plants transduce and transmit through complex sensing systems that are similar to intelligence; while Monica Gagliano (2012) argues that the clicking sounds produced by young corn during growth allows them to map the location of water sources and grow toward those sources. Gagliano contends that plants use calcium-based networks to transmit signals that may form the basis of a memory map.

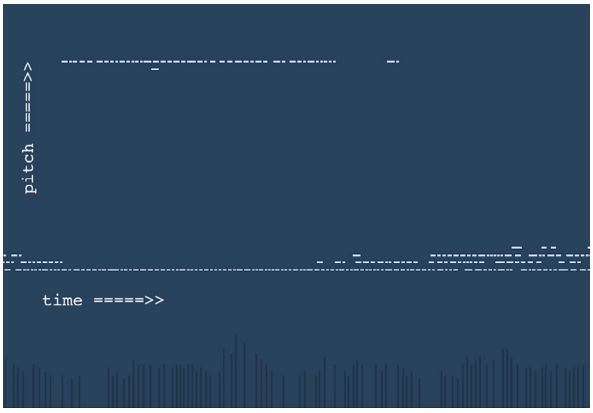

Fig. 3 *Tactile Potentials* (2019) MIDI sequence of a plant signal. Screen-shot from Logic X file. ©Rewa Wright and Simon Howden.

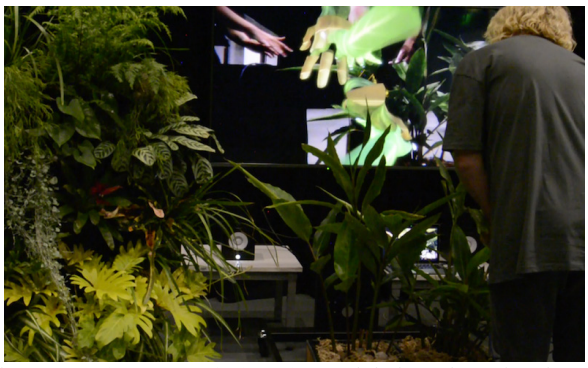

Fig. 4 *Tactile Potentials* (2018). Modulating plant signals using touch, as Leap Motion tracked plant avatars emerge on screen. ©Rewa Wright and Simon Howden.

The impulses generated by plants as signals create quite a different musical output from our human scale (Figure 3). Since plants was operating on a phenological time scale,

we wait for their sonic emission, delivered with their own durational sense, a process over which we had no control. Once the plant emits a signal, co-compositional responses by the human performers (as intra-actions between body, plants, and data) were open ended and durational.

Another way we might approach this software assemblage is by examining its differently expressed modes of temporality. *Tactile Potentials* engages three temporal registers: the micro-temporal register of machines, the phenological register of plants, and the durational register of the human body. In the micro-temporal register of machines, decisions by software operate outside of the threshold of human perception, yet nonetheless influence human movement and action. For example, the gestural hand movements that modulate the agave and agitate the green wall/living plants are tracked, micro-temporally, by a computational system. A computational layer sits on a corporeal layer, as we intra-act with digital augments at the same time as modulating the bio-electrical signal. Human hands are both generative *and* responding to the nuances of the digital and signaletic augmented materialities. In the third phenological register of plants, organic matter elicits a human response via signal. Yet, while the plants are not contributing to the assemblage in the same way we would ascribe to human gesture or action they are nonetheless affecting and being affected. Across these temporalities, material phenomena (data objects, digital augments, infrared signals and so forth) activate one another through intra-actions, where the digital materials of computational networks, tangle with the fleshy material of the body, and the slower paced agential realities of living plants.

These different registers of time might be thought as parameters or thresholds from which to apprehend a different understanding of materiality. Barad explains the relation between intra-actions and temporality: "Intra-actions are temporal not in the sense that the values of particular properties change in time; rather, which property comes to matter is re(con)figured in the very making/marking of time (2007:180)".[10]

Partially and contingently, matter becomes what it is because of an intra-actively enfolded relation with not only the apparatuses that materialise it, but also with time in all its variances (durational, phenological, chronological, micro-temporal, and so forth). The intra-actions that produce time and matter in *Tactile Potentials*, are recursively produced by those same forces. Differentiations between 'which property comes to matter' are enfolded in intra-action as a 'making/marking of time'. Engaging with these differently materialized temporal flows means remaining open to time as a series of material encounters. For example, in the 'agave modulation' segment of the performance, my ear must find an entry point for my gestures, so that they might insert tactile movements into the existing sonics transduced from the plant. Perhaps placing hands at the base of a leaf to shift the bio-electrical signal, or at the tip to cause a stutter, human interlocutors are open to the potentials of the co-composed materialities that might take shape. For example, since plants will not always emit sound, sonics are punctuated by pauses, which cause humans to similarly wait.

Fig. 5 *Tactile Potentials* (2019). Modulating plant signals using touch, with MIDI Sprout interface pads attached to an agave attenuata. ©Rewa Wright and Simon Howden.

Historical Precedents in Art

Artist's co-composing with the bio-electrical processes of plants have engaged with such processes of transduction and transmission since the 1970s, when early examples by Richard Lowenberg and John Lifton used the 'gold needle' technique to measure the bio-electrical signals from plants, transferring those signals to electroencephalography (EEG) devices worn by human interlocutors. Since the 1990s, Miya Masaoka has worked intensively with plants as co-composers, creating ensemble musical pieces for live performance. Her initial plant-human interfaces – a type of Body Area Network established to sense physiological electrical data near the body – were developed with BAN pioneer Tom Zimmerman, who also invented the Data Glove. These innovations incorporate body-plant-energy networks to generate live musical performances as well as scored compositions. In performances such as *Pieces for Plants* (2000-2012), Masaoka networked a specially prepared philodendron by attaching electrodes to its leaves, to react in concert with electrical fields around her body. Using the BAN as an unstable formation, Masaoka modulated with the emergent energy fields. Masaoka has shared her perspective on plants as responsive entities: "Working with plants in my studio, I was astonished by their ability to respond consistently to my walking in and out of the room ... I [became] increasingly aware of the sensitivity of the plant, and gained greater empathy and awareness of their behaviour, needs and responses" (Miya Masaoka 2018). [11]

Clearly, Masaoka considers the responses and behaviour from plants as an element that affectively co-composes the sound piece, citing their ability to emit different signals according to their environment. Masaoka's creative use of BAN's can be thought of as ways to pose provocations to the practice of augmented audio. *Tactile Potentials* reimagines some of her artworks in the context of performing augmented audio by introducing issues of signal flow and modulation. This sonic flow is not under the full con-

trol of the performer, yet it can be adeptly modulated using both carefully placed tactile gestures and subtle body movements. The bio-electrical signal of the plants could be considered as a kind of micro-impulse, a bubbling ground of voltage that conveys a mode of nonhuman affect. Through attention to the micro-impulses in a modulating bio-electrical signal, aural perception shifts focus from the musical notes played as expressive of the intentionality of the performer, toward the sonic forces manifested by the impulses emitted by the plant. Mobilising Masaoka's approach to assist in the development of a generative sonics of augmentation, arrived at through the articulation of real time signal flow, converges both the gestural movements of my physical hands, and digital augments as they pass through the software assemblages, and are further diffracted through processes of performative interfacing.

In the seminal installation, *Interactive Plant Growing* (Sommerer and Mignonneau 1992), plants became interfaces that enact computational forms of growth suggesting artificial life (Sommerer and Mignonneau 1992:1; Whitelaw 2004; Gatti 2009:6).[12] Participants needed to activate the 'interactive plant' soliciting sonic modulations that would cause different varieties of digital plant to emerge on screen. A careful interaction would reveal 'growth' in the real plant's digital avatars, including increases in health, branch and leaf growth. Conversely, a careless touch could promote a negative descent for the avatars to a weed or invasive plant. The artists describe the experience for the participant as one of thoughtful exploration where they must tune to the plants: "Since it takes some time for the viewer to discover the different levels for modulating and building the virtual plants, he will develop a higher sensitivity and awareness for real plants" (Sommerer and Mignonneau, 1992). Sommerer and Mignonneau's work places plants as active elements of the installation; they have some agential materiality with a participatory audience. The tuning that participants must develop to encourage the plants to flourish, is entirely different from art that uses plants for passive aesthetic purposes. On this point, John Ryan (2015) provides a useful summary of the shift toward approaching plants as co-composers: "Whereas visual plant art, tactile plant art, and plants-as-art form exact degrees of representation or manipulation, plant-art produces a flux of meaning iteratively between the plant, artist, audience, and artwork in sensory contact. This flux is the basis of the co-becoming between us and other, between nature and technology, between the vegetal and digital, and is a salient mark of plant-art" (Ryan 2015:54).[13]

Influential installation *Akousmaflore* (Gregory Lasserre and Anais met den Ancxt, various iterations, 2007-present), illustrates the sensory potential of the tactile connection between human and plant participants, through the mutual act of sonic co-composition. In artworks such as *Akousmaflore*, some of the plant processes captured include the conversion of light to chemical energy in photosynthesis, and the selective absorbance of water to 'guard' cells that swell and place pressure on stomata triggering osmosis. These signal transductions and more, come into play to produce sonic emissions, leading to the impression a 'plant singing'. Sensors allow the detection of bioelectric potentials in plants generated by ions (Ando et al. 2011), potentials that are converted chemically by the plants' physiology to an electrical current (Fromm and Lautner 2007).[14] Contact with the plants via human touch, occurs through the meeting of human and plant electromagnetic fields, and this contact produces the sound in the installation. Yet, it is the beauty of the plants in the space itself that draws humans to touch their leaves, and this intangible pull underscores the human desire for a phatic connection with plants as bodies. Inspired by the works discussed above, *Tactile Potentials* introduces MR techniques and methods to enhance the visualization of data emitted by the plants, in attempt to produce a memorable connection between plant and human.

Plant Bodies/Human Bodies

Plant and human biological processes have a clear separation of form, each a differently delineated organic structure that prehends a mode of specifically situated embodiment. However, through mediatic spaces we can make plant bodies and human bodies intersect, generating a greater understanding of the unseen processes surrounding our relations with these organic cousins.

In *Tactile Potentials*, taken up by different modes of matter, the performing plant and human bodies re-emerge in partial transmissions as code, signal, and movement. Through strategies of performative interfacing via the software assemblage formulation, the plant's corporeality is contingently diffracted to digital space, captured in real-time and now subject to modulation by the human performer's musical improvisation. As augmented materials (plants, data, bodies) iterate in the environment of *Tactile Potentials*, infrared signals distort, ultrasonic frequencies squeal, screen augments stutter, and plants vibrate in a bubbling cacophony: all these forces and more re-draw the material boundaries of this software assemblage. Iteratively assembled, MR in this mediatic-ecological environment is multi-sited across screen based *and* physically spaced topologies. The art is in the relation, and the relation does not unfold the same way twice. Thinking with a critical posthuman performance modality, we 'remind ourselves that humans are always already part of the biosphere': such a position might allow 'us to learn to live with these nonhuman others rather than in opposition to, in domination of [them]' (Anderson 2017:37). [15]

Figure 6. (above) Still from the video *Signaletic Flow 2.0* (2020). View here: https://vimeo.com/390429591
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Artist Rewa Wright's relationship with plants is culturally entangled with her Māori ancestry, where the organic kingdom is considered to coexist in a radical cosmological contingency with humans (Reed 1963). Explicated through the concept of *mauri*, which is the idea that each element of the natural environment has a 'life force' (Pohatu 2011), new configurations of care and mutual ethical responsibility emerge through kinship links between human and non-human actors (Royal 2003:95). These nurture familial relations of care or *kaitiakitanga* (Barlow 1991).[16] Episodes of material transferral and transmutation from cosmology are numerous, such as the figure of *Tane Mahuta*, the symbolic man-tree of the Waipoua Forest who, in human form, brought light to a dark universe by pushing his parents (the Sky and Earth) apart, creating the conditions for the material world to flourish. Such cosmological understandings help articulate relations outside of humanist (and Western) paradigms that have artificially separated nature and culture, a paradigm artists such as Eduardo Kac also revoke at the genetic level. Donna Haraway points to the connections between humans and plants, where an acknowledgment of shared genetic matter can assist in the re-assessment of new situated potentials for inter-species contact: "I am fascinated with the molecular architecture that plants and animals share, as well as with the kinds of instrumentation, interdisciplinarity, and knowledge practices that have gone into the historical possibilities of understanding how I am like a leaf." (Haraway 2000:132) [17]
Artists working with plants as signal producers, have for some time been thinking with Haraway's postulate.

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Cyborg and Prosthesis: The Body of Subjective Motivation Extension

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Abstract

The purpose of this study was to investigate the bodily threshold, which is the right to belong inside or outside the body, determined using subjective motivation. The foundations and features of the cyborg and prosthesis are explained in detail in the context of contemporary culture. Borrowing the term "xenembole" from veterinary medicine, the study further discussed providing a way to coexist with technology in addition to the grafting of flesh and extensions. The methods implemented on digital media texts, life phenomena, and art works revealed multiple contexts and code hints. The author used cases to illustrate the interactions between the body and prosthesis and examined the relationship of deconstruction and recontruction of the body. It can be concluded from the findings that bodily threshold is a dual system theory with two types of working strategies, namely wonder body and technical body. The results indicated that the theory can accommodate existing blind spots of interpretation and those beyond perception.

Keywords

Cyborg, Prosthesis, Bodily Threshold, Xenembole, Subjective Motivation Extension, Disembodiment.

Foreword

The term "cyborg" combines the terms “cybernetic” and “organism.” It was first proposed in 1960 to describe assisting or enhancing physiological functions through artificial means, such as biochemically or mechanically modifying the human body. [1]

Prosthetics or artificial limbs are aids for human body parts to replace or enhance their physiological functions. Most prosthetics are used to compensate for the physiological inadequacies of original limbs or organs. In artistic creations or derivative texts, prosthetics are often endowed with reinforcing functionalities or abilities that surpass the capabilities of the original limbs, deviating from our stereotypical understanding of limbs.

Cyborgs and prosthetics are widely used in today's sci-fi texts or fantasy themes to shape three-dimensional characters and support plots and styles. These "bodies" exist and afford endless imagination. They are blueprints of our present and our future and provide many possibilities for art, entertainment, and literature.

The protagonist in the well-known Japanese animation and manga, "Fullmetal Alchemist(鋼の錬金術師)," wears prosthetics on his lower left and upper right limbs. They serve vital functions in the story by not only helping the protagonist lead a healthy life, as if he still had both of his upper limbs, and practice alchemy but also becoming useful "weapons," eventually earning him the title of "Fullmetal Alchemist." Furthermore, the prosthetics also links the main characters in the story. This animation is an original text based on prosthetics; as the story progresses, prosthetics subtly become part of the imagery and concept of the human body. [2]

In the real world, bionic pop artist Viktoria Modesta released her music video "Prototype" in 2014. In the video, the artist wears her prosthetic left leg as a fashion accessory. She also boldly accessorizes her prosthetic for various performances and interviews, making it a personal symbol. She not only accepts prosthetics as part of her body but also uses one to aid her career. [3]

To some extent, fictional texts echo our imagination of the future based on past experiences. In the following section, we discuss science fiction and cyborgs. First, we elucidate people's acceptance of their bodies from the overview of prosthetics. Then, we applied this understanding to define the "human body" and clarify the function of "volition" in this context. Finally, we used this new definition to interpret "physicality" in both the real and artistic sense. We aim to clarify the vagueness of scientific reality and imagination. The "body derived from volition" is a statement on cyborgs and prosthetics and an expectation of self-perceived communication.

With science fiction as background

In the 2019 US cyberpunk-themed sci-fi movie, Alita: Battle Angel, the plot contained many man-computer symbiotic characters. In the fictional worldview of the movie, cyborgs were both a body and clothing, and the mechanics were doctors rather than technicians or engineers. [4][5] The writer and director conveyed many "human" and "body" characterizations for the main protagonist Alita, such as tactile perceptions and emotional dependence, such as familial and romantic love. According to Husserl's definition of normal physiological states, tactile perception refers to the ontology of the body, the outward extension of awareness, and the self-sensing ability to position the body and movements. [6] There were also scenes in the movie where body parts were replaced. These scenes manipulate

the concepts of "volition connector" or simply "connectors." In this context, biomechanical bodies open up endless possibilities for volition. Cyberpunk movies such as Alita: Battle Angel is often set in post-industrial societies. In addition to addressing anti-dystopia and antiphasic civilization issues, a form of self-liberation, or unconscious desire, is characterized in biomechanical bodies. Desire in this context refers to the productive, non-holistic, and positive "desire" emphasized by Deleuze. It is similar to "will" described by Nietzsche. This type of consciousness incited through flesh, biomechanics, or prosthetics is the reconciliation of chaos and order. [7][8] It is the desire to force the contradictory object of consciousness into a custom body.

Science fictional texts are hypotheses of the future. This statement can be validated by examining past texts. For example, the novel, The Jetsons, published in 1962 characterized a smartwatch that was only commercialized in the 21st century. The functions of wearable devices characterized in the novel are similar to those of the devices available today. Another example is the movie, "Back to the Future," that screened in 1985. The movie introduced a variety of technologies, such as green energy, smart homes, drones, and fingerprint recognition, which have all become part of our everyday lives after three decades. Therefore, analyzing science fiction is hugely beneficial. [9]

Study on the limits of the human body: Motivations and methodology

The body is a carrier that conveys the feedback from the inner consciousness. At the same time, it is a mechanism of interaction. Therefore, "phenomena" are achieved when the body communicates with the external environment. Amidst the dual progression of modern and post-modern times, there are a plethora of sci-fi texts set after the most-modern era but before the near future. The existence of cybernetics and prosthetics, both of which are vessels for connecting volition, is like the fracture and reproduction of somatosensory experiences. Their linkage with the physical body is the state of self-consciousness. Returning the spatial-temporal anchor back to the present context, biomechanics, prosthetics, and other parts derived from volition is like "imitation and reproduction" discussed by the ancient Greek philosophers Aristotle or Plato. The body is a conduit for external individuals or societies. Humans use "imitation and reproduction" to give abstract consciousness a new body shape and couples the possibilities for compensation, repair, expansion, and creation with the outside world. Bodies derived from volition coincide with the statement of Foucault: "Imitation and reproduction have lost the ability to provide a cognitive foundation. They can no longer provide a base for integrating complex elements. They are without any composition and decomposition. Any heterogeneous and homogeneous analyses can confirm the reciprocal association of reproduced products." Therefore, a set of boundaries can be established independently from bodily threshold beyond physiological production.

The body threshold is a critical boundary that defines the body and the non-body (i.e., outside the body). In the category of the body threshold, the internal would be the subject and its consciousness. On the contrary, the external would be the object that is directly connected to the will.
Regarding methodology, we adopted the fiction aspect of speculative design as the legal basis for ideological promotion and grounded theory to construct the body threshold theory. [10] The core category of the argument is "the body is a vessel for the extension of volition." Existing texts and works were analyzed, coded, and compared, and the outcomes were consolidated to formulate hypotheses. [11]

Functional extension of prosthetics

The initial aim of prosthetics in terms of functionality was to shift "-1" to "0," or make up for congenital or acquired bodily defects. Today, this goal has evolved from merely filling simple physiological or psychological voids to maximizing the mechanisms of functional extension or improving "0" to "+1" or higher. JC Sheitan Tenet of Lyon, France, used parts from typewriters, sewing machines, record players, and pressure gauges to reconstruct his right prosthetic, converting his initially missing right arm into a tattoo machine. This detachable arm enables him to create tattoo works more accurate than his competition. In this case, the prosthetic became a tool for making a living, and a machine that was made out of interest became a part of the tattoo artist. This real-world example of grafting a prosthetic limb onto the body clearly echoes the idea of giving volition physical limits. [12]

Emotional extension of prosthetics

An example of an emotional extension is Necomimi, a product jointly developed by US company NeuroSky and Japanese company Neurowear. It is a wearable device in the form of cat ears that senses brain waves. [13] The aim of this product is to amplify emotions while simultaneously emulating them through a "new organ." The bionic design also provides a new means for people to communicate extrinsically and facilitate the exposure and representation of volition.

In the art world, emotional and functional extensions are used to backwardly define the position of prosthetics and the body. For example, the science and technology exhibition Prosthetic Limbs - External Links was held in Taipei in 2013. Taiwanese cross-domain multimedia artist Pei-Ling Lee explained that the concept of the artwork derives from a prosthetic-assisted exploration of external links through the perceptions of technology and the body and extension of the physical physique through technology and media. Outsiders and viewers were able to experience visual and auditory feedback and alternative interpretations of body dynamics. [14] [15]

The expansion function of prosthetics will bring about the symbiosis between cybernetics and organisms. This

implies that biomechanics and prosthetics must be juxtaposed and have the capacity to substitute body parts. It also implies that biomechanics and prosthetics are sublimed as an "optional" component for the construction of the body to communicate volition with the external world.

Xenembole: Chip implants and man-machine hybrids

Chip implantation technologies have contributed immensely to the fields of animal protection and smart medicine. Electronic devices and computers can be upgraded by replacing the hardware with more efficient chips or plug-ins. Can human flesh be upgraded in the same way? In the 2018 thriller Upgrade, the body of the male protagonist, who is paralyzed from the neck down, was controlled through the implantation of an artificial intelligence chip. However, the complete narrative should be the control of the protagonist "through the chip," whereby the chip is the relay station for the subjective consciousness. The subsequent development of this commercial film is a suitable counterexample for "the body is a vessel for the extension of volition." In the latter half of the film, the artificial intelligence on the chip robbed the protagonist of the control over his body and locked his consciousness in an isolated eternal fantasy. The protagonist lost his volition during his pursuit of a body. Therefore, the body is not one's own without the extension of volition. [16]

After the theme of forfeiting command of the body was introduced, movies that explored the right of privacy over one's body emerged, such as the 2016 British sci-fi thriller Anon. The story is set in a futuristic city. In order to reduce the crime rate, the government implanted microchips into the pupil of its citizens at birth to easily monitor them over the cloud. This technology is indicative of two aspects. The first is sensory sharing. In the movie, the sense of sight is hijacked by the government. The second is the creation of a backdoor for accessing physiological information. In the movie, hackers used this backdoor to acquire the necessary information. Besides pupil implants, the movie portrays people like the cecum that could inflame at any time, like an organ without a physical function yet at risk of disease. Subsequently, the cloud, which is used to access sensory information, is not limited to the scope of the body because of the lack of volition. This example not only defines the limits of the body but also shows the contrast between ownership of the body and that of the mind. [17]

Subject sovereignty and volition

The xenembole of body structures and modes, such as implanting microchips, can be understood as relinquishing the sovereignty of the flesh and imparting a portion of the highest command and privacy to a foreign entity. [18] When adopting volition to represent a subject, the theory of free will proposed by Thomas Aquinas states that life is a series of acts of man and human acts. Human acts are "non-mandatory" and "diverse." Free will is the ability to accept or reject matters. I believe that free will is an expression of volition and a condition of subject sovereignty. Thomas' argument on the "soul" is more of a comprehensive definition of volition. He classified the soul into five properties, namely, physiological, sensory, sexual desire, spatial mobility, and intellectual. Among which, the "physiological" property describes points that link volition to a physical body, while the "spatial mobility" property describes that the soul adopts "external objects" as the result of activities or movements which coincides with the association between a body derived from volition and biomechanics and prosthetics. [19]

Simulation of volition extension

Based on the concept of "Aping of Truth" proposed by San Bonaventura, the volition-extended body is the threshold of the body. Paintings and engravings are just the imitations of the artist's inner thoughts. Imitations and three-dimensional sculpture replace the words artists use to describe their work. Subsequently, the explicitness of inner thought is like "visually presenting volition," as mentioned in the aforementioned paragraph discussing the emotional extension of prosthetics. Therefore, artists used a technology-generated body to perceive the world and reversely disclose information. In a broad sense, artworks become prosthetics. They are not of flesh yet transfer and exchange volition via a vessel. Therefore, they can be thought of as embodiments. [20]

This kind of simulation within the threshold of the body achieves many contextual interpretations. One such interpretation is the body imitated through volition extension must demonstrate essential physical properties and embodiments. Another such interpretation is drawing simple and accurate meanings and values from the multi-track output of volition, enabling viewers or participants to enter specific perspectives and dissociate or extract the information they need. Using the traditional Taiwanese art, glove puppetry, as an example, when the puppeteer bends his/her thumb to control the puppet, his semantics would neither be recognized as the number "four" nor would people think of his thumb as being bent. Rather, this action would be translated into the movement of the puppet's left arm, the body in which the puppeteer has extended his/her volition. In this instance, volition becomes a tangible body. It is not the voice or posture of the puppeteer that gives life to the puppet. Rather, they become a part of the puppet's body. At that moment, every movement is the imitation of the subject's will.

Reasonable scope of body threshold

Performance artist Stelarc uses his own body to create art. His work, "StickMan," is a dance of an exoskeleton. Wearing a mechanical exoskeleton, the artist continues to move and dance through volition, regardless of whether his

flesh still exists. [21] The embodiment transcended the artist, his audience, and the artwork itself. Any movement of this technology-derived body is ripples created by volition extension. While performing, Stelarc entrusted his body to a machine. The flesh of the artist was only a map of a 3D model. The true 3D model is the body; that is, the mechanical work that extended volition. Another work by the same artist, Ear on Arm, is an analysis of the boundaries of the body. This piece entailed the use of a biopolymer to grow an ear outside the body and then implanting the ear under the skin of the artist's forearm. The artist himself, art critics, and media referred to the implant as a "third ear." Discussion of the threshold of the body is not on flesh but rather the "intentional" extension of emotions. The existence of the ear is the outward propagation of volition. Intent is strong, active, and positive. Intent existed even before implantation and solidified after implantation. As with all bodies, it can continue to respond.

An exoskeleton is synonymous with a body with prosthetics or a moist media symbiotic body with strong biologically properties. The thresholds of both bodies are determined by volition. Such intentionality is the core aspect of body threshold theory and shapes the connection between the subject and the word after the body is controlled. [22]

Re-embodiment

If the body's limbs and organs became components, similar to cyborgs and prosthetics, would these components be convenient structures for people before they became a body? If we simply compared the relationships of independent units, such as "people," "society," "objects," "the world," or the interactions of three or more units, then "disembodiment" would be the preceding operations for the positioning of different units and the creation of different narratives. Only in so doing can we remove the quotations and frameworks of individual units and shift between and blend boundaries. Disembodiment is the simultaneous liberation of people and thing and makes each unit meaningful and inclusive.

The volition-extended body is the shift from "disembodiment" to "re-embodiment." Its value lies in providing a strategy after conceptual superimposition. "Re-embodiment" is the embodiment of original units before setting these "units." That is, "people + object = body," and the establishment of the body is dealt with in advance. Therefore, meaning is liberated within the body, and codes are thrown out of the body.

Human cognition is subverted during the destructive innovation of civilized societies, and new civilized societies are created during the destructive innovation of human cognition. In "How We Became Posthuman," author N. Katherine Hayles mentions that in the theory of "posthumanism," an autonomous self with clear boundaries can contemplate on virtual technology resources with greater complexity. The power of fictional design lies in the depiction of a future blueprint. The re-embodiment involving cyborgs and prosthetics is the disenchantment of shifting the human race towards biomechanics through volition-extended bodies. [23]

Next-generation dual system theory: Hypothesis and validation of body threshold

I adopted an open coding method to code today's contexts using current phenomena, text, and artworks. Then, I used an axial coding method to code prosthetics and cyborgs, and a selective coding method to code the "Redefining internal and external embodiments" section. After evidence is presented, the suggested hypothesis derived from logic is that body threshold is the endpoint of volition-extended bodies. Verification was completed in the body comparison section. Concerning the semantic gap caused by obvious inconsistent fractures in the different body categories, such as flesh, original organs, cyborgs, and prosthetics, I believe that a next-generation dual system theory is required to supplement the contextual discussion of the body. Moreover, the establishment of a dual-system structure can clarify the inner state of body thresholds.

Next-generation dual system theory: Wonder body and technical body

After discussing body threshold, volition-extended bodies can be categorized into two parent groups. The first is physiologically generated "wonder bodies." They are bodies that are formed before attaching volition. In terms of flesh, volition is formed during pregnancy or cell division. The second is artificially created or re-created "technical bodies." They are bodies derived from objects endowed with volition, such as prosthetics. The next-generation dual-system theory is construction by comparing and cross-referencing wonder bodies and technical bodies. This is a systematic induction structure that can be referenced by the subject or others.

There is directionality when switching between bodies. Based on the current situation, directionality implies the shift from a "wonder body" to a "technical body." There are five motivations for shifting from a "wonder body" to a "technical body." They are "comfort," "decline," "escape," "rise," and "hint." The "comfort" factor refers to a compensation mentality or alterations to correct one's body to normal level. Hearing aids help with users' hearing and subsequent senses. The use of hearing aids is the shift to a technical body for the purpose of comfort. The "decline" factor refers to the conscious surrender of one's wonder body and shifts to a technical body because of the influence, temptation, or threat of another's volition. A possible scenario would be a laborer sacrificing the health of his/her flesh or specific organs for living space and money, later requiring artificial organs or aids to complete his/her body. In a contemporary setting, this scenario could occur in factories with chemical odors, new drug trials, or mines.

An extreme situation involving the decline factor would be voluntarily selling organs as a motive for body modification. Another key motive for switching systems would be an escape or opposing volition, such as going on a hunger strike, which is a rejection of a basic need. If body systems are altered due to such motivation, the factor would be escape. The rise factor refers to the switch to a technical body due to the pursuit of the functional or emotional extensions, such as the creation of art or the pursuit of immortality. The final factor has to do with social status. If one voluntarily switches systems due to social influence, stereotypes, pop culture, or conventions, then the key motivation is a hint. The directionality of body systems extends the volition of the subject. However, it also implies that body composition strategies lean to the far-right of capitalism. The five key motivations for switching systems are indicative of this point.

The dual system theory has a very sharp contrast in quality. [Table 1] Referencing the characteristic keywords in the different dimensions of the dual system helps us gradually understand the appearances and possibilities of the system. It is also advantageous to further generate artifacts, texts, and artworks to provide indexing tools for the investigation and inquisition of body threshold contexts.

Wonder body	Technical body
Physiology and nature	Man-made and technology
Purity	Diversified
Low degree of freedom	High degree of freedom
Linear time	Nonlinear time
Cells are essential	Pixels, molecules, or cells
High chroma	Low chroma
Original	Regeneration
Reincarnation	Eternal
Retention and the past	Synaptic and the future
Uniqueness	Reproducible
Cranial nerve	Constellation
Natural language	Machine language
Chaos	Not black or white
Near ontological awareness	Near objective consciousness
Removable but irreversible	Removable and reversible
Smooth coordination	Fracture stitching
Line symmetry	Point symmetry
Water	Electricity

Table 1. Control list of the qualities of the dual system

In the composition of a body system, wonder bodies and technical bodies are not absolute binary opposites. Rather, they are composted based on a weighted ratio. Nonetheless, there are still those with a single body system. For example, the female character, Marguerite, in the Japanese web-based card game, UNLIGHT, is a hologram projected from a levitating sphere the size of a volleyball. The character is the ultimate image of a technical body system. Cyborgs or bodies with prosthetics typically lie on a point on a spectrum. The qualities and characteristics of the body lie within a spectrum of two corresponding keywords in the control list. The spectral descriptions are able to clearly characterize perception and body qualities. They also help to determine coordinates when discussing states.

Conclusion

In terms of volition-extended bodies, biomechanics and prosthetics serve as the supporting pillars of discussion. The drivers of volition-extended bodies are also the defining conditions of the body. The purpose of discussing topics ranging from the thought processes of bodily threshold to next-generation dual system theory is not to create an aesthetic narrative. Rather, it is to organize otherwise chaotic information and ambiguous phenomena. The establishment of a systematic framework is like taking a snapshot that can be referenced now and in the future. The framework also provides subjective interpretations for the terms physicality, embodiment, and physical sensation. By consolidating dual system theory and filling the linguistic gaps of body threshold theory, we provide cornerstones for rationalizing the development of "volition-extended bodies" and "body thresholds" and interpretations for today's contexts concerning cyborgs and prosthetics. Moreover, the discussion on the contexts of current phenomena, texts, and artworks revealed the correlations between the body and volition. This article redefines and re-interprets the body to propose a speculative hypothesis.

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SHORT PAPERS

The Problem with Immersion

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Abstract

Existing terminology is inadequate for the study of immersive design theory. This paper proposes alternatives for the catch-all term "immersion" and suggests a structure for reliably deploying immersive practice. Absorb/engross replaces the general use of "immersion", the distinction between engrossment by form and engrossment by transportation is highlighted, and *embodied praesence* is proposed as a term that engages with the sublime experience of an alternate reality that is at the heart of immersive design practice.

Keywords

Absorption, communitas, embodiment, engrossment, experience, immersion, praesence, presence

Introduction

"Immersion" is not not a term that is sufficient for design or analysis of an immersive practice. A glance at Webster's dictionary sees "immersion" defined as "the act of immersing or the state of being immersed"; "immerse" is defined primarily as "to plunge into something that surrounds or covers" and secondarily as "engross, absorb". In art and design disciplines terms like *immerse*, *immersed* and *immersion* are all but meaningless. At best, definitions differ between disciplines. Some examples of the various definitions of immersion encountered while examining disparate disciplines include:

- "...the player assuming the identity of the character by pretending to believe her identity only consists of the diegetic roles" [1] from role-playing
- considering an experience immersive because it "feels inhabitable" [2] from theme park design
- an experience "so true to life that they could be confused with reality" [3] from panoramas
- an experience in which "you can drill down as deeply as you like about anything you care to" [4] from transmedia properties

Outside of art and design, immersion has definitions that further confuse its meaning; for example, in educational contexts, immersion is a methodology that emphasizes "that learning occurs as a function of its context" [5]. Immersion's meaning is so obscured that it has become an advertising buzzword, signifying nothing (Fig 1).

Figure 1: an advertisement using the term "immersive" uncritically. (NVidia 2018)

In order to effectively explore immersive design as a distinct discipline it is necessary to invent new terminology to refer to the core phenomenon undergone by a participant in an immersive experience. Since "engross" and "absorb" are often used interchangeably with "immerse", any experience that might be called engrossing or absorbing might be considered. Figure 2 lays out a series of absorbing experiences (examples that could be called immersive) on a scale drawn from Milgram's Taxonomy [6] of real to virtual environments, laid out against a scale of physical vs conceptual methods of engrossment. These experiences are fundamentally different, but share commonalities in how their participants are expected to receive them.

Kendall L. Walton's theory of make-believe describes being "caught up in a story" as an experience in which the player is made to "participate psychologically in a game in which the story (or play or painting) is a prop" [7]. This psychological participation is the kernel of the immersive experience — Walton's choice of the term "caught up" evokes the notion of "transportation" that is the foundation of many other thinkers' definitions, and a core component of the sublime state of total immersion. Dunne and Raby use Walton's theory of make-believe to discuss the act that takes place when readers take on the building of an imaginary world as they participate in a story. "It takes imaginative effort but the result is the viewer or reader takes ownership of the idea, and each experience is different" [8]. *Immediate art*, described by Mike Pohjola, is a category of art that "is experienced as it is created and has no use for the division between performers and

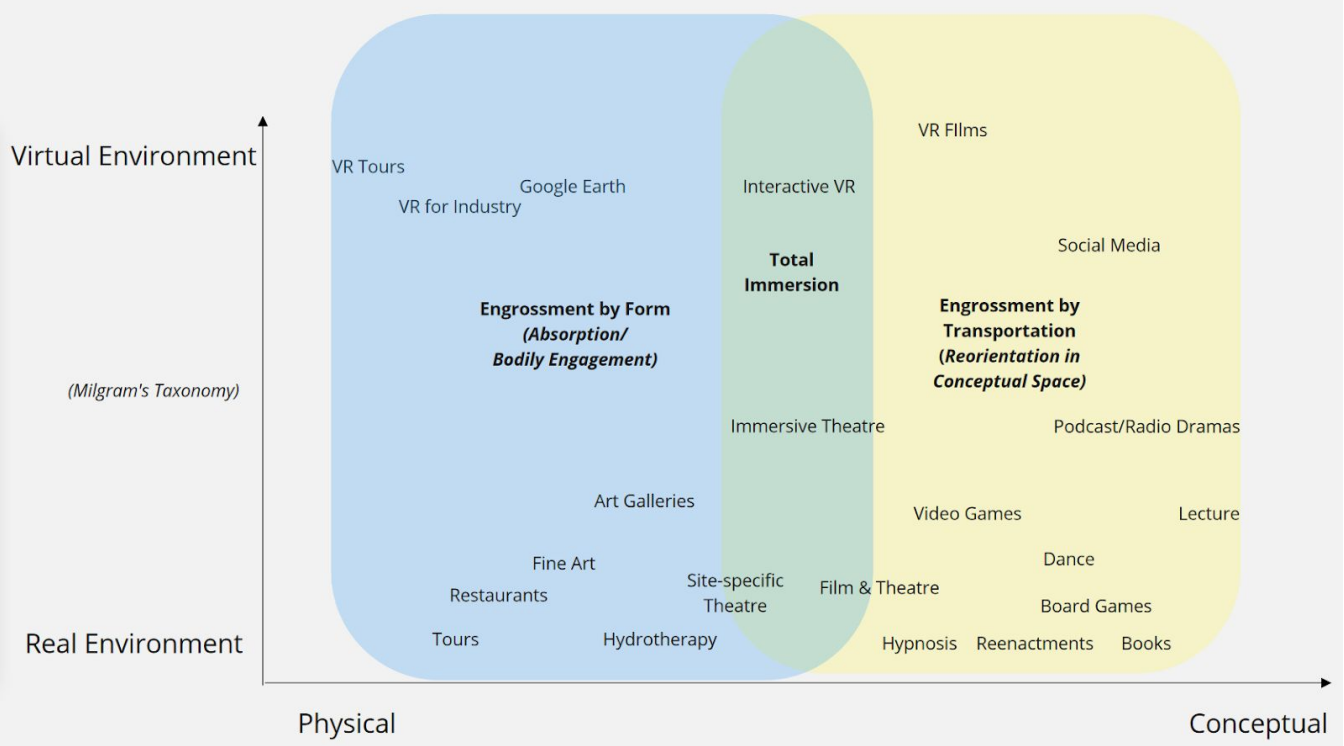

Figure 2: Engrossing experiences by means of engrossment

audience" [9]. He uses musical jams and parties as examples, and particularly highlights role-playing games as works of immediate art. He describes, citing Hakim Bey, all experiences as being mediated to some degree, with immediate art being characterised by engaging "immediately (at once) & immediately (without mediation)." The sentiment of a unique experience generated by each participant is echoed by theatre theorist Josephine Machon in her explanation of what it means to be *praesent*: "The live performance of the work is fleeting and only of the moment, never to be repeated in any form, yet it also lasts in the receiver's embodied memory of the event, a pleasurable and/or disquieting impression that remains." [10]

This notion of *praesence* — translated by Machon as "being at hand" [Ibid] — is a cornerstone of immersive practice. A participant should be undergoing a unique experience defined largely by their own experience of it. Gordon Calleja in his *Player Involvement Model* describes a player's *involvement* in a video game experience — that is, the degree to which a player simultaneously experiences themselves as being present in a video game's virtual space as well as present in their real physical location — as being based on a player's cognitive effort. An experience that is ergodic (an experience that will generate a different result based on a different input) is defined by the cognitive effort placed into it by a player, which includes engaged inactivity (such as passively considering the experience). A non-ergodic experience, such as a film that will not change regardless of the cognitive effort invested in it, cannot be immersive as it does not engender *praesence*.

Calleja's involvement can be thought of as being synonymous with *embodiment*, a core tenet of immersion theory in other disciplines. Embodiment is described by David Crouch as "a means of grasping the world and making sense of what it feels like… in a process of 'making sense'" [11]. According to Adriana de Souze e Silva embodiment is required for experiential learning. Machon declares that "immersive practice is, and must be, and embodied event" [12].

Total immersion [13] is Machon's term for the psychological state characterised by the experience of *engrossment by form* and *engrossment by transportation* simultaneously. Engrossment by form (also called *immersion as absorption* by Machon, and described by her as "bodily engagement") occurs when a participant is engaged in a task that requires focus to the point where they are engrossed/absorbed and lose track of their embodiment in their physical space. An example of engrossment by form is the player of a crossword losing track of time while they complete the puzzle. Engrossment by transportation (also described by Machon as "reorientation in conceptual space") involves the participant being reoriented in another place through the act of imagining, such as what might occur when an attendee at the Wizarding World of Harry Potter begins to believe that they are in the storyworld of the fiction rather

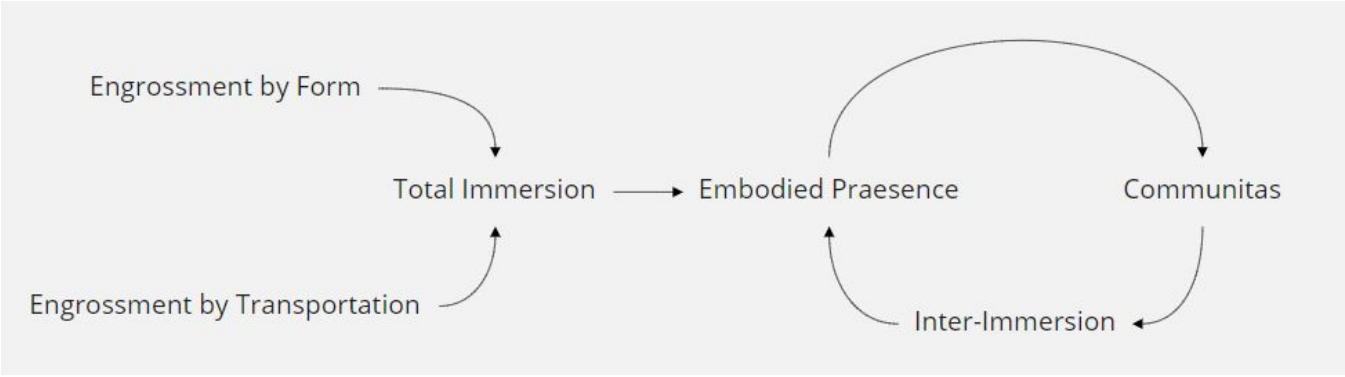

Figure 3: *Embodied praesence* sustained through *communitas*

than a guest at a theme park. When an experience brings the participant both forms of engrossment simultaneously, *total immersion* occurs.

In order to effectively induce a truly immersive experience in a participant, an experience needs to be a work of immediate art that exhibits *praesence* and invites participants to be embodied inside it. The participant must accept this invitation, and then take a step beyond Machon's total immersion into a state that escapes easy definition. This is the phenomenon at the heart of the truly immersive experience, and it is the thing that most defies description.

This phenomenon is, perhaps, why immersion has been difficult to pin down as having any single clear definition. Dwight Conquergood, writing about performance studies, suggests that there are "nonserious ways of knowing that dominant culture neglects, excludes, represses, or simply fails to recognize" [14]. He quotes Kenneth Burke:

> The [written] record is usually but a fragment of the expression (as the written word omits all telltale record of gesture and tonality; and not only may our "literacy" keep us from missing the omissions, it may blunt us to the appreciation of tone and gesture, so that even when we witness the full expression, we note only those aspects of it that can be written down). [15]

At the core of a truly immersive experience is the sublime and uncanny experience of being transported, body and soul, into a alternate-reality space where the rules of the experience overrule those of real life; where the participant can willingly forget for a time that they are participating in a fiction, and believe instead that the rules of the experience are the rules of reality. This is a state of being that I refer to as *embodied praesence*. The actual mechanisms, physical and psychological, experienced by a participant in a truly immersive experience are difficult to capture through literature, and the research required to do so is outside the scope of this paper.

My term — *embodied praesence* — can be used synonymously with Machon's total immersion, but it is shorthand not only for the simultaneous applications of engrossment by form, transportation, embodied experience, and Machon's *praesence*, but also for the ineffable experience of willingly putting aside the rules of reality to participate in the rules of an alternate one while simultaneously choosing to forget that one has done so. To induce the experience of *embodied praesence* in participants should be the goal of the designer of any so-called immersive piece, as it is this sublime and uncanny experience that cannot be replicated in any non-ergodic medium.

A concept highlighted by Machon as necessary to immersion is *communitas*, summarized as the ability of immersive practice to "encourage individuals to invest in each other as much as the work" [16]. Immersion occurs because a story-world "feels inhabitable - as detailed as the real world and shared with others as a sort of imaginary habitus" [17] according to Abby Waysdorf and Sijn Reijnders, theme park scholars. Mike Pohjola, in examining communities of role-players, identifies a state he calls *inter-immersion*:

> As the player reaches the inter-immersive state, she starts to forget she is just pretending to believe it is all real. She acts as if she really believes the diegesis, and when everybody else does the same and reacts to each other's beliefs (instead of the pretensions), they forget they are just pretending and start to really believe. [18]

A sense of *communitas*, then, enhances the phenomenon of *embodied praesence*. Engagement with the experience becomes a form of performance held for the self as well as the other participants, who support one another and enhance the experience with a shared engrossment that reinforces the engrossment of others. The notion that the rules of the world ought to be set aside for the duration of the experience no longer need be held by an individual; it becomes a notion held and supported by a community. It behooves a designer of an immersive experience to induce a sense of communitas among participants, whose shared experience of *embodied praesence* may lead to inter-immersion among other participants and ultimately a stronger sense of immersion.

An immersive experience can be generated and sustained in an ergodic medium by invoking the experiences of engrossment by form and engrossment by transportation in a participant through engagement with an

activity requiring embodiment and a narrative or setting allowing for transportation to occur (see Fig 3). Once total immersion is reached, the sublime state of *embodied praesence* can be sustained through an experience that engenders a sense of communitas among the participants, whose shared experience allows for inter-immersion that strengthens the experience of *embodied praesence*.

Conclusion

A truly immersive experience is one that engenders sublime transportation. It can be generated by placing the participant in an experience that combines engrossment by form and engrossment by transportation, and then supported by a shared communal experience that allows multiple participants to strengthen one another's experiences through inter-immersion. "Immerse", in its common usage as synonymous with "absorb" or "engross", should be used sparingly during discourse in the discipline of immersive design. To avoid confusion and further muddying of the term, I propose *engrossment by form* and *engrossment by transportation* to refer to the mechanisms by which an experience engrosses its participant, *total immersion* to refer to both forms of engrossment applied simultaneously, and *embodied praesence* to refer to the sublime experience of transcending the rules of reality to exist among new ones for the duration of the experience.

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I would like to express my very great appreciation to Cindy Poremba who offered invaluable guidance and humoured me as I researched something so frivolous as immersion.

I would also like to thank Judith Doyle and Haru Hyunkyung Ji whose advice and encouragement I could not have done without.

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Author Biography

Nick Alexander is a director, writer, and mixed reality interaction designer specializing in uncanny immersive experiences. A graduate of the Ontario College of Art and Design University (OCADU)’s Digital Futures graduate program and York University's School of the Arts, Media, Performance and Design, Nick has created escape games at Casa Loma, immersive theatre as co-founder of Truesight Collective, and mixed reality performance at the National Film Board of Canada. Their practice situates audience members as active participants inside immersive fictions and invites them to play in altered realities. By inhabiting fictional worlds we might, perhaps, come to better understand the real one. Their website is nickalexander.ca.

A Little Better: Emotions in the age of cryptocurrency

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Abstract

A little better is a research art project that looks at cryptocurrency instant messaging platforms through the prism of the International Relations "aesthetic turn", for which by looking at emotions and sensibility an additional analytical insight is given to world politics.

Keywords

Cryptocurrency, Emotions, Aesthetic Turn, International Relations.

Introduction

2018 was the year cryptocurrency went from the fringes of culture to the mainstream. The conversation about cryptocurrencies economic value, digital protocols and decentralized ledgers took the world by assault. Even major financial institutions jumped in, assessing how to adopt such technologies. There was also great speculation, volatility, even plain fraud. *A little better* is a video artwork based in these narratives as they were communicated in dozens of instant messaging platforms channels and groups, which I followed for over a year. I decided to create an artwork focused on the emotions and feelings nourishing and interconnecting micro communities around the globe. I draw from the International Relations "aesthetic turn" to look at these narratives, both visual and textual, to better reflect on how such feelings and emotions can create an accurate reflection of the current world economy exuberance and irrationality.

A Little Better

The appearance of Bitcoin is widely understood as a byproduct of the 2009 Financial Global Crisis (FGC). For this project, I decided to track back my research to 1971, year in which Richard Nixon announced the end of the gold standard, terminating the convertibility of dollars into gold, which was the foundation of the postwar Bretton Woods system. Since then, it can be argued that the value of currencies is entrusted solely to promises made by state authorities and central banks since they lack any tangible reserves.

Weeks before Nixon terminated the gold standard, he was secretly recorded talking about the economy. In a moment of brutal honesty or perhaps self-delusion he admitted: "*We are just running the chaos a little better*". Almost half a century later, delusional thinking and hope may fuel the rise of cryptocurrencies. It makes sense to ask if it's sustainable, even rational. Perhaps not, but one could argue that as of today neither is world economy.

Taking the former as premise, the most pertinent locus to discuss these topics were instant messaging platforms, which became by default the communication channel for cryptotraders, protocol developers and others. For several months (precisely in the period which saw the cryptocurrency market capitalization rose from USD$200 to $700 billion: Azaola, Rodrigo*: A little better: A conversation with Bob Henderson,* 2018), I followed different groups and chats, actively participating in their discussions and generating debates on specific topics such as trust, value, risk, the meaning of money, the role of central banks, national sovereignty, etc.

At the same time, I particularly followed the visual language created for said discussions: memes, GIFs and videos, all of which carried a particular narrative pertinent to these discussions, permeated with exuberance, irrationality, speculation and greed, but also with true hopes of better and more open and transparent financial future.

There was a powerful notion beneath all these conversations: world economy had forgotten an entire generation, and they only could look at the future with despair. I gathered textual and visual material, and it was clear to me that traders and developers, as they attempted to consolidate financial digital protocols legitimized by cryptographic algorithms, were also establishing value resistant to the oversight of any sovereign state or central banks. Even within such apparent irrationality, there was a clear-cut aim, one that given the exclusionary nature and disparity of world economy, wasn't at all out of place.

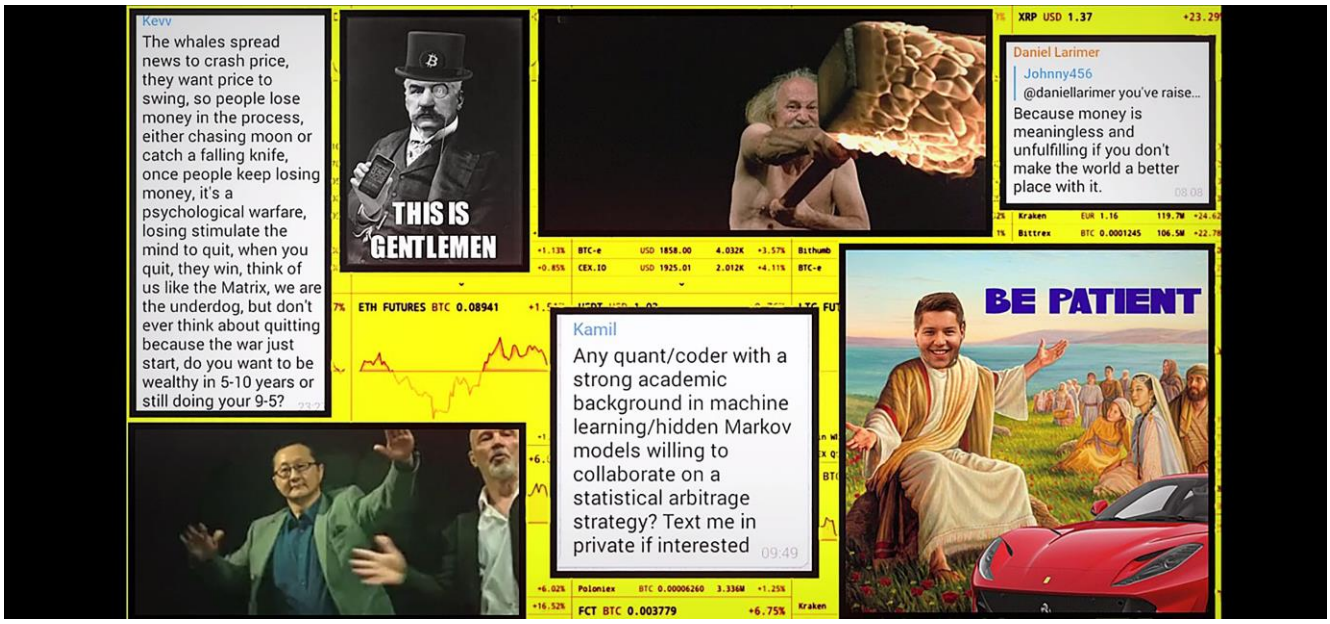

Figure 1. *A Little Better* (2018). Still. © Rodrigo Azaola.

The Feel Factor

The emergence of poststructuralist critical geopolitics allowed researchers, and later artists, to leave behind the two-sided dimensions of classical/neo-classical geopolitics, in which the sole actor and focus was the state, to look and examine a rather complex and abundant set of political and aesthetical actors.

This theoretical departure point was later enriched by two subsequent trends, that of Rancière proposing a creative fusion of aesthetics, ethics and politics, therefore suggesting a critical art, able to reconfigure the landscape of the visible (Rancière 2010, 2013); and that of the "aesthetic turn" within International Relations theory, for which sensibility and imagination can offer further insight for a better analysis of world politics.

Particularly, Bleiker formulated that for several decades International Relations neglected emotions and feelings, and proposed then to integrate them as unavoidable sources of analysis (Bleiker 2001, 2008). Once both Rancière and Bleiker recognized aesthetics as a tool to rethink global predicaments, demonstrating that artistic practices are relevant to the study of the geopolitics, new research agendas multiplied and traced new paths of inquiry. This is indeed the crossroads at which *A little Better* finds itself. How emotions and feelings take part in the world economy? There is a constant narrative stretching from the end of the gold standard to the 2009 FGC and the appearance of Bitcoin and beyond: economy is irrational, and profoundly emotional I'd add. Indeed, markets and finances are deeply affected by assumptions, beliefs, hopes and fears. In developer parlance, irrationality is not a bug, but a unique feature of world economy. My goal then was summarizing these emotions in an artwork: over 500 hundred screenshots, JPEGs, GIFs and videos, capturing the feelings and hopes most frequently found in chat platforms were reunited in the video installation *A Little Better,* exhibited in AirSpace Sydney, in January 2018 (Figures 1 and 2). As complement to the show, I published an extract of several conversations I had with Robert Henderson, who in 2008, as a derivatives expert in Wall Street, saw his oil hedging strategy of 200 million US dollars wiped out in one month. After that, Robert wrote about the financial crisis and the "illusion of control", a very pertinent concept to my artwork that pervades the world of finance, as it opposes subjective expectancies of success with objective probabilities.

The rise of Blockchain

Enough has been written about the beginning of blockchain technology and its particular technicalities and capabilities (Narayanan, 2016; Lee 2017). For the purpose of this paper, I'm interested in what happened in 2018, year which saw the launch, consolidation and demise of hundreds of different projects within a context of major price speculation. Some of those projects tried to tackle major concerns around the three main aspects of blockchain-based ledger technology protocols: decentralization, scalability and security. Others were focused in privacy, while others more attempted to reduce the gap between this sort of technology and practical use daily life cases and applications, such as market places, secure communications, crowdfunding and even games.

The development of projects, and the not so uncommon incongruent valuation, went hand in hand with increasing media attention, which in turn made more people not only aware of digital protocols but also made them active participants as traders, developers, content writers, researchers, etc. Communities arose and consolidated around different projects throughout the world, mainly in Europe, North America and Asia.

Some discussions, but certainly not all, were directed

towards technological efforts to avoid and surpass government surveillance and censorship and state-controlled monetary, financial and taxation systems (Bashir, 2016; Bouri, 2018). Those discussions implied as well the sorrowful conditions of the post- global financial crisis state of the world economy. Cryptocurrency opened a window for those who rightly felt left behind by traditional banking and the precariousness of world economy.

But even for those inclined to reject or avoid such underlying assumptions, it was evident that the current financial system was far from being rational, and that its flaws could be solved through more efficient and trustworthy systems.

Interestingly enough, even those who participated in the cryptocurrency community "for the money" were inadvertently advocating a major shift in world economics. The mere ownership of digital protocols meant the politicization of money (Milutinović, 2018), and with it, a clear challenge to the traditional, analogue and centralized tenants of how and who decides what is valuable for society. At the same cryptocommunities were enthusiast about new developments, major international organizations (UN, G20, OECD, etc.) and financial institutions (World Bank, Financial Stability Board, Basel Committee on Banking Supervision among others) were also diligently researching how to curve and, at the same time, adopt such technologies.

The value on the eye of the beholder

One of the most interesting byproducts of the explosive rise of digital protocols has been the paramount interest of its participants in the inner workings of economy. The role of central banks, fiscal and monetary policies, schools of economic thought, wealth distribution and inequality, the intervention of governments in markets and else were notions incisively questioned.

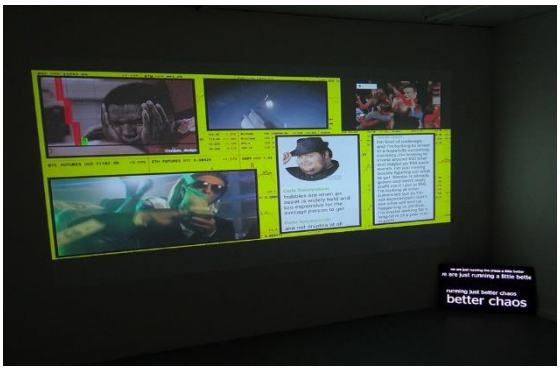

Figure 2. *A Little Better* (2018). Installation view at AirSpace Sydney. © Rodrigo Azaola.

Unsurprisingly, all those interrogations lead to the bedrock of economic science: what is the meaning of money. Beyond its functional use as medium of exchange, unit of account and store of value, money, and later cryptocurrencies, has a lot of different uses and meanings as it operates within the fluidity of social contracts. But rationality and money more than often are incompatible, as it's easy to witness in a casino, in an exchange floor trade or during an economic crisis. People gives to money different values and attach to it different needs and wants (Bijleveld, 2014). In sum, the value and use of money is profoundly emotional. Even in our hyper efficient algorithm-fueled global economy, the "market sentiment" it's as important as to be considered behind the econometrics of the Chicago Board Options Exchange Volatility Index, also known as the "fear index".

Conclusion

Perhaps overlooked, beyond the obvious motivation of quick monetary gains and speculation, is the fact that the analysis of emotions and feelings of cryptocommunities can shed light on a very significant shift: one that directly challenges the political and economic order. The "aesthetic turn", by widening the scope of analysis within International Relations theory, takes a careful look at sensibility and the rational of emotions and feelings in order to provide a further insight into world politics. By taking a careful look at the visual and textual narratives created by cryptocommunities, several trends appear that because are not fully or scholarly articulated, would seem at first irrelevant. But once looked at through the lens of the "aesthetic turn", some very interesting concepts appear by which a reconfiguration of the visible landscape is possible. *A little better* takes a snapshot of a very colorful and imaginative visual production, but within it, it's also necessary to pay attention to the underlying emotions fueled by the fact that, for the first time in history, a young generation is capable of create, own and transfer wealth through stateless/censorless digital protocols. This is a tremendous shift, one that shakes the very core of traditional economy and certainly the current monopoly of central banks and governments to create and maintain wealth. Simultaneously, other emotions less positive, such as despair and hopelessness, also are manifest and ascribable to the chaotic rise of new technologies in an already delusional financial and economic context. Given the 2009 FGC and subsequent arrangements, and recently with the irruption of digital protocols, is very much still valid to reflect, as once Richard Nixon did, if "*we are just running the chaos a little better*".

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Beyond the turn and towards the event: analyzing the curatorial as a material-discursive practice

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Abstract

This paper discusses the processual ontological transitions of the curatorial after Paul O'Neil's "curatorial turn". Studying the curatorial from its discursive conception to a new materialist approach, it explores what can change when the curatorial is considered both a discourse and a practice, with no hierarchical distinctions or separations between them. To envisage the curatorial as a material-discursive practice is to admit that matter and meaning emerge together and one does not exist in the same way in the absence of the other. In this epistemology, the question changes from what the curatorial *is* to what the curatorial *does*, considering it as a mode of production of different kinds of knowledges.

Keywords

Curatorial, material-discursive, sentience, agency, media art, curating, material turn, curatorial turn.

Introduction

In his famous text *The Curatorial Turn: From Practice to Discourse* [5], a book chapter published in 2007 that analyses a big and rather polemic ontological shift on the role of the art curator, Paul O'Neil identified signs of a transition which had been happening since the beginning of the 90's. For him – and for many others like Maxence Alcade [16], Éric Troncy [18], Natalie Heinich [17] Richard Habinowitz [12] and Steven Lubar [13] – the activity of curating is more than selecting artworks, building connexions between them, or looking after a collection. The most important function of a curator, they all seem to agree, is to elaborate a cohesive discourse, and in doing so become the author of a larger artwork, which would most of the times take the shape of an art exhibition.

For centuries now, the humanities have been focusing on creating and analysing discourses in order to produce knowledge. This may be the reason why O'Neil seems so fervent in his wish to elevate the curatorial practice to the "level" of discourse, to which it had not yet been consensually promoted. Paraphrasing one of the Foucauldian definitions of discourse as "the general domain of all statements", [6] O'Neil fails to build the bridge Foucault has cherished between matter and discourse, but succeeds on focusing on their hylomorphic differences:

> Curating-specific discourse engenders a requisite level of prestige, necessitated by the dynamics of contemporary curating. Practice alone does not produce and support such esteem, rather distinct moments of practice translate into a hierarchical 'common discourse' of curating as it is understood through its discursive formations. [7]

One of the several consequences of the favour of discourse over practice in contemporary curatorial theory is the arising conception of the curator as a decoder, the translator who brings meaning to ungraspable and complex artworks. If the curator is indeed an author and as an author she is supposed to elaborate ampler discourses from a unique combination of artworks taking part in a curatorial event, then her central goal would be to engender meaning. As Beatrice von Bismarck would say, "the exhibition is an ephemeral argument within a larger discussion." [8]

If we followed this logic, we would envisage the production of knowledge within curatorial work as coming predominantly from the construction of discourses capable of being sufficiently understood by a specific audience. The materialities, or all of the techniques and actual events happening throughout the duration of the larger curatorial event, would play no significant part in it. The way the discourse comes to be, its specificities, the detailed materialities that constitute it and allow it to exist, wouldn't actually matter. They are, after all, only practices, not as ontologically important as discourses. Within this framework, knowledge can only emerge from the results of a curatorial event, its achievements and failures, contributions and complexifications to the understanding of the bigger picture the exhibition is supposed to depict. Everything that happens in between – all that is immanent to the event itself – does not get to be taken into consideration.

In his work *Production of Presence: What Meaning Cannot Convey* [1], Hans U. Gumbrecht reflects on the historical hierarchical privilege of comprehension when compared to perception. On his conceptualization of the aesthetic experience, he claims that there should be a balance between "meaning effects" and "presence effects", the latter being identified as everything that "exclusively appeal to the senses" [2]. Hence, Gumbrecht considered that enabling this kind of experience – which is one of the many potential outcomes of the curatorial gesture – does not equal to helping the public find out the possible discursive significations that

would hide behind the material artworks[1]. It has just as much to do with understanding as it has to do with feeling. With that idea in mind, he suggests the following provocation:

> Whenever conveying or exemplifying an ethical message is supposed to be the main function of a work of art, we need to ask – and indeed the question cannot be eliminated – whether it would not be more efficient to articulate that same ethical message in rather straightforward and explicit concepts and forms." [3]

Adapting this reflection to the curatorial work, we should acknowledge that if the role of the curator was solely to attribute meaning or to create cohesive discourses, she wouldn't need to elaborate or think about original and innovative curatorial gestures and strategies. There would be no room for the whole domain of curatorial studies, since curatorial work would not be capable of developing knowledge or engendering artfulness. We could then ask ourselves: where is the work within the curatorial? Is it only in what we can access through the exhibition? Are all practices that constitute it not important for accessing and creating knowledge?

What the curatorial does

Similarly to what happened to the notion of curatorial, the definition of the word "sentience" has also shifted throughout time – but in this case, more cohesively with current post-structuralist views. As well described on this call for projects, in the 1600's, its Latin origin *sentientem* meant "capable of feeling". On the 1800's though, according to the Online Etymology Dictionary [19], the word's most common use became closer to that of "consciousness", or of "being conscious of something". If we opt to focus on the process of correspondence between terms, this demonstrates an important approximation, or a relative reduction, of the classical barrier between interpretation and feeling. Every act of interpretation would require, in this scenario, an act of conscient reflection, which by its turn could not be parted from the feeling emerging through it.

In the very conceptual transition of the word "sentience" could reside the key to detaching the curatorial work from the strictly discursive duty it has been charged with since O'Neil's "curatorial turn". In this presentation, I will talk about what would change if we envisaged the curatorial as the drawing out and bringing forth of the material within the discursive, and of the discursive within the material, as two complementary sides of the same construct.

In the article *Posthumanist Performativity: Toward an Understanding of How Matter Comes to Matter*, published in 2003 and now an important canon of the new materialisms, Karen Barad also starts from Foucault to explain why we should no longer use only language, representation and discourse to analyse the world. When defending the need to include the material in this equation, she says:

> Foucault's analytic of power links discursive practices to the materiality of the body. However, his account is constrained by several important factors that severely limit the potential of his analysis and Butler's performative elaboration, thereby forestalling an understanding of *precisely how discursive practices produce material bodies*. [14] (my underline).

The "how" is a fundamental part of the curatorial. It is only through a series of curatorial choices that a curatorial event – which we could associate here to what Barad calls a "material body" – can take place. This "how" includes a string of practices that have recently been identified as belonging to the realm of "curating". According to Beatrice von Bismarck [9], curating involves a set of practices and activities that allow the curatorial event to take place. It could include, for instance, invitations to artists and calls for projects; studio visits; designing the space; setting up the exhibition; producing curatorial statements and pedagogical elements. But von Bismarck is clear when she states that "these activities feed into the curatorial; they are part of it". [10]

The techniques of curating are usually centered on the figure of the curator and on the construction of the curatorial event. They set the tone of the event, delimiting it and circumscribing it in a particular framework. The curatorial, on the other hand, is focused on the process, and specifically on the unpredictable phenomena inside the event, which also has its own set of agencies. As Irit Rogoff states, "in the curatorial, the emphasis is on the trajectory of an ongoing, active work, not an isolated end product but a blip along the line of an ongoing project" [11]. Therefore, the curatorial emerges from within curating, in procedures, gaps and momentums performed by curatorial practices and their actors, human and other-than-human. It is only through the analysis of these practices – which are at the same time discursive and material – that we can access the curatorial.

The material phenomena that constitute an exhibition or any other curatorial event is also discursive because they frame what is shown and said within them. Borrowing Barad's concept of "intra-action", we can envisage a relational ontology where not only the material artworks and artifices define the exhibition, but also the exhibition defines the artworks and everything else that is a part of it. For Barad, "reality is not composed of things-in-themselves or things-behind-phenomena but 'things'-in-phenomena" [15]. Hence, reality can only be grasped, observed and experienced from within a specific event. As a material-discursive practice, where matter and meaning emerge together and never in the absence of the other, the curatorial englobes not only the processual practices leading up to the exhibition, but also the artists, the artworks, the audience, as well as the gallery space, its scenery, its location, so far so on. All of that matters, and knowledge can emerge from the specific intra-actions happening at any point along their line.

[1] Regarding a potential argument that some artworks can be immaterial, we align with the work of Grosz (2011) and Robichaud and Cooren (2013), who think that materialities are a question of degree, some things being more material than others, but that everything becomes materialized in a certain way – even thoughts, dreams, or ideas.

In Barad's account, discursive practices are material remodellings of the world in its becoming. This is what the curatorial does: it rethinks, re-enacts, reconfigures and reestablishes the world through a series of practices. It is only by taking the practices under consideration that we can access the discourse, for practices do produce discourses and vice-versa. These practices include emotions, feelings, mistakes, misconceptions, and many other uncontrollable, irregular and erratic events performed by different entities. The curatorial as a material-discursive practice brings sentience to its core as it does not isolate or hierarchize discourse. Discourse does not prior practice, neither does it determine it nor is it more important than it. On the contrary, their relation allows for the existence of each other.

Conclusion

We could conclude that understanding the curatorial as a performant, sentient practice disturbs what is usually expected of it. The curatorial transforms, makes and creates; it changes artworks, spaces and people; it brings out of the shadow elements that wouldn't normally be on stage; it makes them pro
protagonists. The curatorial is not necessarily a storytelling, an effort of representation or an elaborate apparatus to support sense-making. The curatorial does things, and in doing them, it "generates new forms of experience; it tremulously stages an encounter for disparate practices, giving them a conduit for collective expression… it generates forms of knowledge that are extralinguistic". [4] Curation becomes creation not by establishing a competition with the artists or artworks exhibited, or by stating that the exhibition is a bigger work than the works themselves. It does so by putting all of those elements in relation and waiting to see what happens.

That is the main power of the curatorial: it carefully enables all kinds of things to emerge out of submersion, and from that moment on, they become something else.

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Sleeping Eyes: VR narcolepsy storytelling through the duality of presence

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Abstract

Sleeping Eyes is an interactive cinematic virtual reality (VR) piece that tells the story of a narcoleptic Korean artist, Sungeun Lee. VR was used as a medium to represent the symptoms of narcolepsy and provoke fundamental reflections on the boundary between dreams and reality. In VR, even if we are immersed in the virtual world, we simultaneously exist in the physical world. This duality of presence and embodiment resonates with Sungeun's narcoleptic states. We investigated these ontological similarities as a catalyst to provoke the audience's self-reflection about Sungeun's situation. Non-linear narrative and gamification techniques were applied to allow the audience actively explore the stories. Additionally, a heart-rate sensor was used to visualize the audience's stress states, implicitly making them aware of their own feelings about the artwork.

Keywords

Virtual Reality; presence, embodiment; disembodiment; reflexivity, narcolepsy; non-linear narrative

Introduction

Virtual reality (VR) has been used a tool to represent the life situations of people with mental issues. For example, there are cinematic VR works that present stories about chronic fatigue syndrome (e.g. *Unrest VR*, Jennifer Brea, 2017) and bipolar disorder (e.g. *Manic VR*, Kalina Bertin, 2019). There have been also attempts to visualize the inner states of dementia (e.g. *Virtual Dementia Experience*, Dementia Australia, 2013) and express bipolar disorder patients' embodied movements using VR [1]. However, there is a lack of exploration of issues related to narcolepsy.

In this artwork, we used VR to poetically express the inner experiences of South Korean artist, Sungeun Lee. Lee suffers from narcolepsy, a neurological disorder that makes people fall asleep uncontrollably. Narcolepsy is simply understood as uncontrollable sleepiness, even though it entails complex and confusing symptoms and experiences such as attention deficiency, unconscious automatic behaviours and blurred recognition between dreams and reality [2]. Furthermore, narcoleptic patients' social and cultural trauma shape other issues surrounding self-image, identity and psychological suppression.

VR can be an effective tool for investigating and expressing various layers of narcoleptic experiences. When Sungeun describes his narcoleptic states, he often uses the metaphor of quantum mechanical superposed states. Fundamentally, the nature of VR is that it provokes a duality of presence and embodiment, which resonates with the metaphor of quantum states from Physics. Even if we embody virtual bodies in VR, our physical bodies still exist in the physical world. This simultaneous existence can create ontological tensions and confusion which can be used as a catalyst to provoke the audience's embodied self-reflection about narcolepsy and Sungeun's states.

VR is often called an *empathy machine* because it creates a sense of presence and embodiment as if we are experiencing someone else's life situations [3]. However, immersive engagement without critical or reflexive awareness has the potential danger of objectifying others' pain or emotionally identifying with others' difficult situations without critically thinking about the social and historical issues centred around them [4] [5]. Moreover, in phenomenological perspectives, the self, others and the world belong together in the embodied experiences, and intersubjective relationships are constantly changing and shifting. Thus, the self is always interconnected with the other but can't encounter the concrete other; the other is inherently transcendental [6] [7]. The potential of VR in understanding the other might not come from inducing simple identification or immersive engagement. Instead, VR could be used so that audiences can explore unfamiliar and different sensory experiences and help them extend their perceptions and boundaries with embodied reflection [8].

The practice-based research described in this paper aims to elicit self- and social reflection about issues and symptoms surrounding narcolepsy rather than forcing empathic feelings or engagement. We represented Sungeun's internalized traumatic experiences in high school and the army by making the audience embody Sungeun's first-person point of view. Gamification techniques were applied to add non-linear, exploratory elements to the story [9]. We used biometric feedback – a wearable heart-rate sensor – to apply the audience's stress level as a visual change, which causes audience members to reflect on their own phenomenological responses to Sungeun's states [10]. By using the embodied and ontological characteristics of VR and biofeedback sen-

sors, we permit the audience to actively and physically reflect on their own states and fill in the gaps between Sungeun's situation and their own states.

Sleeping Eyes

Background

Narcolepsy is not well known in South Korean society. Even though the mass media has recently given more attention to sleeping disorders, they tend to treat it at only the surface level. Based on a more critical perspective, the first author directed the work with Sungeun. A one-year ethnographic study was part of the collaborative process of story development [11]. The story was based on numerous conversations and interviews with Sungeun. The characters and environments were also inspired by Sungeun's drawings about his dream world.

The work represents Sungeun's dreams about when he was in high school and in the army. He did not realize that he was narcoleptic until he joined the military for two years of service, as almost all South Koreans are required to do. Especially in high school and in the army, he experienced a great deal of physical and mental social violence and oppression. People perceived him as lazy, rude and distracted, so he developed a distorted self-image. His memories of violence are often represented in his dreams, and he still experiences considerable fear in these dreams. As a narcoleptic patient, he sleeps and dreams a lot uncontrollably, so he becomes confused about the boundaries between dreams and reality. This means he still "lives" in his confused, unconscious worlds of high school and the army.

Based on his story, we created two main environments, a high school and an army watch tower, then confused audiences about which is reality and which is a dream. The quantum mechanical metaphor was used to describe Sungeun's existential confusion. Both in school and in the watch tower, a teacher and a superior threaten him because he is sleeping, which reveals objectified and ignorant perceptions about narcolepsy.

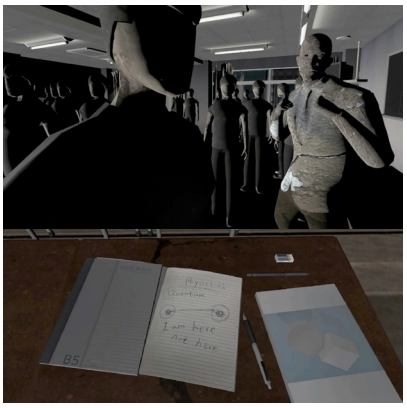

Figure 1. Still from *Sleeping Eyes.* The perspective is from Sungeun.

Story and Non-Linearity

We made the story non-linear to create a tension between certainty and uncertainty, inviting participants to be exploratory, provoking active engagement, as well as embodied reflection [9, 12]. The basic synopsis is as follows.

The audience enters a virtual room that contains a desk with a few objects that identify Sungeun. There is a virtual hand, and Sungeun's narration is triggered when audience members grab certain objects, such as medicine, photos of a watch tower and school, and physics notes. Once the audience hears all the informative narrations about Sungeun, the scene changes to a high school. A teacher is giving a lesson about quantum mechanics and Schrödinger's cat and asks the students to participate in an experiment involving two doors. As Sungeun, audience members must enter one of the rooms, but only when the other students are not watching. Otherwise, the teacher becomes violent, and the door is blocked. One door leads to the school, but the other is connected to the army watchtower. In the watchtower, Sungeun's body appears dressed as a soldier. An army superior threatens him because he fell asleep. He becomes confused as to whether school or the army is a dream. Suddenly, he falls from the watchtower, but he arrives at the school and becomes one of students who was watching him. An alarm rings, and he wakes up in a hospital bed. There are two potential endings. In one, Sungeun is wearing a school uniform, but his army superior is walking into the hospital. In the other, he is instead wearing a military uniform, but his teacher is walking into the hospital. These two endings are randomly generated.

The Schrödinger's cat experiment, as well as the probabilistic storyline, were included in order to poetically represent the quantum mechanical nature of reality as Sungeun experiences it. Sungeun describes his world as undetermined, constantly shifting between states of consciousness with little control. Under the Copenhagen interpretation of quantum mechanics, it is postulated that observation (or measurement) of a quantum mechanical object causes its probability wave function to collapse into a single value. We use the concept of wave function collapse as a metaphor to illustrate how Sungeun is moved into various states when others draw attention to him, or when he draws attention to himself. The idea of quantum superposition draws parallels with the duality of embodiment and disembodiment in virtual and physical worlds. We actively use this tension between virtual and physical embodiment to portray Sungeun's illusory experiences of reality. Physicist Nina Rajcic advised on the story design in order to accurately employ quantum mechanics concepts as metaphor.

In addition, the interactive, game-like narrative makes audience members physically explore the virtual stories about Sungeun. In the introductory scene, instead of simply delivering linear narration, we allow the audience to explore the

fragments of information embodied in physical objects, which made them focus more on Sungeun's voice and fill in the gaps between separated informative narrations.

For the Schrödinger's cat game, audience members must avoid the lasers that come from the students' eyes. This creates a sense of playfulness and suspense that further immerses them in the virtual story.

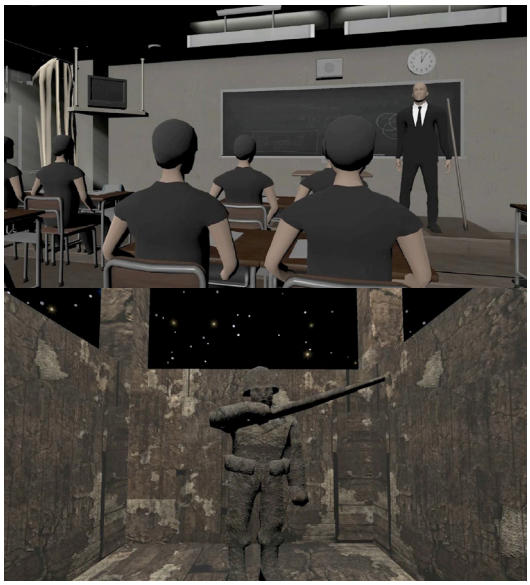

Figure 2. Example images that used a game-like aesthetic in a school environment (top) and rocky and cracked aesthetics in an army watchtower (bottom)

Visual Aesthetics and Heart Rate

We built the story's sets as 3-D models, designed for a real-time environment. We used the game-like aesthetics to create an ordinary, minimal and unified world that poetically reflected a computer's simulation of life that resonated with the concepts of matrices and dreams. When violence occurs, the visual textures change to rough, rocky, peeled or cracked materials, representing violence and vulnerability (see Figure 2). We tried to use these visual changes to reveal the tensions between the normal and the abnormal, between suppression and violence, dreams and reality. We also created identical students without faces, representing collective and oppressed identities.

Biometric feedback is used to represent the phenomenological aspects of Sungeun's everyday experience to the audience. A MIO Alpha Bluetooth heart rate sensor was connected to a custom Windows application which transmits the processed heart rate values to the Unity game engine via a local socket. This system allows us to measure heart rate (HR), and furthermore compute heart rate variability (HRV). These values are then mapped to the work's visual aesthetics in real-time [10].

Heart rate is used to drive elements such as the lighting, which pulses in synchronicity with the audience's heartbeats. We use HRV as a proxy for the participant's stress when immersed in the work; high HRV is understood to correspond low stress, whereas low HRV corresponds to high stress [13]. The audience's HRV measurement influences the visual aesthetics (such as textures and colour of surfaces) in an effort to implicitly relay back to them their affective state. We use these measurements to visually represent Sungeun's varied states of consciousness, such as being sleepy or alert (see Figure 3). More importantly, we aim to create an affective feedback loop, which adds another mode of interaction with the story, as well enhancing the connection that the audience feels towards Sungeun. Furthermore, we want to foster emotional reflection in the audience, provoking viewers to reflect upon their own visceral responses to their embodying of Sungeun.

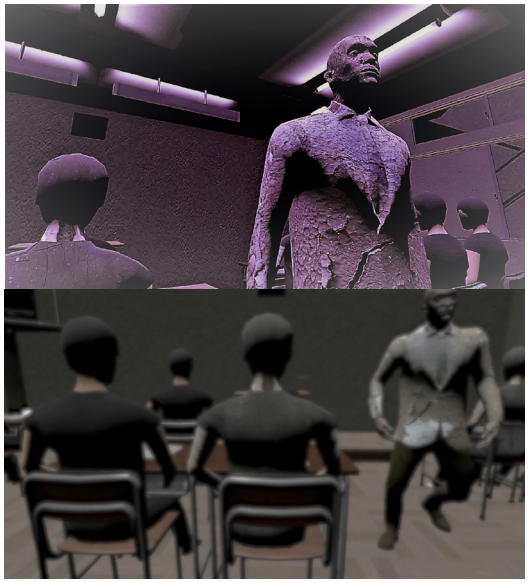

Figure 3. Example images driven by audience HRV (top) and HR data (bottom)

Re-embodiment and Reflexivity

We designed various virtual bodies to represent the different dream-like states of the participant, drifting between embodiment and disembodiment. In the school scenes, for example, only transparent hands appeared, and the audience members could grab objects and open the door. In the army watchtower scenes, the audience members embody a full-bodied soldier (see Figure 4). In the hospital, there is no body or hands; instead, participant's float disembodied around the scene, as if in an out-of-body experience.

In each scene, there are differing of levels of control with regards to bodies and visual representations. These provoke the participant's ongoing awareness about their own perceptions and identities through continuous re-embodiment. In

VR, we can't perceive our own bodies; even if we embody another virtual person's body, there is always a disembodiment from both the virtual and the physical world. We can use this discontinuous disembodiment as a catalyst for re-embodiment and reflexivity that encourages the rearrangement of our physical sensory experiences to understand and explore different experiences [14, 15].

This kind of discontinuous re-embodiment and duality of presence provokes the audience into phenomenologically interconnecting with the Sungeun's narcoleptic inner states. It also elicits fundamental reflexive questions about subjectivity and objectivity as well as dreaming, reality, materiality and immateriality.

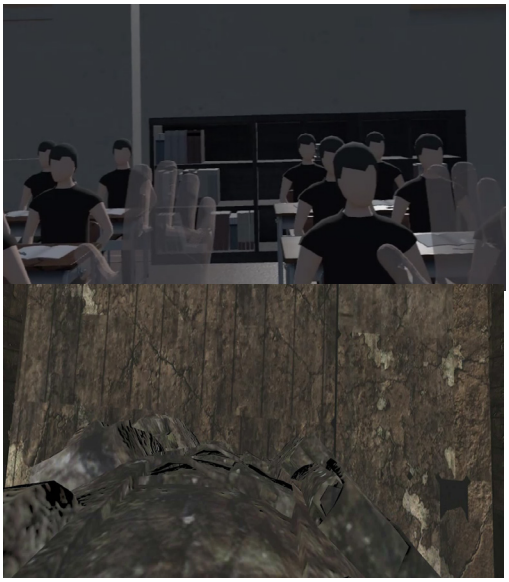

Figure 4. Example images of virtual embodiment with transparent hands (top), and a full body (bottom).

Conclusion

Sleeping Eyes seeks to explore a narcoleptic artist's inner experiences using interactive virtual reality. We investigated the technical limitations of VR in simulating narcoleptic states, metaphorically mirrored as quantum mechanical superimposed states that resonate with the duality of existence in VR. The non-linear story and biofeedback-driven visual changes represent the uncertain and surreal states of narcolepsy and provoke questions and reflections about dreams and reality as well as social violence and ignorance. We also used the discontinuous re-embodiment process as a reflexive tool to make the audience actively aware about their own perceptions and identities.

Acknowledgements

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Post-immersion: Towards a Discursive Situation in Media Arts

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Abstract

Immersion is a much-fetishized word in the domain of media arts. It is through immersion that the audiences are often made to engage with the media artworks. In these works, immersion operates as a context for realizing the production of presence as an illusion of non-mediation (Reiter, Grimshaw et al). The main concern of this paper, and the corresponding artworks, is whether the audience tends to become a passive and non-acting guest within the machinic immersive space often constructed by an authoritarian and technocratic consumer-corporate culture and driven by machine sensibility. I will argue in the paper that in this mode of non-activity the audience may lose the motivation to question the content and context of the work by falling into a sensual and indulgent mode of experience, therefore rendering the consumerist-corporate powers to take over the free will of the audience. From the position of a media artist myself, in this paper I will argue for producing a discursive environment with a human agency rather than a machinic immersive one. I will examine the possibility to create artworks where the individuality of the audience is carefully considered and taken into account as a parameter for the artwork's dissemination.

Keywords

Immersion, media art, presence, machine agency, discourse

Introduction

There is a clear and present danger of climate change, whether or not we pay adequate heed to the facts and figures that are lurking around us. Perhaps we are yet unmindful of this reality. Perhaps our fear and anxiety lead us to avoid the matter even when we cannot disengage us completely from the onslaught of information about climate change and the unavoidable and devastating consequences for our lives. There are other pressing issues, such as the insensitive handling of migrating groups of people in Europe with its social and institutional failure to provide adequate support to war-destitute that was Europe's own making. These issues need more public discourse.

On the other hand, the phenomenon of climate change seems to be slowly casting a longer shadow over artistic production. A number of recent artworks directly respond to the issue with an environmental concern. An unprecedented number of artists gathered in Paris for the "conference of creative parties", ArtCOP21 in the last climate change summit. Currently, we witness student protests on the streets questioning the political status quo. Through such participation, a global network of cultural engagements with climate crisis has been created. This engagement sheds light on how artists may contribute to the current social and political discourse, and what their contribution may mean to the local and global communities and humankind in general. There is certainly a growing sense of disenchantment against institutional stagnancy, and a need to further involve the issues such as climate change, global warming and migration in artistic practice to affectively engage the public sphere. One cannot afford the lazy and numb inaction in the face of grave and urgent crises.

This ardent need to trigger more public engagement, awareness, mobilization and action through art also opens up a debate about the apropos methodologies of artistic practice in an attempt to appeal to the yet uninitiated towards the burning issues of climate change. What can sound artists and practitioners do in this context and how can they make committed contributions to the world's crisis? Sound art often seems to possess less power in instigating societal change due to its lack of actual penetration in the public art venues and institutions till yet. The problem is also due to the immersive and pleasantly enveloping qualities contemporary sound, audiovisual and interactive media experience generally proliferates often failing to infuse the discursive and questioning faculties of its audience. In the light of this problem, we need to critically examine the sonic experience of immersion, particularly in the context of producing and discussing sound art, in order to speculate if more environmentally, socially and politically aware works can be produced in the future.

Immersion is a fetishized term in the domain of contemporary sound art, experimental music, audiovisual, and interactive media art, e.g. VR. It is through immersion that the audience is often made to engage with the artworks, especially those involving multi-channel sound, visuals and spatial practices. The rapid emergence of multichannel surround sound in film and media art was possible due to its reliance on the medial dispositif of immersion to surround the audience sonically. In these works, immersion operates as a strategy to realizing the production of an "illusion of non-mediation"[1] where the presence of the technology and the medial devices are made to appear as

[1] (Reiter, Grimshaw et al 2011)

unobtrusive as possible so as to sustain a smooth and engaging entertainment.

Etymologically, the word immersion suggests a plunging or dipping into something or an "absorption in some interest or situation," and, when applied to sonic space, offers the idea that a person who enters such a space will be transformed. Immersion suggests the idea that a space through its multitude of architectural, material, performative, and technological mediation may wrap up or envelop an audience within it. The ability to immerse an individual who opens up the ears to its environs is related to its multisensorial modes in terms of the constructed narratives that are involved often in a suppression of a conscious subjective formation. In this contribution as an artistic research exposition, I consider the immersive spaces that inherently involve contexts of a consumerist nature, such as sound diffusion in a live multichannel performance in a commercially funded festival or a commissioned interactive sound artwork, or sound design for a commercial film or VR work. There is a dangerous power relationship between the producer and the consumer of the immersive works that are mediated and purpose-designed so as to overwhelm and overpower the audience in order to convey and transmit directed information and knowledge of a consumerist nature. This is a fundamental problem, given the times we live in, when the analytical faculty of a subject is most needed for awareness to contemporary issues. If we approach immersion emphasizing the often-glorified design- and experiential side of a space and disregard the research-analytical capacity of an individual experiencing it, we might err on the side of open thinking and discourse. In fact, we should ask critically why immersion is viewed as a positive entity in a philosophical and conceptual sense. This is a make-belief fantasyland where the real is always hidden in order to create pleasure. The main concern here, however, is whether the audience tends to become a passive and non-acting guest within the immersive space often constructed by an authoritarian and technocratic consumer-corporate culture. In this mode of non-activity, the audience may lose the motivation to question the content and the context of the work by falling into a sensual and indulgent mode of experience, therefore rendering the consumerist-corporate powers to take over the free will of the audience.[2] As a result, the audience may succumb to the enveloping and engulfing power of a fantasy world created by the creative industry with economic, political or other hegemonic intentions. From the position of a socially and environmentally conscious sound and media artist myself, I will argue for producing a more discursive environment, rather than an immersive one. In the contemporary sound art and the artworks that will be conceived and produced in the future, I will fervently demand a discursive space where the individuality and the questioning faculty of the audience is carefully considered and encouraged, and taken into account as a parameter for a successful dissemination of the artwork. Here discursive situation is a term that underlines the contemplative processes triggered by an artwork to interlink the artistic object and the listener's mind that apprehends it. In such a discursive mode, a sound artwork can become more socially committed, responsible, responsive and respectful towards the aware subjectivity of the audience and the mindful context within which the artistic experience is formed. However, many of the previous and current sound works tend to glorify immersion as a dominant mode of production, diffusion and experience. What can be a better future sound art experience? Can we imagine a sound artwork advocating discursivity and dissent? As *Cities and Memory*[3] informs, field recording artists "have been recording protests around the world to create a sound map that reflects today's political environment".[4] What these recordings mostly contain are the shouts and screaming made by the protesters on the street. In the current state of inaction, it might be a loud earth-shaking scream that is what the future could sound like. This is when the pleasant mode of immersion can be broken through which sounds may enter, creating a fertile premise for a condition I term "post-immersion".

To understand the term post-immersion, I underscore a disjunctive moment in a medial experience, where the alert subjectivity of an audience is encouraged to take form. Here I refer to the philosopher Vilém Flusser's notion of "homeland" and "homelessness" - which are central to his thinking. Flusser suggests that only when a person is removed from their home he or she becomes aware of the ties, which reveal themselves as unconscious judgments. The idea of homelessness is useful for my argument. The non-immersive/discursive situation I am trying to defend here is based on the awareness of the spectator about the possibilities of loosening the ties between the sited experience and a subjective formation. This disjuncture is crucial in my own sound art practice as a mode to personalize an immersive sonic experience for a self-aware critical faculty to emerge. Inspired by Flusser, I suggest four specific approaches to disrupt the pleasant immersion, 1) noise, or a loud scream, as an alarm mechanism, 2) a-synchronism – a disjuncture between sound and image (analogous to the asynchronous mode of cinema as proposed by V. Pudovkin[5]), 3) disrupting the narrative flow with some discursive elements, such as critical commentaries, contemplative moment in a stream of thoughts or poetic utterances, and 4)

[2] (Lukas et al)

[3] A global collaborative sound project: https://citiesandmemory.com/

[4] http://www.wired.co.uk/article/sounds-of-protest-trump-brexit-sound-map

[5] See: http://pzacad.pitzer.edu/~mma/teaching/MS114/readings/EisensteinEtc.pdf

participatory intervention of the audience to "activate" the artwork. Such disjunctive moments in the narrative flow of a media artwork creates a sense of what Gilles Deleuze and Félix Guattari term "deterritorialization", a notion that resonates with Flusser's "homelessness". Deleuze and Guattari used the term "deterritorialization" (1972) to describe the condition of the disembedding and re-embedding of social relations from various objects and sites. The term describes the process that decontextualizes a set of relations, rendering them remote and virtual outside of the constraint of the enveloping here and now, and preparing them for more actualizations outside a fixed local territory. Many anthropologists use the term to refer to a "weakening of ties" between culture and place, site and self; meaning the removal of cultural objects from a certain location in space and time for new subjectivities to form. In the context of a closed immersive medial experience, both the ideas of homelessness and deterritorialization will help opening up the experience for personalization and subjective intervention through this weakening of the ties with the immersive space of media arts; and through this rupture the individual audience may regain his/her critical faculty.

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Sensing Contemporary Mexican Art: Ariel Guzik's Sonic Machines

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Abstract

This essay addresses sentience as engagement with sensorial immediacy with the non-human through the work of Mexican artist, Ariel Guzik. It discusses one of his sonic machines, *Nereida*, as an example of the overall focus of his overall practice, which interrelates the denaturalization of science with broader decolonization processes in ecology, and in particular concerning the degradation of oceanic environments in Mexico. From this perspective, the author argues for expanding art historical scholarship by engaging artistic practices, which like Guzik's focus on critiques of science, as an integral part of contemporary ecological practices in global art, social movements, and indigenous thought.

Keywords

Ecology, Mexico, art, science, sound, Ariel Guzik, sentience, Nereida, Sea of Cortez, Art History.

Introduction

For more than twenty-five years, Ariel Guzik (1960, Mexico City), a self-taught artist, musician, inventor, healer, and researcher based in Mexico City, has been interested in non-human sentience as a focus of his research in sonic interfaces. Guzik funded the Laboratorio de Investigación en Resonancia y Expressión de la Naturaleza (LIREN) [Nature's Expression and Resonance Research Laboratory] in 1974, where he continues to work with a team of artists and designers to produce machines based on this focus.[1] These works, which combine electronic and natural components, act as receptors and transmitters that invite sensorial connection with plants, animals, natural bodies and phenomena (water, wind, heat, vibrations, and electromagnetism). Until recently, Guzik's work was virtually unknown both in and outside of Mexico. Interest has been building since 2011, leading to Guzik's selection to represent Mexico at the 55th Venice Biennial (2013) with *Cordiox*, a sonic installation, and nomination to "Visionary Pioneers of Media Art" at the Prix Ars Electronica in 2015, among other awards and exhibitions in Mexico, North America, and Europe.

This late interest in Guzik's practice emerges from the current environmental and new materialist turns in the art world and in academia. In this context, expanded concepts of sentience have become popular, as for instance exemplified by the resonance of the political theorist Jane Bennet's *Vibrant Matter* (2009). Bennet's "vital materialism" refers to a concept of materiality that includes non-human forces and objects as agential beings engaged in social relations that profoundly shape human lives. Among others, the art historian T. J. Demos has cited this concept as an example of the overall departure from Enlightenment definitions of sentience framed by a mechanist concept of non-human beings and nature (René Descartes). Moreover, Demos points out that several indigenous scholars have highlighted how Bennet's notion has long been central to indigenous thought and epistemologies; a fact that is still unacknowledged by Western scholars, including Bennet.[1] Ultimately, Demos' interest in contemporary ecological art and what he calls "the politics of ecology" (with artists from a variety of locations, including Mexico), is compelled by an activist perspective. According to him, the relevance of this work is its premise on "decolonizing nature". This perspective dovetails with the overall underlying implication in his book, as framed within a kindred project, the decentering/decolonizing of art history, which has been well on its way for a while now.

I agree with Demos' assessment of the contemporary ecological art practices he discusses, as projects intent on both aesthetic and political statements. However, this understanding requires in my opinion further expanding, as one of the main focus of such projects is a critique of the politics of science. Demos largely downplays this focus, instead framing this work in terms of social engagement (a grassroots push toward addressing climate justice). Critiques of Western science are moreover salient in the work of contemporary artists interested in art, technology, and ecology, such as Guzik (among many others working both in the Global North and South). Art historical examinations of this work are therefore incomplete without accounting for this aspect. Worse, this omission could be mistaken for a longstanding romanticized tradition in Western thought and scholarship, which seeks to represent the Global South as a region devoid of scientific thought and technology, in contrast to the North, and thus synonymous with different and more harmonious relationships with the environment.

In contrast, critiques of science and its underpinnings in dualism, are forefront in the work of scholars, social movements, and artists coming to this issue from the perspective of those living still with the consequences of colonization.

For example, in addressing Bennet, Kim Tallbear, a scholar working on the intersections of environmental science, queer, and indigenous studies, writes that the "nature-culture, animal-human split . . . has enabled domineering human management, naming controlling, and 'saving' of nature". As a counter-measure to the use of science for domination of what she calls "queer inhumanity" (those defined as less-than-human or as non-human), Tallbear calls for the democratizing of science.[2] [2] Similarly, in Chiapas, Mexico, the Zapatistas demand that science be reimagined by both scientists and the grassroots together as a technique of resistance (opposed to extraction). Likewise, the work of artists in the Global South, including those using technology such as Guzik, tend to a relationship with nature that is qualitatively different than populations built on the intersections of imperialism and heavy industrialization.

Artists like Guzik are ahead of art historical scholarship. Moreover, their work is similarly largely unknown in science and technology studies, including environmental studies. In this context, it is even more urgent to highlight these artist' focus, on implicating science with decolonization processes. This essay focuses then on Guzik's ecological project, not only in acknowledgment of his artistic contributions, but also with an eye toward highlighting his critical engagement with science. In this regard, his work has resonances with related critiques by artists working in the Global North who are similarly concerned with the othering of sentience (sensorial immediacy), with the triumph, of what the Australian artist Simon Penny calls "computationalist cognitive rhetoric".[3] In this book about the subject, entitled *Making Sense*, Penny discusses how this paradigm is based on privileging abstract disembodied reasoning, mind-body dualisms, mathematically rule-governed manipulations of symbols, and computationalist worldviews. In contrast, Penny calls for a "postcognitivist media art" in support of embodied performance and a creative, dynamic materiality.

Guzik's practice echoes Penny's concerns. Counter cognitivism, it articulates them through machines that resonate with the Italian feminist Silvia Federici's call, after the Zapatistas, for re-enchanting the world; that is, to create means to hone "our capacity to recognize the existence of a logic other than that of capitalist development."[4] Guzik's sonic interfaces are strictly designed, to paraphrase him, to enchant. Conceived as experimental investigations, such machines emerge from Guzik's wide-ranging interests, spanning scientific studies of resonance, electromagnetism, and acoustics, biology, ecology, to traditional medicine, music, and myth, as much as they do with his concerns about our present environmental disconnection. Built on a synthesis of art and science, his sonic instruments and installations engage in counterpoint with non-human sonority, in Guzik's words, with the goal to "expand on the perception of the universe through mechanisms of resonance that combine fantasy with care for the earth and its creatures."[5][3]

Nereida

While this transformative focus is illustrated in all of Guzik's long spanning practice, I will focus on it here, for the sake of brevity, through his latest project, concerning cetacean communication. This work began with *Nereida* in 2007 (figs. 1, 2), as a long-term investigation into establishing sonic encounters with sea mammals. Named after the sea nymphs of Greek myth, renowned for their melodious voices, the *Nereida* is a fused quartz capsule with a core mechanism of cords and circuits. It is lowered in the sea from a drifting boat with the intention to explore its capabilities to establish a link with cetaceans through music. Guzik and his team tested *Neireda* several times in the Sea of Cortez (Gulf of California). The first experiments sought to observe the responses of cetaceans in the locality, mostly dolphins and gray whales. In later expeditions, Guzik's team used hydrophones to listen to and record the sounds made by these animals. Guzik conceives of these recordings not as imitations of scientific studies (thought they may be of interest to scientists) but as resulting from interest in establishing a non-invasive encounter with these ocean creatures.

To this point, the project's location, the Sea of Cortéz, has significance, for it speaks to the historical and current dynamics behind the degradation of Mexico's oceanic environments. For Spanish colonizers, this body of water had mythical resonance. So, guided by imagined maps, the Spanish explorer, Francisco de Ulloa named it in honor of his patron, Hernán Cortéz, in 1539. Olloa's quest was to locate and map the fabled Northwest Passage, named the Strait of Anián, which was erroneously thought to be located there. The goal was to secure a trade route with Asia for the Spanish crown.

Obviously, Ulloa's quest never came to fruition then. But, it has however today, and at great cost for this stunning oceanic environment. Currently, the Sea of Cortéz is controlled by illegal poachers in service of drug cartels supplying Asian traffickers. As a result, the Sea of Cortéz is mostly known to ecologists for being home to two critically endangered marine species, the totoaba and the vaquita. The totoaba's swim bladder is both considered a delicacy in Chinese cuisine, and erroneously thought by many Chinese to have healing properties, and thus is used in traditional Chinese medicine as a treatment for fertility, circulatory, and skin ailments. Moreover, illegal totoaba fishery impacts the vaquita, the world's smallest cetacean only found in the Sea of Cortez. The vaquita is fast disappearing as bycatch caught in the gillnets set to trap the totoaba. Chinese demand and willingness to pay high prizes, (200 bladders may be sold for $3.6 million at 2013 prices), drives this globalized commodity chain as well as links criminal networks in Mexico, Hong Kong, and mainland China.[4]

These circumstances suggest a very different dynamic than the one portrayed by Anna Lowenhaupt Tsing in her lauded anthropological mapping of the global matsutake mushroom trade. Tsing's account may be, as she has it, an exemplary instance of how in contemporary capitalism the whole "progress narrative" has been supplanted by a messy patchwork of precarious survival, which is also a latent commons. [6] In contrast, the Sea of Cortéz's illegal totoaba

trade suggests no such redemption. Rather, it is a site where the entanglements of human/not-human life resonate with what Macarena Gómez-Barris calls an "extractive zone", spaces of capitalist ecological exploitation based on having high levels of diversity. In other words, these are locations where colonial relationships to the ocean unfold as ecological violence.[7]

In contrast, Guzik's quasi-mechanized sea nymph, the *Nereida*, is intended to act as a framework compelling creative relationships with non-humans. As the artist stresses, his work is not concerned with communication. Its focus is rather on creating sensorial immediacy and encounters. The *Nereida* beckons dolphins and whales as collaborators. If answered, human, machine, and animals then engage through play, literally by performing music together. During these encounters, Guzik and his team act much like producers, and the artist occasionally even releases records under the genre of sound art, on independent music labels. The British curator Nicola Triscott, once invited by Guzik to listen to one of the unreleased recordings of *Nereida*'s interactions with cetaceans in Costa Rica in 2014, describes it as follows:

> It is apparent, even to the uninitiated ear, that there is a large number of cetaceans in the vicinity. Over the subtle chiming tones of *Nereida*, a 'choir' of dolphins' whistles of frequency-modulated pure tones is heard, underlain with the deep reverberations of humpback whales, probably present at a far greater depth. The serendipitous intermixing of tones and sounds gives the impression of a musical performance, as though this sound-based community is harmonizing with *Nereida*'s chimes. [8]

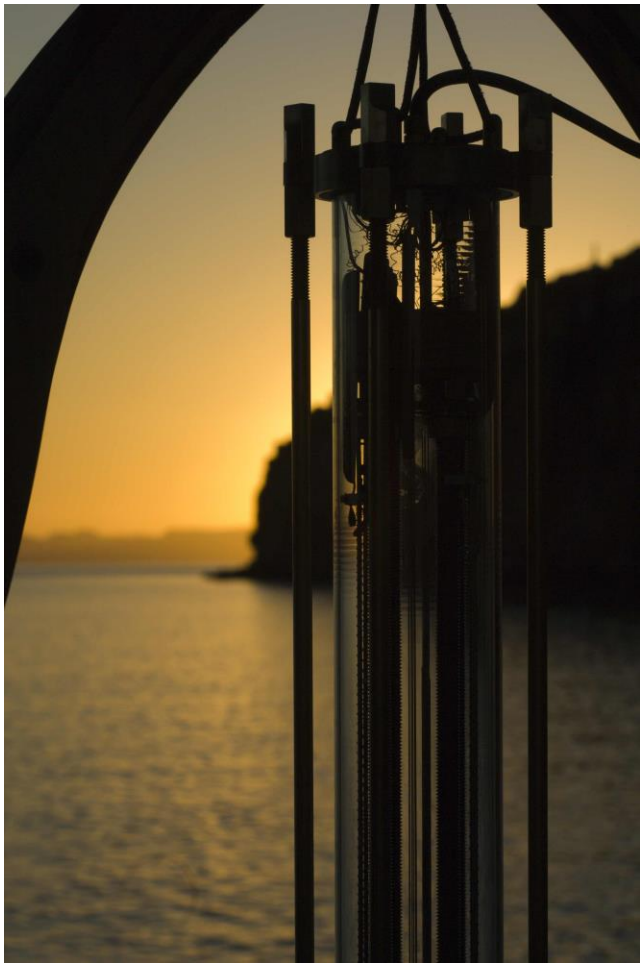
Whither Reimaging Machines

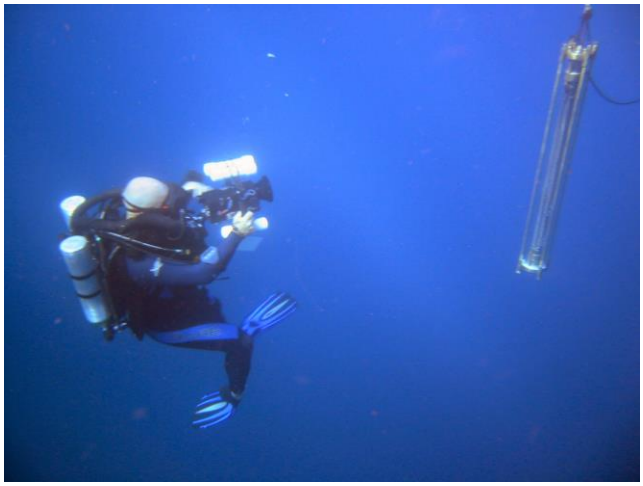
As mentioned in the introduction, Guzik's concern with sentience similarly underscores Simon Penny's rejection of existing technologies as inadequate to art practice. Citing the limitations imposed on artists working with technologies, Penny goes on to suggest that the task of the artist, then, is "no longer to imagine possible technologies but to decode the assumptions of the designers and to disentangle functionalities from these complex artifacts, or at least to proceed with an awareness of the sedimented imbrications of purposing".[9]

Likewise, in interviews, Guzik has consistently cited his integration of science in light of reservations about the ties between science and technological (read, progressivist) development at present. Like Penny, Guzik sees this model to be inimical to concerns about sentience, and by extension artistic practices like his own, intent on exploring the sensorial capabilities of the non-human. Contrary to Penny, however, Guzik categorically refuses the role of the artist as a translator, or one whose task is to decode anything at all, even the biases embedded in machines, as Penny suggests. To do so, as Guzik furthermore implies, would hew too close to the logic of science. In his own words:

> The scientific aspect of my work does not pretend to decipher but preserve mysteries. My work does not obey nor confirms the rule, nor classifies, but simply expresses. Hence my interest in creating individual experiences devoid of utilitarian intent or even witnesses.[10][5]

The need to create sensorial connections with the "environment" in order to encourage an ecological ethos is underscored by the pervasive sense of disconnection that frames "environmental issues" as containable, distant, dismissible topics. Yet, the sense of kinship, connection, and unrevealing between nature-culture, human-animal, as among others, called for by scholars and social movements cited here, needs to be accompanied by projects aimed at denaturalizing science and technology. Guzik's work is situated between both these concerns. As such, it behooves us then to listen to the underlying premise of this artist's critiques; that is, their implication that decolonizing art (or its history) is not sufficient. Nor is decolonizing science. These projects, as Guzik's practice implies, are not separate, but rather, intimately linked.





Figures 1, 2. *Nereida*, Sea of Cortez, Mexico, 2007. Courtesy of Ariel Guzik.

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[2] See also, Kathryn Yusoff, *A Thousand Black Antrophocenes or None* (Minneapolis: Minnesota Press, 2019).

[3] "Expandir la percepción del Universo mediante mecanismos de resonancia que conllevan a la enso*ñación* y al cuidado de la Tierra y sus criaturas." The term *enso*ñación is here playfully used to also invoke the sonic (són means noise in Spanish) component of the work.

[4] The Mexican government has sought to intervene into this situation through environmental laws and monitoring. The area's remote location, corruption, and poverty, render these measures but ineffective. It should also be noted that the government is implicated through industry in the environmental degradation of the Sea of Cortéz. So for instance, on July 12, 2019, Mexico's largest mining company, Grupo México, spilled about 3,000 liters of sulfuric acid into the Sea of Cortez. Previously, the same company spilled 40, 000 cubic meters of the same material in the Rio Sonora (an important Sonoran waterway) in August 2014. This spill is considered to be the worst environmental disaster in Mexican history, and residents continue today to be impacted by the effects of the damage.

[5] "El aspecto cintífico de mis obras no pretende develar misterios sino más preservalos. No obedece reglas, no comprueba ní clasifica, simplement expresa. De ahí mi intéres en fomentar experiencias individuales en las que no haya utilidad ni necessaríamente testigos."

“I try to stay neutral”: digital assistants and their stance towards gender

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Abstract

This paper seeks to understand current trends of development of digital assistants and their stance towards gender, exploring the questions that emerge when the relationship between gender and AI is subject to inspection. It begins by addressing AI and its integration in our daily life, namely through the form of digital assistants. It then examines trends of development of current digital assistants such as Alexa, Cortana, Google Assistant and Siri, considering the features and functions that are being prioritized in AI evolution. This approach is complemented by an analysis that reveals how these assistants tend to be feminized through their anthropomorphization, the tasks they perform and their behavioural traits. Furthering this discussion, we focus on the main questions, justifications and concerns raised by researchers and academics when examining the feminization of AI, while also taking into account common discussions around this phenomenon in the context of online media coverage. In this manner, this study seeks to promote discussion and incite reflection on how current developments of this technology reveal a stance towards gender, questioning whether AI tends to reinforce traditional and normative conceptions of gender and femininity.

Keywords

Artificial intelligence; digital assistants; anthropomorphization; gender; femininity.

Introduction

Personal digital assistants are no longer a thing of the future: mobile devices have them, social networks want them and it seems like every computer coder wants to make them, whether it’s for an app, a website or instant messaging platforms. They talk to us, listen to us, help us and, as artificial intelligence’s increasing ubiquity often goes unnoticed, they are becoming a natural part of our daily interactions. They are now embedded into our mobile devices and web-based services, not only assisting us in daily tasks but increasingly acting as friendly companions. In an attempt to become closer to our social reality, they are assigned human-like traits, features or even personalities. However, this growing anthropomorphization inevitably entails gender attribution which, in this context, tends towards femininity, resulting in a behaviour that conforms to certain stereotypes and reinforces traditional assumptions of femininity. [1] [2]

This paper seeks to tackle into the questions that arise when this phenomenon is subject to closer inspection. It discusses digital assistants and their integration in our daily life, addressing their growing ubiquity, efficiency and companionship.

We then look into current trends of development of digital assistants, namely Alexa, Cortana, Google Assistant and Siri, highlighting which functions and features are being prioritized and discussing how AI evolution entails a stance towards gender. This view is complemented by an analysis that reveals how these entities tend to behave in an affectionate and feminized way, be it through their voice, the tasks they perform or by assuming behaviours that are traditionally deemed feminine. However, we also discuss how some of these assistants attempt to diversify their behaviour, so that they aren’t exclusively associated with femininity, revealing awareness of this tendency.

We then address the main possibilities and questions raised by researchers and academics when examining this phenomenon, while also taking into account its current discussion in the context of online media coverage.

In this manner, this study seeks to incite reflection on the social and cultural conventions that inform the conception and development of artificial intelligence, seeking to spark discussion on how these entities end up reflecting common conventions back us.

From assistants to friendly digital companions

Artificial intelligence is increasingly part of our daily lives, namely through chatbots that play the role of personal digital assistants, embedded into our devices and becoming a natural part of our digital conversations, through short type, natural language interactions. William Meisel distinguishes two groups of chatbots: “general personal assistants”, which refer to more developed and complex assistants like Siri, Alexa or Cortana, and “specialized digital assistants”, which refer to a “tsunami of more narrowly focused chatbots”. [3]

AI systems of the first type can help with “some subset of the standard virtual assistant skill portfolio” and, usually, general digital assistants are integrated directly into our devices, becoming simultaneously ubiquitous and subtle. [4] This growing ubiquity relates to the intent of conceiving chatbots “to become friends and companions”. [5]

This sense of companionship develops alongside with the anthropomorphization of artificial intelligence, either through names, voices or avatars, but also more humanized dialogues and interactions. According to Jutta Weber, anthropomorphization entails an intention of turning our

common interactions with this type of machines into more social ones. [6]

So, by creating anthropomorphized digital assistants, giving users the false sense they are talking to another human being, human-machine interaction is influenced by feelings of intimacy, closeness and empathy, evoking Weizenbaum's ELIZA effect. [7] In this process, personal digital assistants engage in conversations with us, evoking a not-so-far-away world "where some of those conversational partners we'll know to be humans, some we'll know to be bots, and probably some we won't know either way, and may not even care". [8]

Alexa, Cortana, Google Assistant and Siri: current trends

Taking into account the growing ubiquity, efficiency and humanization of AI, we sought to inspect which functions and features are being prioritized in their development, looking into official statements by Amazon, Microsoft, Google and Apple regarding their assistants and how they're planning to further develop them.

Overall, Google and Amazon aim to further anthropomorphize their assistants, making them more human-like when relating to their users, while Apple and Microsoft are focused on improving voice recognition and multitasking faculties. [9]

The assistants also have the goal of being increasingly present in our daily lives, allowing for various tasks to be carried out at the same time, and increasing their humanized interactions as to make them appear more human and sensitive to their user's emotions.

However, authors like Hester argue that, in order to achieve this goal, gender is being instrumentalized and femininity emerges in this context "as the product of deliberate choices about how best to relate, assist, or persuade the imagined technology user". [10] For example, Alexa is intentionally conceived as a female entity, tapping into gender notions that not only reinforce and perpetuate certain stereotypes, but also intend to ease interactions with its users.

Awareness of this issue is shown by Apple and Google, since their assistants offer alternatives to the female voice and also assume behaviours that don't necessarily echo traditionally female traits, seeking gender diversification.

Female in character vs beyond gender

Aiming to further inspect the presence of gender in AI, we elaborated a specific set of questions in order to analyze particular aspects of these digital assistants regarding their anthropomorphization, the tasks they perform (as assistants) and their humanized, socio-emotional interactions (as daily companions).

We observed a lack of male or gender neutral attributes considering the predominance of feminine names and default voices (with the exception of Google Assistant and Siri).

Additionally, they all perform a similar set of tasks, evoking what Dale calls "the standard virtual assistant skill portfolio", [11] which, in turn, Gustavsson describes as having its basis in the "stereotyped image of female qualities (...) [which] have become a standard component in a service script". [12]

Beyond their assistance role, these entities also promote a relationship based on friendship, expressing interest on the user's day, mood or interests. Their behaviour frequently displays caregiving attitudes that characterize them as empathetic and reassuring entities, while personality traits deemed as male, such as being assertive, dominant or willing to take a stand seem to be lacking. In this manner, their behaviour conforms to a "stereotypical female image of caring, empathy and altruistic behaviour" and they end up automating sociality, emotionality and femininity. [13]

In sum, Alexa and Cortana are presented exclusively as female entities, articulating these attributes with a motherly, caring and submissive role. Although Google Assistant and Siri also tend towards feminization, they try to oppose this tendency diversifying their behaviour and offering multiple voice options.

Adding to these results, we examined the functions that are being prioritized in the development of these assistants and their stance towards gender. It's noticeable how AI is being developed as to appear more humanized to their users, pandering to their emotional needs. In this process, there is a deliberate intention of turning virtual assistants into friendly companions, revealing how gender and femininity are being instrumentalized to achieve this goal by complying to their users expectations through stereotypes that deem women as trustworthy and caring.

Nevertheless, we can also observe how Apple and Google seem to be aware of gender related issues and the impact their creations might have. Siri and Google Assistant offer counterparts to the female voice, either oriented towards diversification or even neutrality. Furthermore, they are also focused on contradicting the overall tendency of femininity in virtual assistants, namely by designing behaviour that doesn't echo female subservient and submissive roles. Thus, they move from assistants that are "female in character" towards those that state they are "beyond gender".

Discussing gender and AI: justifications, concerns and suggestions

We then sought to confront our observations with the main questions and concerns that arise, or even suggestions, when discussing the feminization of AI within specialized fields of knowledge, such as artificial intelligence, gender theory and new media studies. We also tried to understand how popular assertions about this phenomenon are being debated, namely in (online) media coverage.

The fallacy of gender neutrality is often debated, and some argue that "when voice technology is embedded in a

machine interface (…) it may trigger in the user's mind a whole set of expectations associated with that voice's gender". [14] Although virtual assistants aim to appear neutral and disembodied, it is commonly argued that they embody the archetype of a "competent, efficient and reliable woman". [15] In this sense, common media discussions emphasize that users tend to interpret these entities through the lenses of their own biases, namely often addressing assistants by the pronoun "she".

Common justifications emphasize that feminine voices are better suited for virtual assistants because their voice is easier to perceive and because women are more caring than men. [16] On one hand, it is argued that the tasks these assistants perform tend to "exploit our assumptions about feminized labour" and caring behaviours. [17] On the other hand, it is also discussed how this technology is designed as explicitly feminine (and submissive) in order to "emphasize human dominance over technology". [18]

Another common belief is that femininity emerges as a consequence of having artificial intelligence being developed mainly by men. [19] This is also suggested in a very recent publication by the United Nations, addressing the digital skills gender gap, but also emphasizing the social and cultural repercussions of the rise of gendered AI. [20]

Adding to those justifications, are the concerns about how gender stereotypes "seem to be so deeply ingrained that people even apply them to machines". [21] The link relies in what consumers "are trained to expect from service workers: subservience and total availability" and our virtual assistants are the perfect example of that prospect. [22]

Additionally, common media discussions are concerned with femininity being the default in digital assistants as it might reinforce pre-existing expectations on how women should behave, arguing that "when we can only see a woman, even an artificial one, in that position, we enforce a harmful culture". [23]

There is, however, little consensus on how to counter this phenomenon. As previously observed, gender neutrality in digital assistants is often questioned and considered hard to achieve, since their voice immediately conditions our perception of the AI's gender.

A common view is that virtual assistants should allow for more diversity, for example by offering a "simple setup guide during startup of devices with virtual assistants". [24] Siri can exemplify this move towards diversity, as it offers feminine and masculine voices in different languages.

In turn, it is also suggested that "allowing virtual assistants to possess […] a gender as fluid as that of human beings, would hopefully be part of their humanization". [25] So, digital assistants could avoid a binary approach to gender through an androgynous, fluid or even genderqueer characterization. Google Assistant doesn't have a gendered name and tries to bypass gender related setups, assuming the device or software's default language and gendered voice, while its different voice options are named after colours. Another example is Q, presented as the first genderless voice which aims to "end gender bias in AI assistants" by proposing a voice that is neither masculine nor feminine. [26]

In sum, the debate is growing, in both specialized and common terms, revealing increased awareness on this phenomenon, often highlighting the way femininity tends to be instrumentalized and questioning whom this truly benefits. Some argue that they aim to achieve a positive perception and experience of the users and that a technical system is perceived more vividly by anthropomorphizing and humanizing it.

Conclusion

In conclusion, with this study we sought to tackle the questions that arise with current developments of AI, and its inherent stance towards gender. As digital assistants become more humanized and fill the role of friendly companions, they tap into gender conceptions. We also observed how their development reveals awareness of their feminization and attempts to move away from this tendency.

However, there is still a need to raise awareness and foster debate on how artificial intelligence is influenced by our social and cultural views. In this sense, researchers and academics highlight the way gender and, by extension, femininity, is instrumentalized to persuade the imagined technology user and ease interactions. In turn, common discussions in the context of online media coverage often debate how these entities perpetuate gender roles and stereotypes, emphasizing how AI is a field is mostly developed by men.

Although there is little agreement on how to tackle these issues, neutrality is often questioned in favour of gender diversity, namely, allowing the user to customize their assistant. Some authors even point out how these entities could fluctuate between more than one gender, thus being genderfluid and accompanying society's progresses of breaking down the gender binary.

In this manner, this study sought to raise awareness and foster debate on how current developments of AI are influenced by our social and cultural views. As these entities proliferate and become increasingly closer to us as companions, as much as they aim to appear neutral, they end up reflecting our cultural views back to us.

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UNMASK - Digital Thinking with Brutalism

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Abstract

Brutalism originally rose to popularity in architecture as a response to excessive ornament, and lack of clarity in the function of buildings. Inspired by the modernists it took on many of the aspects, but stripped away any obfuscation of the functionality of the building. In recent years this design theory has been brought back for use in the field of web design, for the same purpose of removing obfuscation of function. The application also created pages that are more accessible to both those with disabilities, and those in developing countries, where connectivity is limited. This expansion of these theories suggests their potential to be adopted in further areas, such as the creation of interactive art pieces, and installations.

Through examination of brutalist design theories in architecture, their adaptation into web design, and borrowing from the process of speculative design, a brutalist methodology was created. This methodology was simultaneously created alongside and applied to an interactive installation. The two established brutalism as a useful method of constant justification of any content or additions to a project or artwork. It encourages the creator to think about what is important, and needed for the project over what is expected.

Keywords

Interactive installation, brutalism, framework, methodology, reactive installation, generative art.

Introduction

Limitations are something that are growing to be less and less common in the digital world. Much of the work on digital platforms is removing any barriers or limitations that are imposed on it. However these limits can aid in the process of creation. Having barriers to work within means fewer paths to work down, meaning more effort can be put into a singular vision.

In the early 20th century, architecture was going through a similar loss of limitations. It was easy and faster to create buildings, which resulted in ones that were more and more ornate, without a reason for being that way. This sparked a rise in the modernist movement, which quickly spawned the brutalist movement. The goals of which were to pare down buildings to their most bare and honest form. [1]

These ideas can be valuable to adapt into the digital world, allowing the process to adopt new technologies without compromise, but keeping true to the intent and goals of the piece. I used these theories in practice to create a brutalist framework to work within.

The intent is to create a new approach to tackle design challenges, and change the way technology is handled and thought about. Adopting an honesty based framework to work within can provide a new, and interesting perspective.

History

Brutalism was meant to be a response to the optimism and appearance of ease that was common in the architecture of the 1930s and 40s, often featuring intricate and ornate detailing all over the building. [2] Brutalist architects saw this use of ornament as a way to hide the building. A dishonest representation of what the building truly was. They created buildings that were stripped bare of any

Figure 1. The Monadnock Building, Chicago. An early, heavily ornamented, skyscraper.

ornament, and brought the buildings down to their bare materials. Accentuating features of a buildings function that would often be hidden away in other forms of architecture become centrepieces for brutalism. There was no attempt to make the structures look easy, or comfortable, often aiming to go in the exact opposite direction of that. [1] It was meant an unobscured vision of the world, showing this quite literally with its defining look of bare concrete. The results were often seen by critics as being lazy, and ugly. But its detractors can't deny the impact it had on the direction of modern architecture. [3]

Brutalism had a very practical side to its adoption as well, coming into the wider view following World War II, where many of the cities in Europe had been largely destroyed, leaving housing as a fairly large issue. Brutalist buildings were fast, cheap, and easy to make, and thus found themselves appearing all over Europe. This expansion continued in North America, with university campuses looking to expand in a similar fast, and cheap way. [4]

Brutalism is also a very misunderstood design language. The first misunderstanding coming from the idea that Brutalism just rejects what is accepted as aesthetically pleasing, which it does not. This is the core of Anti-design, which has a very different look and feel. [5] The paring back to the essentials can also be confused with minimalism. Though the two are from the same base (modernism), minimalism has the goal of making the output appear more clean and simple, where brutalism aims to just remove any excess. If you picture a brick wall, the minimalist way of approaching it would be a coat of white paint, where brutalism would leave it bare and uncovered. [6]

Honesty is the core of brutalist theory. Almost everything about the movement can be brought down to it, and as such, honesty became the core of the methodology used in the creation of UNMASK.

Into the Web

The movement was largely dead by the 1980's, with many people understandably wanting to move onward from the concrete monstrosities, once again replaced due to new technologies. At this point the buildings were also beginning to show their age, with raw concrete not able to stand up the the elements as well as the treated and covered buildings.

Decades later though the ideas of the movement found a new home in web design. The Web Brutalist movement shared many of the same ideas as the architectural movement, providing a new alternative to how a website could be constructed, by tearing away the layers of excess, and leaving only what is crucial in its place. [7]

Web brutalism is where the idea for further adapting the theories began. The designers in the movement had already fabricated a framework to work within in web design, bridging much of the gap between physical and digital materials. [8] An interesting point of it is that unlike with architectural brutalism, the bare materials are not considered to be the actual 'material' the website is made from. As there is not actual material, the natural place to arrive is that the HTML, CSS, and Javascript would be the bare materials. This is not the case. The content of the site is considered to be the bare materials, as that purpose of the site is to host that content. [9]

Bare Concrete & Honesty

The first stage in the application of brutalism was to find the concept to base the piece on. Using, and creating, a methodology based on honesty requires a solid concept, and core to turn back on, and use as a place to reflect to find that honesty.

In order to find this basis, I chose to expand the methodology slightly beyond being just about the piece itself. I chose to use this idea of honesty as the conceptual core of the piece by applying it to myself, and my own life and experiences. I chose to confront my issues with mental health, specifically issues of anxiety and depression, and use them as the core of the piece. These topics are not easy ones to think about, or discuss, but Brutalism isn't about choosing the easy methods. [2]

Figure 2. Emotion:Spheres I, 2018.

In 2018, I created a series of pieces based on the distortion of photos (as seen above).. I had originally created the series as an output of emotions that I could not properly explain. As I looked back upon the pieces through this new mindset, I began to see them more as artifacts and representations of my experience with memory distortions. Each of the photos that had been used were in some way related to a memory of mine that had been bent, or entirely lost because of trauma brought out by anxiety and depression.

This concept of memory also lent itself to the choice of using old monitors in the installation. CRT monitors have a distortion that comes from placing them close together,

they start to warp the image. Combining this with the ‘glow’ they produce can create an ethereal effect which well suits the concept of the piece.

This concept was key to moving the project and the research forward. While being important for any project to stay with in order to have a focused vision, it was even more important to have solidified to pursue a brutalist representation for the project. Without a vision and a concept for the project, it would be impossible to present the project in its most honest way.

Nodes as Material

With the concept decided on, the construction of the project could begin. The pieces that I had based on the concept for the installation upon were created in Blender, but would need to be moved into a different application in order to create the orbs both in real time, and to allow a form of interactivity between the viewer and the installation.

TouchDesigner was chosen as the basis for the project because of this, it allowed a similar workflow for the creation of the effect, as well as a fast method of prototyping that allowed it to stay adaptable, something that would be needed with the Brutalist method of identifying what are crucial features.

At this point the second piece of the framework came into play. Part of what kept the honesty in brutalist architecture was a reliance and celebration of the ‘bare materials’ of a building. In architecture this was easy to identify, being the literal bare concrete that the buildings were made of. This gets harder when using digital formats.

Web brutalism provides an interesting way of looking at this. Rather than viewing the bare materials as the literal building blocks of code, it views it as what is important in the construction. In web design this is the actual content of the page. Touchdesigner is a node based program, with each node adding something to the output, and providing a visual flow of information.

These nodes are the bare material of this installation. Using a different display for each of them would provide this flow of information in the final construction of the piece, showing the user every step of what was going on to create the orb. No part of the function would be obscured. This was combined with a reference to the brutalist Habitat 67 in Montreal to create the final shape of the installation, with each monitor getting its own ‘pod’ to sit in. [10]

Figure 3. Habitat 67, Montreal..

All in a Name

The final stage in the process of creating the piece was forging a name. It would not serve the purpose of using Brutalism to give it a name with little or no meaning. That would not be fitting towards the honesty of the piece.

UNMASK was chosen as it fit the purpose of the piece. By using these ideas of Brutalist architecture, I was lifting the mask away from the art, and away from myself. I was laying it all out in its most bare, essential, and honest form. The framework for the methodology will change slightly for every project that is being worked on, but the overall steps are the same.

1 - Find the core to reflect everything back onto. This will serve as the basis for your honesty.

2 - Find the bare materials of what you are working with. Make sure these are in line with your concept. Never obscure them.

3 - Always question every addition of a feature, or aspect to the final output. Question if it is crucial, or just ornamental.

Figure 3. The most recent install of UNMASK.

Reflecting back on this process is an important step in the creation of both the framework, and the piece itself. However this reflection is aided in this case by the constant reflecting that the process forced. This is where the brutalist ideas can really aid the creative process, especially in a field as wide open as digital media. It forces a path on the creator, giving them far fewer paths to go down. This process may not be excellent for all purposes, as the restrictions it provides may hinder an aesthetic, or creative vision, but it provides a new way of looking at starting and creating a project. It is a process that should be looked at in the same way that speculative design is. A pathway to take in order to open new areas, and refresh your mind with new ideas.

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Author Biography

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ISEA2020

Mycorrhizal Curation: minimal cognition for maximal cooperation

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Abstract

Since 2015, when the authors first wrote a chapter about the state of curation for electronic art (pointing to the absence of works significantly addressing the epistemic implications of a computational logic), artificial intelligence and wider algorithmic forms of logic have become more pervasive themes within mainstream art, with, for example, exhibitions such as 'AI More than Human' (2019) at the Barbican Centre, London, the increasing profile of the Lumen Prize, as well as headline grabbing events such as Christie's auction of the AI-generated painting 'Portrait of Edmond Belamy' (2018, created by GAN [Generative Adversarial Network]). The logic of computation is now, if not generally understood, a ubiquitous facet of the curatorial imaginary, begging the question: where are the alternatives and challenges to Western computation, to the Neoplatonist ideals of mathematical logic? Appraising discourse addressing the non-human and the arboreal, the authors present a radically alternative set of practices, framed as *Mycorrhizal Curation*, a provocative affront to human representational systems and power relations which place the human at the apex of all epistemic hierarchies, but also, the authors intend to provide a provocative challenge to the hegemony of the artworld, with shifts to models of amicable cooperation and wealth distribution.

Keywords

Mycorrhizal, Physarum polycephalum (slime mould), epistemic, curation, artificial intelligence.

Introduction

When examining the current state of digital artworks, one might argue that they have not yet made a groundbreaking impact on the cultural landscape of the early 21st century and that a reason for this lack of notoriety is the obsolete model of agency deployed by many digital artists [1]. During the past five years, the authors have been investigating interactive systems, artists' tools, applications and techniques that can provide an insightful and up-to-date examination of emerging trends in the application of new technologies and curatorial thinking. In this context, an interesting model emerges; one that is neither human nor non-human-centred, doesn't recognize decipherable patterns of existence and is in no way linear in its operation. There have been various attempts to 'define' this symptom which, in reality, explains that there are now clusters and a rhizomatic model as an antipode to the previous linear reality (Bourriaud 2009 [2], Bishop 2012 [3], Fuller & Goffey 2012 [4], Manovich 2016 [5], Kholeif 2018 [6]). It is true that one can rationally discern a relation between the technological changes of the past thirty years and the way this has impacted on one's access to information. Networks form an essential part of one's daily routine (whether they are social media, group chats, search engines or algorithmically suggested purchases) and yet there is an implicit assumption that humans remain the initiators of such networks. However, what is proposed here is a shift to our representational systems and the introduction of a model that, as a fungus, can function beyond the human factor.

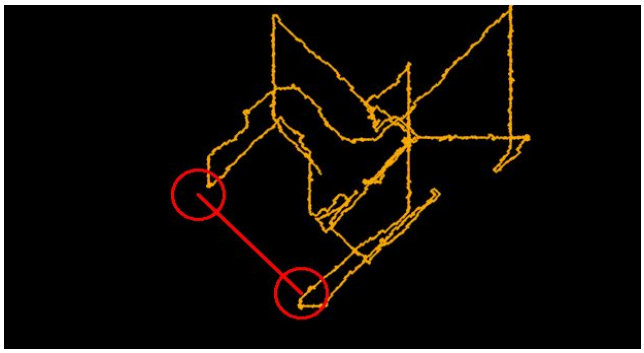

Figure 1. Computational model of slime mould, Eleanor Dare 2019

Orthodox path-finding algorithms are constructed to find optimal pathways through an information space or formalised model of an actual space, through the deployment of graph theory and graph traversal algorithms. A path-

finding algorithm will seek the best path through a space given a starting point and an end point with a set of a priori criteria for success, for example, in Dijkstra's algorithm, the shortest path. Alternative path-finding systems can be found in the natural world, for example, ant colony behaviours, the swarm activity of birds and insects and the phenomena of *Physarum polycephalum*, or slime mould, a primitive sensory system. Slime mould is "an active living substrate" (Vallverdu, Castro et al. 2018 [7]) which is neither animal or vegetable or mineral, it has been used in "developing un-conventional computing devices in which the slime mould played a role of a sensing, actuating, and computing device" (ibid. 1). It has also been used to resolve combinatorial optimization problems, employing highly complex networks as in the case of the Tokyo rail system (Tero, Takagi et al. 2010 [16]). Biological networks such as *Physarum polycephalum* "develop without centralized control and may represent a readily scalable solution for growing networks in general" (ibid., p. 439). As an organism, it is suggested that slime mould can find solutions "with properties comparable to or better than those of real-world infrastructure networks" (ibid., p. 442), taking the form of an interconnected network that serves the purpose of expanding the discovery and exploitation of new resources. As such, unlike anthropogenic infrastructure systems, it has been "subjected to successive rounds of evolutionary selection" and "[is] likely to have reached a point at which cost, efficiency, and resilience are appropriately balanced" (ibid., p. 439).

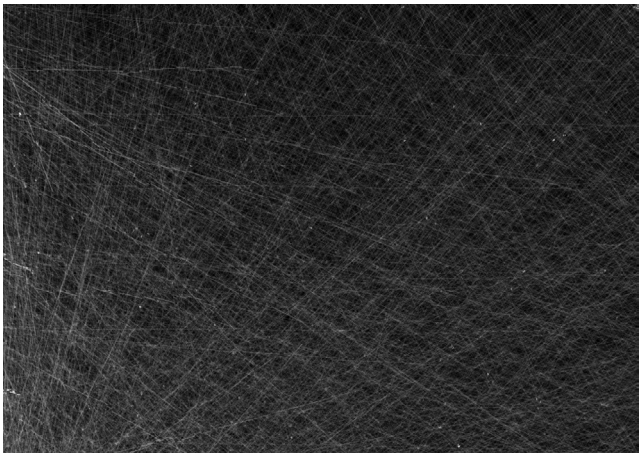

Figure 2. Computational model of slime mould, Eleanor Dare 2019

Unsurprisingly, slime mould has caught the attention of computer scientists for some time but has hitherto been neglected by curators. By modelling the behavior of slime mould and the inter-dependencies of Mycorrhizal networks, the authors propose the deployment of an adversarial approach to both orthodox computation, in particular, artificial intelligence, which perpetuates a neo-platonic, Western colonial legacy, in which mathematical models of the world, and of knowledge, are privileged over myriad other epistemic traditions as well as non-human cognition.

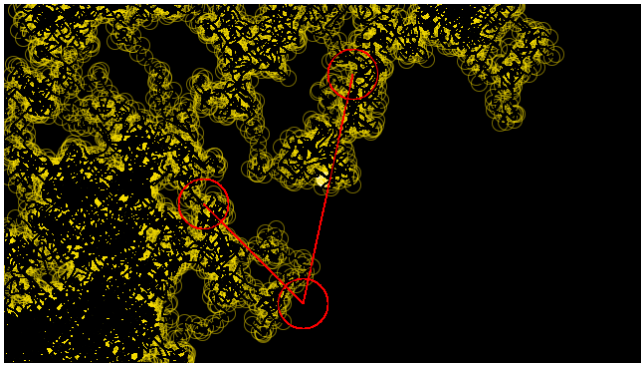

Figure 3. Computational model of slime mould with pathfinding, Eleanor Dare 2019

Slime mould and mycorrhizal networks are here presented as providing alternative curatorial imperatives and patterns of exchange. Readers are invited to interrogate slime mould and mycorrhizal models of affiliation and curation, to enter a cooperative and amicable system of curatorial partnership, a redistribution of wealth in which the exchange of vital nutrients supports new art practices and underrepresented communities. The mycorrhizal and slime mould models avoid, we hope, the reductionism (ethical hedonism) of Bentham's *felicific calculus* [8] and the similarly idealised metaphysics of Aristotles's Organon [9].

Modeling slime mould and Mycorrhizal networks

The algorithms developed by Eleanor Dare in late 2019 began with models of random walks, also known as 'stochastic' movements in two dimensions. Food sources (represented by ellipses) randomly intersect by means of arbitrary walks (pixel movements across the screen). Once discovered, the location of food sources is stored and the shortest path between nodes (or food sources) calculated using graph theoretic equations, such as Euclidean Distance. How slime mould does this in the physical realm, without a nervous system or brain is unclear, it is presumed a form of biochemical signal stores pathways, and that shortest paths are calculated using the flow rates of cytoplasm in the branches of *Physarum polycephalum*. The work of Furnam et al in 2014 [10] has concluded that these simple organisms are effective pathfinders, able to optimise in some cases, as efficiently as mainstream computer programs. By manipulating light sources in physical models of slime mould pathfinding scenarios, researchers Watanabe et al (2011) [11] were able to simulate landscape features which the Tokyo metro cannot navigate, thus

replicating the topology of that network and seeking optimal pathways through it in the event of say, an Earthquake or transport malfunction. Similarly, in the example of Mycorrhizal Curation presented here, we have simulated the wealth of galleries via pixel brightness, thus generating a pattern of avoidance, in which poorer galleries, with lesser known artists, become sources of nutrition for *Physarum polycephalum*. Combining this model with a mycorrhizal network of mutually beneficial cooperation, the simulation inverts presumed orthodoxies of traversal between galleries based on what, in social network analysis, is the idea of the 'rich get richer', where nodes which are already highly connected gain further connections, excluding less connected nodes (in this case artists and galleries), forming a so called 'virtuous circle' of the already privileged.

It is important to point out that our model currently omits the ability of mycorrhizal networks to conduct chemical aggression in the event of resource scarcity. Improvements to the model could include self-avoiding random walks, ones which never intersect with themselves in order to optimize the process of wealth distribution. The work presented here is a provocation in line with Maturana's autopoetic network, or proto-consciousness' [12] as well as curatorial activism [13] and Adversarial Design [14] in which we 'expose and document patterns of influence in contemporary society'[15] in particular its hegemonic or dominant power relations.

Figure 4. Computational simulation of slime mould with Mycorrhizal weighting towards mutual support for less wealthy galleries and neglect of the already well off, auto-generated city, Eleanor Dare 2019

Mycorrhizal modus operandi

Based on current art trends and tendencies, especially as far as digital arts and interactive networks are concerned, a mycorrhizal and slime modus operandi leaves space for a quasi-anarchic, rhizomatic, non-linear system of operation that is not entirely (or not at all, depending on the given situation) dependent on human semiotic systems. As such, it goes beyond mathematical logic to form a non-symbolic intelligence, abiding to a fungal and slimy set of criteria offering an alternative set of practices for future collaborations. From an organisational point of view, it tracks the optimal solutions to complex problems without centralized control. From a Cartesian point of view, it introduces an efficient curatorial model that can accommodate different types of computational and interactive practices, whilst responding to contemporary theories (and increasingly changing requirements) of interactivity, artificial intelligence, and curation.

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Authors Biographies

Eleanor Dare is Reader in Digital Media at the Royal College of Art's School of Communication and Head of the MA Digital Direction (London, UK). She has a PhD in Arts and Computational Technology from Goldsmiths University of London (Department of Computing), supported by a full doctoral studentship from the Engineering and Physical Sciences Research Council. Her doctoral thesis and MSc (Distinction) at Goldsmiths were concerned with computer programming practices, subjectivity and artificial intelligence for interactive and responsive books. Since completing her PhD in 2011 (titled: "Navigating Subjectivity: South a Psychometric Text Adventure"), she has continued to research the ways in which computational systems try to understand humans, especially what happens when computers attempt to generate human-like cultural expressions. Inevitably, this has resulted in an increasing concern with the significance of the human and the non-human, with situatedness and embodiment. In 2018, she completed an Open University MA in Creative Writing (Distinction), addressing virtuality and non-linear narrative structures. She has exhibited work addressing both the limits and potential of VR/AR and AI.

Elena Papadaki is a visual historian, cultural theorist and curator based in London and Brussels. Her research interests lie in the intersection of screen-reliant imagery, curation, interactivity and audience reception. Her doctoral thesis from Goldsmiths University of London was titled "Curating Screens: Art, Performance, and Public Spaces". Having previously held posts at the Hellenic Ministry of Culture (department of Museum studies) and the International Council of Museums (ICOM), she has over ten years of professional experience in the arts and museum sector. Elena works as a Lecturer in Curation and Digital Arts at University of Greenwich (London UK) and as a Contextual studies tutor at the Royal College of Art (London UK). She is also founder of Incandescent Square (a collaborative meeting point for design, art, and research); with the latter, she has curated and managed exhibition projects in France, Greece, Malta, Portugal and the UK.

Machine Generated 'Portraits' as Impersonal Gestures

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Abstract

This paper considers the Artificial Intelligence (A.I.) renderings from the website "This Person Does Not Exist" (TPDNE), published in early 2019, which are high resolution images that are often indistinguishable from actual photographs. While learning algorithms are widely critiqued for amplifying bias and hierarchy within already biased data sets, the learning algorithm that generates the TPDNE images proposes an alternative potential. The TPDNE image makes an opening to experience the co-composition of personhood and photographic media. What is at play in the TPDNE image is not the replacement of a human intelligence for an artificial one, but a reconstitution of the photographic portrait as a spacetime of generative encounter. This encounter both exposes and dampens the way the photographic image is enmeshed in subjective affects and agencies aligned with a human-centered concept of personhood, capture and extraction. In this paper, the TPDNE portrait is figured as a gestural opening to problematize such agencies as they are reconfigured in computational spacetime. The TPDNE image performs the possibility of a sense transformation that allows for imagining new and heterogeneously co-constituted subjectivities that traverse registers of representation, technology and corporeality.

Keywords

Artificial Intelligence, Photography, Gesture, Personhood, Learning Algorithms, Animation, Sentience

Introduction

Various theorists across the humanities have expressed concerns about the impact that A.I. will have on knowledge practices and society more broadly. Florian Cramer [2] identifies how A.I. shifts emphasis away from heuristic modes of interpretation in the humanities to statistical ones, operationalizing semantic content while obscuring the bias in quantitative processing. Wendy Chun describes the role of A.I in proliferating homophilic echo chambers on social media that stabilize, gather and separate users to target individual consumers [3-5]. In response, Chun asks, how can we "unpack, reimagine and remake the retrograde identity politics embedded in the world of networks" and develop "unusual collaborations" as well as "livable forms of indifference" [6]. Queer theorists José Esteban Muñoz and Mel Chen help to elaborate what this livable indifference might mean. Muñoz describes an indifference that is not passive but requires a sustained and arduous labour of questioning and expanding modes of relationality [7]. Mel Chen develops such a labour through the queer figure of toxicity, which can be generatively aligned with TPDNE renderings as it proposes a problematization that preserves the co-existence of contradictory modes, such as "living dead", "dead living", "inanimate affection" and "anti-social love" [8]. The contradictory play of the title "This Person Does Not Exist" proposes a reading of the person that both questions and collapses the difference between the photograph and the person. The TPDNE rendering itself poses a plurality of possible co-existences, including the real and fake, capture and error or glitch, the human and the non-human, desire and indifference, the personal and impersonal, photograph and computation. As referentiality is delocalized within this contradictory spacetime, what emerges are new modes of animacy that enlarge the possibility for situated, ethico-aesthetic collaborations.

"This Person Does Not Exist"

The renderings from TPDNE are the outcome of an A.I. algorithm that learns to generate the likeness of a high-resolution, photographic portrait of a person, based on the numeric profiles of a vast data set of actual images. In some cases, the renderings are completely indistinguishable from an actual photograph, while in most cases, there are subtle indicators that reveal traces of the computational process. Whether visible as computational renderings or not, the images reorient what Villém Flusser describes as the gesture of photographing: a gesture that considers how taking a photograph creates an expanding surface upon which events of visual perception take shape, while maintaining the possibility of achieving a consensus between photographer and image spectator [9]. The ubiquitous capture of photographic information in the context of digital satellite imaging and the datafication of surveillance infrastructures, have respectively been identified as generating an excess of (and differential access to) information that results in a kind of non-visibility, undermining the possibility of this consensus [10-11]. The generative capacity of the TPDNE

Figure 1. Left: TPDNE rendering where subtle changes in facial form occur in and around shadowed areas; Right: TPDNE rendering where clothes are rendered as skin. © Imagined by a GAN (generative adversarial network) StyleGAN (Dec 2018) - Karras et al. and Nvidia Original GAN (2014) - Goodfellow et al.

algorithm expands the scope of this non-consensus by demonstrating the degree to which photographic data can be extracted from the photochemical event to encode photographic appearance. Once unmoored from literal referentiality, the photograph reappears in the doubleness of its techno-material and affective productivity. The photograph becomes sensible as what Alessandra Raengo identifies as an imaginary fixation that reifies racial stereotypes while distancing the agency of personhood and things [12]. In the encounter with the TPDNE image, fixation gives way to a relationality that is think-able as both referential and indetermined both "over-coded" and "under-coded", a terminology developed by Sven Lütticken to understand how gesture carries meaning [13,14]. If that which allows gestures to *pass* is being both over-coded and under-coded then the renderings of TPDNE become potent gestures as they render a simultaneous excess and absence of information. The productivity of this over and under coding stretches the significance of the image in several different directions: it a) creates a sensible milieu for questioning the alignment of photographic exposure with histories of passing that convene passing for someone with passing across legal, national and citizenship borders; b) troubles the surface of the photograph that otherwise passes for the surface of pictured objects, where the world is eminently referential, transparent and scalable; c) and perhaps most significantly, opens up new registers of passing that animate a more-than-human, gestural ecology. This gestural ecology operates through formal and aesthetic determinations, which include affective worlds and exceed authorized claims to personhood and concomitant access to rights, empathy and care. The affective worlds in question expand the potentials of visuality itself, which becomes think-able as an incorporeal event and has an effect on how one inhabits agency, autonomy and concomitant narratives of status, aging and progress.

Stopping on the Gesture of Photographing

As the TPDNE image presents a photographic image that problematizes the gestural configurations of photographic capture, the modes of sentience and recognition that it *does* animate take on increased relevance. After Robin Wall Kimmerer, Professor of Environmental Biology and Member of the Citizen Potawatomi Nation, and early animation commentators Sergei Eisnstein and Jean Epstein, Thomas Lamarre describes the sense of vitality or animism in animation as creating an incipient personness that is distinct from anthropomorphism. This process occurs, in part, through "stopping on movement", which produces a "non-localizable inside, or a kind of superject" that emerges in the at times gaped movement given by the animatic apparatus, alongside the appearance of its plastic formation and deformation. Personness occurs as the plastic figuration of characters acquires dramatic concern—as their specific heredity opens towards a future—situated within (and extending outward from) the animatic ecology [15].

This formulation is relevant to unpack the animacy of TPDNE renderings when aspects of the computational

process appear in the image (described in detail in the next section). These renderings *stop on* the "gesture of photographing" by de-localizing the object of photographic capture, signaling a new gestural ecology that takes shape in the appearance of forms and textures with unfamiliar corporeal lineages. These give rise to a concern for future life-worlds driven by the instances and possibilities of human-machine confluence, at the threshold of visibility. Put otherwise, the relevance of truth-claims associated with personhood initially posed by whether the A.I. generated image can pass for a person, give way to a prioritization of a newly distributed personness that is inseparable from the computational apparatus and its worlding of emergent modes of perceptibility. Human-centric figures of personhood reorient towards the *minor* possibilities within the encounter itself. For Isabelle Stengers the minor signals the togetherness of "practices," which cannot appropriate or identify humans to the exclusion of non-humans and are cause for thought, feeling and hesitation [16]. As an impersonal gesture, the TPDNE rendering signals the minor holding together of computational and photographic visibilities, and the possibility for this holing together to become a cause for emergent thought and articulation. Rather than figure A.I. in opposition to or as passing for a person, these minor renderings propose a compositional process that resonates with and can potentially inform diverse practices and modes of sentience.[1]

Impersonal Gestures

The Impersonal Gestures of TPDNE renderings include what I am calling *soft spots* and *horizontality*. Soft spots signal irresolvable differences between corporeal and computational heredities but seem guided by an appearance-based logic that conjures speculative and experimental possibility. Soft spots can manifest as a disruption of the form-ground relation, or appear at the edges separating hair, cloth and skin. Light effects such as shadow, highlight and saturation can appear to be the projections of missing objects, suggest material solidity, give an angular or patchwork quality to the skin's surface or support new form-ground continuities. Sometimes objects that are otherwise distinct (like hair, jewelry and skin) merge and form altogether new configurations, the basis of which sometimes suggests formal mimicry. Soft spots have no general mode of articulation—their ontological basis resides in the specificity of each example and the event of its recognition. Softness marks a quality of encounter where intelligibility is both familiar and unpredictable, fixed and indetermined.

Horizontality appears over the course of the fourteen-day training period of the learning algorithm (as pictured in a .gif animation in the article linked to the TPDNE website) [17]. In this animation, values are heterogeneously articulated over the computational surface and facial features appear to have an equivalent material value to hair—the nose, eyes and lips are as impermanent as the changing volume, length and shape of hair. Amidst this modification of the relative permanence of facial features, their shapes and textures seem to actively animate and co-constitute the appearance of the face over time but in a way that disrupts the possibility of localizing any singular expressive agent. This allows for reimagining the stability with which the photographic surface holds an image and that with which the face and other material objects operate as either figurative or subjective references in time. Horizontality offers the possibility of moving recursively, both with hesitation and abandon, to sense and co-ordinate a non-linear bodying across photographic, computational and corporeal surfaces.

Conclusion

The TPDNE image reveals the photograph as a gesture, as a particular ordering of sensory experience, that constructs persons both figuratively and affectively in the instant, as evidence, as objects of capture. As the TPDNE rendering stops on the gesture of photographing it de-coordinates this alignment while simultaneously offering new modes of sentience that traverse the human, the photographic and the computational. Just as TPDNE renderings upset the stability of the photographic gesture, they reformulate the person through impersonal gestures that propose a mode of thought, which is not restricted to a separation between human thought and the black box of algorithmic function, but that helps to configure speculative possibilities for reimaging and *resensing* the co-composition of media and corporeality. The TPDNE image makes think-able modes of sentience that can challenge, dismantle and live alongside existing media as well as computational infrastructures designed to maximize capture through automation, predictive targeting and ubiquitous surveillance.

[1] I explored how the impersonal gestures of the TPDNE rendering could inform a collective drawing practice in the workshop "Thresholdings between drawing, photography and A.I. generated images" for the conference *Thresholdings: Intimacies. Opacities, Embodiments* (2019), McGill University.

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Expanding Sensitivity in Immersive Media Environments

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Abstract

This paper proposes a shift in aesthetics that can account for the bio-chemical dimension of subjective experience. We argue that this shift allows to become more sensitive to *how* we experience, instead of focusing on just *what* we feel. To achieve this, we focus on media environments that manipulate temperature, air flow, or oxygen levels in the air, in order to affect human subjects in a bodily as well as emotionally-affective manner. We argue that media environments that intensify climatic processes so that they can be sensed, potentially change what we consider to be important in our environment and what we include in our consideration of future actions. To explore this shift, we will take an immersive virtual reality (VR) environment that we have created to flesh out the characteristics of such an embodied aesthetics. The VR environment represents a natural surrounding in which the participants' respiration impacts the growth of virtual plants. Over the course of five minutes the participants experience the correlation of their own metabolic processes, the photosynthesis of the plants, and the rising temperature in the surrounding with different sense modalities. Based on observations of emotional and behavioral responses to relations mediated by the environment, we propose that an *aesthetics of metabolism* allows us to become more sensitive towards our own bodily involvement with the world and towards other sentient beings we are sharing the world with. Lastly, we believe the media environment presented here illustrates how a practical aesthetics and prototyping can help developing new forms of knowledge in the humanities and provide best practice examples for interdisciplinary research.

Keywords

Aesthetics, Embodiment, Immersive Environments, Media Ecologies, Virtual Reality, Phenomenology

Introduction

Our research follows the assumption that we need to develop new sensitivities for environmental processes in the everyday in order to cope with complex phenomena like climate change. In most industrialized countries, we spent a large part of our life in climate-controlled environments. Embedded in a relatively stable climate, our bodies usually do not go through processes of adaptation that would be intense enough to be sensed consciously. And yet, the climate of our planet is changing at an increasing speed, a process that we only slowly get to feel in our everyday lives. The subjective experience of climate change takes the form of extreme weather conditions from dryness, to heavy rain, and an increasing number of hurricanes. Is there only shock left for us as a possible experience of climate change? The key objective of our research is to analyze and explore precisely how aesthetic milieus provide an experience of usually intangible processes like changing climatic conditions in one's own body, and between bodies and the environment. Aesthetic is understood here in the sense of information gathered through the senses as opposed to the appreciation of beauty. An aesthetic milieu thus shifts the awareness of an experiencing subject towards the way something appears to the senses. We thereby propose that a heightened sensitivity to minimal-affective processes *inside* and *outside* of our bodies can help us to relate to external events, even, perhaps, on a planetary scale. To highlight how a new category of aesthetics can help to refigure concepts like human and non-human and the status of conscious awareness in navigating the shared world, we introduce operations of meaning-making that usually are not used in aesthetics to describe experience. Central will be the concept of *stigmergy*, commonly used to describe behavior in large insect colonies.

An Aesthetics of Metabolism

The way climatic processes in our surroundings or metabolic processes inside our bodies influence who we are and what we do is usually not explicit to us in experience. Yet, how much energy we have, impacts the way we feel, how we act, what we consider possible (Cole, et. al. 2013). What could an aesthetic practice do for the sensitization for climatic processes in our surroundings and the metabolic processes that go along with them? Can a shift to the aesthetic mode of perception – to the way *how* we experience and come to form abstract thoughts – allow us to attune to the metabolic processes that are the condition of life itself? In this text, we will address these questions by examining an aesthetic situation that draws attention to the metabolic interrelations that exist between human subjects and their

surrounding environments, thereby refining the subjective experience of metabolic processes.

A focus on metabolic processes allows us to explore the interconnections of the biological, social, habitual, and rational dimensions of human life. Metabolic processes traverse these dimensions, they can be found internal to bodies, external in their surroundings, as well as at diverse thresholds between what we use to refer to as the inner and outer domain of organisms. They maintain the living organism to enable the transformation of oxygen or food into energy, and to repel what is not needed or not usable in form of wastes. Metabolic processes happen usually on temporal and spatial scales outside of human conscious awareness. Thus, providing an aesthetic experience of their effects, of the different intensities associated with them, and how they can be reflected and acted upon, also shows how our everyday actions are influenced by unconscious processes. In the following, we explore the characteristics of an aesthetic experience of metabolic processes in a virtual environment that simulates correlations between the participant and vegetal life forms.

An experience of being interrelated with a virtual plant

In order to explore if expressions of metabolic interconnectedness between a human subject and their envrionment can lead to a better understanding of the affectability of our own bodies as well as our surroundings, we developed a virtual reality experience in a team of philosophers, artists, and designers. The team consisted of Michaela Büsse (ixdm, Basel, Switzerland), Sarah Hermanutz (artist, Berlin and IKKM, Weimar, Germany), and Andreas Rau (designer, Berlin, Germany and Oslo, Norway).

Figure 1.VR Installation, detail particle stream. Copyright: Michaela Büsse

Give and Take is an immersive and responsive environment aiming at creating a sensitivity for atmospheric processes and how we share the atmosphere with nonhuman others, like plants. The correlation between the nonhuman other and the human subject is made experiential here through breathing. In breathing, our bodies share the atmosphere with other entities such as plants, altering it at the same time through adding carbon dioxide, for example. Carbon dioxide on the other hand is converted through the photosynthetic activity of plants into oxygen, which we and other aerobe organisms need in order to survive. One could thus state that we constantly share metabolic pathways with vegetal and animal life surrounding us. This sharing of metabolic pathways through breathing was made explicit in our prototype, as shown in Figure 1.

The prototype is comprised of a VR headset with an attached breath sensor, heating lamps, and fans. We now demonstrate the characteristics of a metabolic aesthetics in this media environment by giving a walkthrough of the virtual experience we designed for the first prototype. Inside the VR headset the user sees a grassland with plants and experiences on a physical level, how the environment gets warmer. We visualize the oxygen particles emanated by the plants and the carbon dioxide that the user-subject exhales, as shown in figure 2. The breath sensor adequately measures their

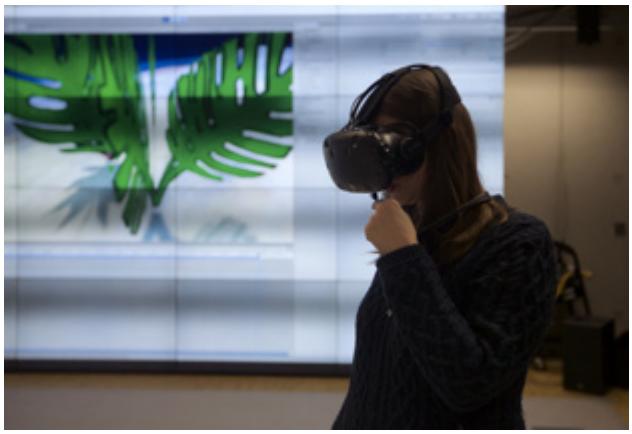

Figure 2. Prototype VR Installation, detail breath sensor. Copyright: Desiree Foerster

breathing rhythm to match the visualized particle streams of exhaled carbon dioxide. We use the heating lamps and fans to facilitate the effect that the temperature rises. Thus, on a visual level, the subject sees how the plants get impacted by the increasing temperature, how they begin to wither and are less able to convert the carbon dioxide that is exhaled into oxygen. Over the course of the virtual reality experience, which lasts about five minutes, the oxygen particles begin to fade out and the particles representing carbon and pollution become denser, until they fill up the visual space, darkening it. At the same time the air around the user-subject gets warmer and breathing harder.

As a virtual environment, *Give and Take* stimulates particular expectations that follow a dynamic of command and control: the way we are commonly introduced to VR is gamified, we expect to interact with the virtual environment, to solve a puzzle or to operate something, such as playing golf. This is not the case in *Give and Take*. The user can only observe, feel, move a little away from a human centered perspective and possibly start thinking in an atmospheric way:

not clinging to subject-object boundaries, but in becoming aware of dynamic relations between entities. Our relation to the – artificial – environment, our expectations about the experiences it offers, are thereby disrupted. This possibility of a non-anthropocentric perspective is in the following explored with the concept stigmergy.

Understanding our VR experience via the lens of stigmergy

Give and Take allows to experience with multiple senses how our own bodily presence impacts our immediate surroundings. It is a prototype to further explore if human subjects can become sensitive towards interrelations with others that might not be human, such as plants, when a digital environment mediates the effects of these interrelations. If digitally and atmospherically conditioned environments register for example the relation between carbon production, temperature, air condition, and express their effects on other forms of life in such a way that they can be felt by a human subject, we might develop a new sense of sharing the world with these other life forms. This sense of being in the world with others can be further explored with the notion of stigmergy.

Stigmergy as a concept was first applied to the study of insect colonies like ants and termites in order to understand the way they use the environment to transmit information. In general, this concept, coined by entomologist Pierre-Paul Grassé (Grassé 1982), describes a mechanism of coordination that not only is used by insects, but also other networks, including human networks. The openly collaborative online encyclopedia, Wikipedia, is a well-known example of a stigmergic environment. As such, stigmergy grew as a concept that now entails cooperation and self-organization in large groups, in which the agents communicate through changes in the shared environment.

The feature of stigmergic environments that made it attractive for human contexts of organization is that the local individual is able to act within global complexity without being overwhelmed – because every agent in a stigmergic environment acts at a localized point within a larger network:

> [L]ocal agents with limited knowledge and resources are not overwhelmed with global complexity, as they are exposed to optimal information load and problem solving which requires only simple actions. Self-organization of local interactions can yield a coherent systemic outcome that provides required control in the hands of local agents, who are unaware of the global problem as well as the impact of their own actions on it, and at times, even of the actions of their local peers (Van Dyke Parunak 2006).

Local agents act therefor on perceivable *marks* in the environment without the necessity to know how these marks or the action that follows, relate to any kind of larger context. This action itself in fact leaves a mark in the environment, re-shapes an aspect of the environment that stimulates further actions.

Stigmergy still is primarily researched in symbiotic relationships, in which two or more species form a relation within an environment that offers different conditions for each. Here, the behavior or state of another being – which might even belong to a different species or is temporally and spatially dislocated – starts to matter for an individual entity or a different species as a whole. Species that engage in a symbiotic relationships often seem in this sense to develop a sensitivity for the meaning of environmental conditions for the other species they interrelate with.

This can be exemplified with the symbiotic relationship between *Atta* ants and *Lepiotaceae*-fungi. The ants cultivate the fungus in their nests primarily for nutrition. Both, ants and fungus need oxygen. However, the fungus seems to need higher levels of oxygen to thrive. As a consequence, *Atta* ants seem to have developed a sensitivity to the meaning of the environmental conditions for the fungus. They learned to become sensitive to patterns that express processes that are not of immediate importance for them, but that would endanger the health of the fungus. The shared atmosphere in the nest functions as a stigmergic environment that signals necessary actions on behalf of the health of the fungus.

So what does the consideration of different forms of meaning-making that come before conscious awareness imply for the role of art and aesthetic experience for the possibility to re-figure our relation to the environment and others we are sharing the environment with? The installation *Give and Take* does not offer ways to control the virtual environment. But in attending towards the suggested metabolic interrelations and the perceivable traces they leave in the environment and the user's body, affective processes that usually form the background of experience can come to the fore and allow for reflection. Following that, aesthetic situations that relate us to others in ways that are not manageable by ordinary, anthropocentric means, might create a base to think about ways to co-create livable worlds with others that are never fully graspable, human and non-human alike.

In using the biological principle of stigmergy to create aesthetic milieus, we propose learning environments that increase our sensitivity for environmental co-dependencies, which ultimately might lead to a new sense of caring for others we are sharing environments with as well. If aesthetic milieus such as the above described installation intensify the effects our bodily presence and our actions have on an other such that they can be felt, we might become familiar with metabolic interrelations without necessarily being able to reflect on them at the same time. In this way, we suggest, we develop an embodied, intuitive knowledge that allows to respond to new affordances around us.

Conclusion

The interdisciplinary work on the different prototypes until the realization of the installation has proven to be beneficial for the participating scientists and artists. the development

of questions of different complexity was accompanied by ongoing explorations, which not only allowed to refine the questions but also to challenge the used vocabulary. To place one's own sensitive body and its ability to establish an affective connection to an animated object at the center of an investigation, inevitably influences the reflection on subjective experience.

While it seems certain that aesthetic experience can enrich our subjective experience in the everyday we argue that learning environments such as presented here can provide meaningful experience of our embeddedness into the world, in which a sense of the embodied nature of this experience is maintained. In this way, we argue, the bodily, emotional-affective dimension of our being in the world, may gain importance.

In this paper we explored how the multisensorial capacity of bodies can impact our sense of self and how we act in environments that are mediated as sentient. To address new meaning to relational processes that embed us into our environment, we propose with an aesthetics of metabolism an aesthetic that foregrounds the intensities that come with exchange processes between entities rather than discrete objects. What we have found is that aesthetic experience as a mode of experience, in which "raw" sensual experience is transformed into a meaningful experience had by an individual subject, can increase our sensitivity for the affectability of our sentient environments. An inquiry into aesthetic experience in this sense helps us to understand better how we come to make sense out of our engagement with the world. Developing a sense of our bodily withness with the world beyond what is consciously graspable, might ultimately extend our sensitivity beyond a human-centered point of view. This is because sensations that are not linked to an intention or representational system, which must be placed beyond the position of the self-identical subject, start to matter. An aesthetics of metabolism thus provides a certain orientation to the world, a new perspective which is open to affective processes that transgress bodily and temporal boundaries. We propose to understand this orientation as a practice to reimagine our relation to the world based on a foundational interrelatedness through shared metabolic pathways.

Acknowledgements

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Desiree Foerster holds a PhD from the Institute for Arts and Media, University of Potsdam, Germany. She graduated in Philosophy, Literature (BA) and Media-Culture-Analysis (MA). Currently she is a visiting student at the department of Cinema and Media Studies at the University of Chicago, where she will start a PostDoc in Spring this year. Her current research focuses on how we come to understand the relation between the human and their environment through the lenses of process philosophy, aesthetic theory, and experimental research.

Blimpy - an artistic framework for creating a spatial augmented reality experience with helium blimps

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Abstract

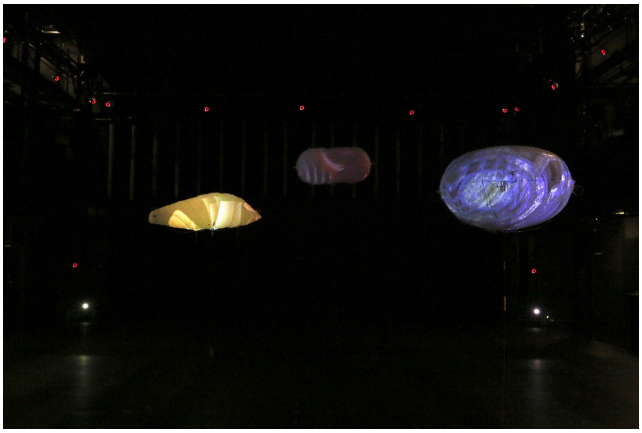
Drone technology combined with spatial augmented reality software provides novel opportunities in the creation of immersive audiovisual performances and installations. The Blimpy project leverages these opportunities by developing a spatial augmented reality experience built around helium devices, which are ideally suited for this application, to explore future research questions on the formal aesthetics and interaction between autonomous agents, people and physical spaces. This paper introduces the framework, which has evolved from the Blimpy project and provides encapsulated components dealing with the technical challenges arising in the creation of such experiences. The framework is designed to be transparent to artists and people whose sole interest lies in the creation of audiovisual performances and has been implemented at the Immersive Arts Space of the Zurich University of the Arts for verification and experimentation. The design of an interdisciplinary workshop employing the framework and Immersive Arts space will further leverage the interaction between researchers and students.

Keywords

SAR, helium balloons, 3D audiovisual mapping, drone, blimp, artistic research, autonomous agents, iot kit

Introduction

The idea of Spatial Augmented Reality (SAR) has been around for more than 20 years [1]. When compared to Augmented Reality (AR), which has become ubiquitous through smartphones over the last decade, the adoption of SAR has been limited because of its technical complexity and required resources. For the use of SAR, where graphics are projected on (potentially) moving objects, a precise and low latency motion capture system, projectors with low input-lag, and powerful graphics hardware are required to create effective real-time audiovisual immersive experiences. SAR has therefore mostly been an academic endeavor with explorations in research experiments [2]. However, continuing technological advances accompanied by cost reduction, especially the affordability of high-performance graphics cards, make SAR attainable for a larger community. At the same time, the release of powerful open source software for 3D audiovisual projection mapping [3], which handles multiple render passes, transformation hierarchies and projector calibration, provides potent and accessible tools and reduces the technical overhead for the community of artists and creative technologists. In combination, this is finally opening up SAR to the field of artistic research [4][5].



Picture 1. The picture depicts three helium blimps in the Immersive Arts Space of the Zurich University of the Arts. The blimps are tracked with motion capture cameras (red lights surrounding the blimps) and projected onto with projectors in each corner of the space (white lights a the bottom).

Parallel to this development, a new breed of light shows have emerged based on swarms of multi-rotor vertical take-off and landing drones, commonly referred to as quadrocopters. Sophisticated proprietary hardware and software has been developed to control these drone swarms and their lights in 3D space accompanying music and/or artists performances. Several companies have specialized in this field operating on different venues, indoors and outdoors, and create shows with hundreds (and sometimes even thousands) of individual drones [6][7].

Yet in the context of SAR the potential of these drones is limited since they provide little surface area to project onto owing to their physical simplicity. While it is possible to increase the surface area by enhancing drones with

additional physical entities [8], the downside is shorter flight time due to their increased payload. Instead, helium blimps have been recently adopted as an alternative to the highly dynamic drones seen in light shows [9][10][11]. Due to the lifting property of helium large physical entities ideally suited for projection mappings are conceivable, which in addition are inherently more safe and offer longer flight times when compared to drones .

The aim of this paper is to introduce Blimpy, a framework for the realization of immersive spatial augmented reality experiences with autonomous helium blimps. The framework allows artists and designers to develop their own creative language by designing the blimps' shape, behavior and the audiovisual content for the overall appearance. It is designed to be mostly transparent to those creatives that prefer to focus on aesthetic aspects, but approachable for those that wish to engage with the technical details. In addition, it functions as a teaching platform that introduces different skills and techniques required for the creation of such complex spatial augmented reality experiences with moving objects. The software and design resources of the Blimpy framework is publicly [12] available to open the framework to the community for experimentation and creation of immersive spatial augmented reality experiences.

In the following paragraphs, the core elements of the Blimpy framework are described together with the main technical challenges and related solutions.

Blimpy framework

Considering the project's requirements, the following core modules were identified that need to work together: the helium blimps, a manager, a motion capture system, the Spatial Augmented Reality software and client application(s), see Figure 1.

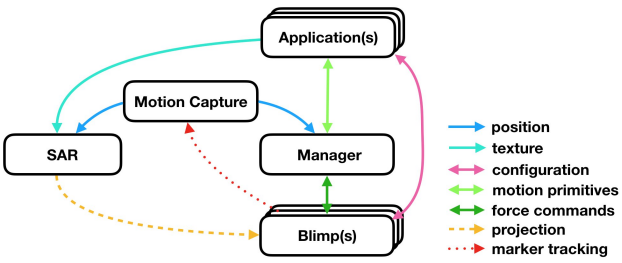
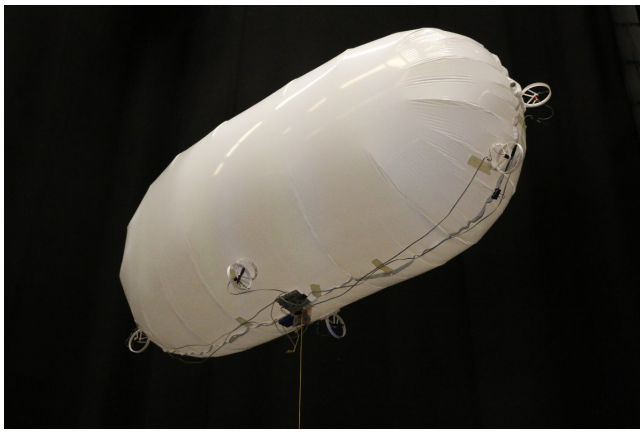


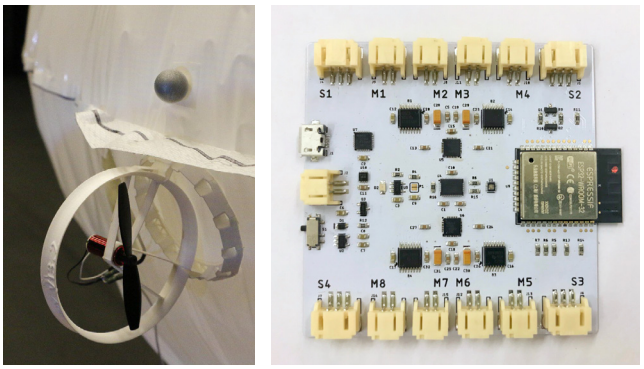
Figure 1. This diagram provides an overview of the Blimpy framework's core components and their interplay.

Helium Blimps

The helium blimps embody physical entities in different shapes, which can be choreographed to move in space and



Picture 2. The helium blimp in this picture is equipped with 6 motors to allow full actuation in its 6 degrees of freedom. The battery and control board are installed at the bottom of the blimp.



Picture 3. The picture on the left shows an actuator of the blimp. The grey ball on top is a marker for the motion capture system. The picture on the right shows the controller board, which can control up to 8 DC motors with propellers and 4 servo motors.

provide diffuse surfaces for the projections. This requires following four main components: 1) a helium balloon, 2) a controller board for receiving commands and controlling actuators, 3) actuators for propulsion, and 4) a battery for power supply. One such blimp is depicted in Picture 2.

In the spirit of creating a framework attainable for a large community, care was taken in the design of these components to allow a fast transition from envisioning a certain blimp design to the actual implementation with no prior knowledge.

The balloons are made with a 32 micron thick foil of EVOH material [13] that is weldable with professional welding machines and dense enough to keep helium inside. The foil is coated with white particles to increase the roughness of its surface for diffuse reflections ideally suited for projections. A beneficial side effect of the coating is the reduction of phantom reflections, which pose problems for the motion capture system.

A custom-designed control board employs a 32-bit, dual-core internet-of-things microcontroller with integrated WiFi and Bluetooth stack for receiving and processing commands. It is designed to handle up to 8 DC motors with the ability to reverse their spinning direction and 4 servo motors to cover a variety of propulsion solutions ranging from propellers powered by DC motors to flaps and wings actuated by servo motors.

For rapid prototyping a dedicated 3D printed enclosure is provided, which holds a specific DC motor and propeller combination and can be firmly attached to the balloon with double-sided tape at a desired location. Since the size of a blimp has an immediate influence on its ability to generate lift, care must be taken in the design process to be able to compensate the weight of all attached components; in reverse conclusion, a lower component weight allows a greater flexibility in the design process. In general, a large fraction of the total weight is attributed to the battery and hence a larger battery for longer flight time and agility of a blimp implies a larger blimp.

The controller board software is designed to receive desired forces and torques commands with respect to its body fixed coordinate frame. These commands are then allocated to actuator commands of the attached actuators, whose actual location and hence effect on the blimp can be configured remotely via Bluetooth.

Motion capture system

Existing commercial motion capture systems allow tracking of position and orientation of objects in a large space with high precision and low latency, both of which are required for projection mapping with dynamic objects. In general, a sub-millimeter precision and latency on the order of milliseconds is desirable to achieve good projection results. The tracking information is distributed in a computer network with standardized protocols for further processing by other components such as the SAR and manager.

Spatial Augmented Reality software

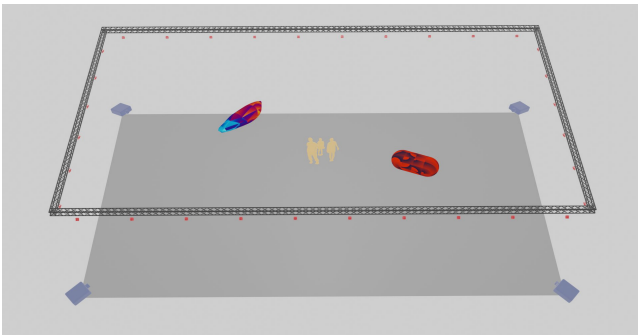
The SAR software is based on SPARCK, which is an open source 3D audiovisual mapping software. SPARCK receives tracking data for each blimp from the motion capture system and calculates dynamically the soft edge-masks for each blimp to project seamless textures onto the blimps. The texture content can either be generated by SPARCK or sent from client applications. SPARCK requires an accurate 3D model of each blimp onto which it should project. For this reason, a pipeline for scanning a blimp's shape and calibration of the projection mapping was developed to guarantee the best possible mapping result.

Manager

The manager provides an abstraction layer between the blimps and the client application(s). Each blimp is controlled to maintain a desired position and orientation by processing its current position and orientation information received from the motion capture system and sending force and torque commands to the blimp. The manager receives desired position and orientation commands for each blimp from external applications and stores them in a queue for periodic processing. At the same time, the manager can also act on higher-level commands such as flying specific predefined paths (i.e. circles), approaching certain points in space, and avoiding or following other blimps. In combination this allows a transparent interaction with a blimp, since the complexity of controlling a blimp is encapsulated within the manager and therefore hidden from the user, who only interacts with client application(s).

Application(s)

A client application sends commands such as desired position and orientation or higher-level commands for one or multiple blimps as described in the previous section to the manager obeying its application interface. At the same time, texture information of one or multiple blimps is sent to the SAR software to complete the desired choreographed projection experience. The choice on the applications' implementation details and complexity depend on the intended target user (i.e. design student, researchers, artists with no technical skills) and her or his requirements. In its most simple form, an application may avoid the manager entirely and instead directly interface with a blimp by sending force and torque commands, which could for example be a smartphone application acting as a playful remote control. In the context of SAR, by employing the manager, an application may be designed to integrate path and texture generation for a single blimp such that a swarm of blimps is controlled from distributed applications. For the generation of a choreographed audiovisual performance, one single more sophisticated application that centralizes the path and texture generation for an entire swarm is likely more practical.



Picture 4. The picture depicts the scale model of the Immersive Arts Space, with the aproximate location of the tracking cameras and the projectors in order to cover as much as possible of the available space.

Blimpy @ IA Space

The Blimpy framework has been implemented and tested at the Immersive Arts (IA) Space of the Zurich University of the Arts (ZHdK), which is a 20m x 12m x 6m space equipped with a commercial motion capture system with 40 cameras and 4 projectors. The motion capture software and manager run on a standard desktop computer, which is connected to a computer network. The SAR software runs on a separate desktop computer with a high-performance graphics card, which is connected to the projectors. A client application generates paths and texture for three blimps. A still of a such a choreography with these blimps is shown in Picture 1 and a 3D-model of the space and the positioning of the devices is shown in Picture 4.

Interdisciplinary workshop

The framework has been designed to provide a rich tool set to creative people and empower them in the process of creating audiovisual performances in the context of spatial augmented reality experiences. To test and validate this design, the framework components were developed in such a way that they can be used in experimental interdisciplinary workshops. The workshops will involve researchers and students of different Bachelor programs of ZHdK such as industrial design, visual communication, interaction design, visual art and music performance. The interdisciplinary workshops engage the students in a series of activities aiming at creating custom flying agents in combination with related behaviors and audiovisual content. The format features the following structure:

- an introduction to the framework components
- conceiving and building custom blimp shapes by cutting and welding the foil
- assembling a blimp by attaching control board, battery and actuators
- programming of the application software
- designing a complete immersive experience by conceiving movement and audiovisual content

The technology transfer enacted by the workshops, which are designed to be interactive and collaborative with the framework's developers, will help to further define future iterations on the framework and improve its documentation.

Conclusions

This paper introduces and releases a framework for spatial augmented reality experiences with helium blimps, called Blimpy, empowering creatives to focus on aesthetic aspects. At the same time, it aims at providing an innovative teaching platform where different skills and techniques are introduced to an audience with little prior knowledge and contact to the complex technology involved in spatial augmented reality experiences. The framework has been implemented and tested in experiments in the IA Space of ZHdK for verification of the concept and chosen technical solutions.
Future research will now focus on more sophisticated swarm control algorithms that enable blimps to avoid each other, different actuation methods such as flapping / wagging movements and interactive performances integrating performers and visitors into the experience.

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Playing with Emotions: Biosignal-based Control in Virtual Reality Game

Project H.E.A.R.T.

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Abstract

Project H.E.A.R.T. is an interactive, virtual reality-based installation which probes the 'militainment' video game genre as a satirical starting point for exploring pop culture, mediated violence, empathy, automation, and quantification of emotional engagement. *Project H.E.A.R.T.* invites the viewer to place their fingers on a custom biodata gathering device, and then summon their enthusiasm to engage a holographic pop star as a form of "combat therapy." The emotional labor of the viewer is quantified through biosensing technologies, giving the viewer indirect emotional control over artificial agents. The narrative of the work implicates the viewer in military violence through their affective participation in entertainment technologies, highlighted in VR through the voyeuristic gaze. The incorporation of physiological metrics into artificial agents fosters a liminal situation between the VR user's corporeal body and virtual space. In an era of self-help apps and biometric devices for controlling one's emotional state, *Project H.E.A.R.T.* embodies a dystopic and satiristic interpretation of these technologies, as well as the limits of technologically mediated empathy and sincerity often championed as the new frontier for interaction in virtual contexts.

Keywords

biometrics, militainment, interactivity, virtual reality, affective computing, video games, avatars, vocaloids

Introduction

Project H.E.A.R.T. (Holographic Empathy Attack Robotics Team) is a satirical pop-militainment VR game that uses a custom built biosensing device to gather data from the virtual reality user relative to blood flow and skin conductance in order to facilitate a kind of emotional interactivity. A user's "enthusiasm" (detected by sudden increases in skin conductance, shifts in cardiac activity and amplitude of the pulse signal) stimulates the holographic pop star to sing in the virtual warzone, inspiring military fighters to continue the war. At the end of the experience the user is confronted with their score: how many of their soldiers were traumatized vs how many enemies were killed.

Background

The Pop-Star Protagonist: Who is Yowane Haku?

Yowane Haku, the main protagonist in *Project H.E.A.R.T.* and the player's proxy, is an officially recognized derivative of the Vocaloid character Hatsune Miku. Miku is the most famous 'vocaloid' developed by Japanese company Crypton Future Media. She, along with a host of other "vocaloid' characters, provide avatars for synthesized human voices made accessible through DAW softwares, and are also otaku-celebrities in their own right [1]. In vocaloid fandom, Haku is acknowledged as a representation of untalented vocaloid users who complain that their work never receives adequate attention [2]. Haku was selected because of her ambiguously satirical character that represents both aspirational celebrity and failure within the scope of a participative media experience. In the game, Haku appears on the battlefield ready to entertain and distract the soldiers as a hologram emitted from a Roomba, which is already a quotidian vulgarisation of military technology [3]. Haku is tasked with channeling moral support by cheering on robot soldiers in correspondence with the player's affective biodata. The player's score in *Project H.E.A.R.T.* finally quantifies how their physiological responses helped to delay the inevitable loss of morale within the cyborgian soldier team as they suffer mounting psychological trauma during battle.

The Concept and Narrative Plot: Moral Support of a Technologically Enhanced Super Soldier

The core mechanic of the gameplay of *Project H.E.A.R.T.* revolves around the moral support of a semi-automated human-mech combat team. These agents are tasked with killing as much of the technologically inferior enemy (represented as human soldiers with standard combat gear and weapons) as possible. The technological inequality

between the two sides demonstrates how the largest danger to the player's technologically advanced soldier team is not physical, but rather, the psychological trauma of violence. The VR user is tasked with supplying moral support to these advanced soldiers through their generation of quantifiable "encouragement," which is channeled by biosensors into in-game holographic pop star Yowane Haku (the details of this process will be covered in a subsequent section). As the robots go about the task of killing the human soldiers, their morale diminishes. The Haku character automatically hovers to the soldier in need of the most moral support, ready to for the user to cheer them on with an enthusiasm-triggered song and dance. In order to gauge the morale of the soldier team, each soldier vocalizes platitudes or complaints between one another, providing clues to the VR user about the overall state of the team. As the overall morale of the team diminishes, increasing amounts of negative platitudes are relayed to the VR user. If the user does not sufficiently provide physiological evidence of her excitement to the biosensing technologies of *Project H.E.A.R.T.*, eventually all robot soldiers suffer from emotional breakdown and ceasefire. When this happens, a flying drone picks up the Roomba that is housing Haku, and the game transitions to the end stage that displays the player's score: a quantification of traumatized soldiers on her team, as well as the total death toll of enemy soldiers killed on the battlefield.

Methods

The Battlefield Environment

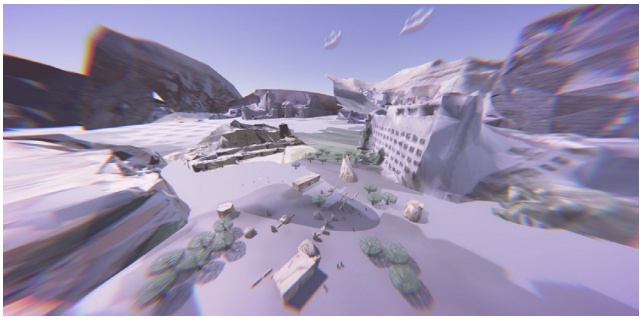

Figure 1. In-game screenshot of *Project H.E.A.R.T.* © 2017 courtesy of authors

The environment design of *Project H.E.A.R.T.* involves a method called photogrammetry. Whereas photogrammetric methods are typically sourced from direct photographs of the subject, in *Project H.E.A.R.T.* the fragmented landscape is assembled from Google Earth images. The images were gathered from geopolitically loaded locales such as Afghanistan, Syria, Yemen, and Iraq. Just as militainment often simplifies and confuses complex politics for a simple narrative of colonial good versus foreign other, the '123D Catch' software attempts to stitch together multiple vantage points of these locales into a cohesive 3D model, but creates large sections of artifacting and noise which fragments the original landscapes. This fragmentation and abstraction alludes to how Western audiences often perceive these locales only through their mediatization- as bite-sized, fragmented, and distorted images that create backdrops to sensational narratives.

The VR user: How does biosensing detect emotional engagement?

The use of sensors to detect and quantify the affective states of a user is commonly referred to as affective computing [4]. While scientific results remain inconclusive on the specific use of physiological sensors to detect emotions particular to valence, it is generally accepted that sudden increases of skin conductance are a robust (if somewhat sluggish) indicator of a broad sense of emotional engagement in response to emotional stimuli [5]. Using Erin Gee's *BioData* library for Arduino-compatible microcontrollers [6], each player's skin conductance is sampled and conditioned with low-pass and high-pass filters in real time during the three minute introductory sequence of the work. After the introductory sequence has passed, gameplay begins. When skin conductance surpasses a predefined threshold, the system labels this event as sufficiently indicative of enthusiasm, and a song response is triggered from Yowane Haku on the battlefield. Complimenting this physiological mechanic, the cardiac activity of the viewer is obtained through photoplethysmography, and filtered over a window of time. When the cardiac activity indicates higher levels of overall arousal, this will similarly increase the area of effect for Haku's song, allowing her encouragement to reach even more of the player's soldier team. These are very rudimentary methods for determining one's affective state, however the game itself is purposefully vague in its references to the emotion needed of the viewer in order to stimulate its engagement algorithms. By using language like "enthusiasm, energy" or "arousal," this allows the system to respond to any number of emotional states that might broadly fall under these linguistic categories of emotion, and integrate them into the algorithmic logic of the virtual battlefield. While the integration of affective sensing into this system might make it more "humane", the ironic potential for interpreting negative emotions broadly—as "enthusiasm"—is not lost on the authors.

In Free Fall: Virtual Reality & Vertical Perspective

There are visual and conceptual maneuvers specific to the medium of virtual reality which are embodied in the game. Verticality is a visual maneuver which repeats itself in various stages within gameplay. The intro sequence has a

moment in which the verticality of the user is heightened by a lack of ground plane. This serves to create variability in the player's biodata by eliciting a physiological or emotional response to the verticality, preparing the sensor calibration for later gameplay.

This perspective of free fall references the social and political dreamscape of geopolitical war as seen from the detached position of technological power. Recalling the critical poetics of Hito Steyerl as she speaks about verticality in technological media, falling can imply a new certainty falling into place, or also grappling with an inevitable force of gravity that propels us into an agonizing present.[7] The place we are falling toward in the game is shifting and dynamic. The movement of the camera in the VR game itself predicts the player's influence on this environment that they are thrust into, a technologically mediated super position that is simultaneously once removed, smooth, and removed from physical harm.

Quantification of a Moral Support System

The game revolves around a complex and indirect system of control. In order to "win", the player's team of soldiers need to outperform their adversaries. However, both the soldiers and Yowane Haku are autonomous agents that cannot be controlled directly by the player. Instead, by changing the state of player biosignals through control of affect, the player activates Haku's ability to inspire soldiers to continue to fight.

The algorithms in *Project H.E.A.R.T.* calculate each soldier's morale through a single numerical value which varies according to a number of in-game events and situations. Hitting an opponent slightly increases a soldier's morale, but killing or getting shot decreases morale. A soldier's morale is further influenced by the morale of their peers in their vicinity, representing the effect of group morale. When a soldier's morale reaches zero (0), the soldier is traumatized and cannot act anymore in the game.

Both the player's soldiers and the enemy soldier teams follow these mechanics; in the case of the technologically inferior enemy team, not only their morale is damaged, but they are physically harmed and die. The in-game algorithms that control the soldier teams take advantage of this mechanic, as soldiers will prefer shooting at enemies with low morale/physical state in an attempt to decrease their morale and eventually eliminate them. Furthermore, soldiers will tend to be psychologically fortified by one another's presence: a soldier that wanders off alone is more vulnerable to psychological distress.

Morale is represented in game through visual and sonic feedback. As each soldier experiences mounting psychological stress, he is surrounded by a halo of red color representing their morale. Team members also regularly vocalize platitudes that represent their state of mind.

Examples:
For the future! (high morale, happy utterance)\
If I die, it is because I didn't try hard enough. (medium morale, neutral utterance)
When will the screaming stop? (low morale, despair utterance)
My good intentions are worthless. (critical morale, trauma utterance)

The morale system is tuned to make the soldiers lose morale over time, and thus, be unable to participate in the battle, however the game provides a mechanism to tilt things in favor of the player's team through the interventions of Yowane Haku. By controlling their own body signals to meet the requirements at the right moment, the player can trigger Haku's inspirational power of song. This event is represented in-game by hearing the popstar vocalizing as musical notes appear over her head. When this happens, friendly soldiers in her vicinity experience a significant increase in morale (figure 2).

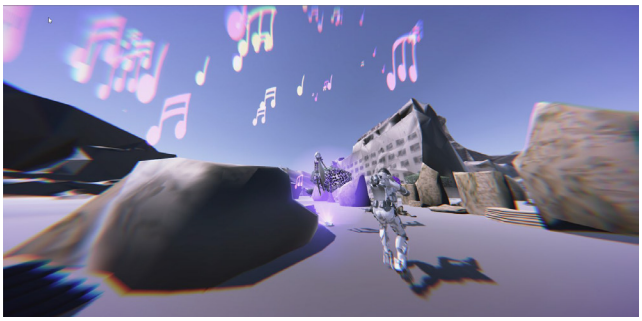

Figure 2. In-game screenshot of *Project H.E.A.R.T.* © 2017 courtesy of authors

The holographic pop idol's movements are beyond the player's immediate control. She moves across the battlefield to get closest to the soldiers with the lowest morale. The core game mechanics rest on an artificial ecosystem where morale is a resource that gets depleted over time, but can be replenished by the player's indirect control over the main character via their physiological markers of emotional engagement.

Discoveries

The VR User: Responses

During the non-interactive, introductory portion of the work, the biosensors commonly detect increased levels of arousal at specific moments, giving the artists concrete physiological feedback about how their pre-rendered work impacts viewers. First, there is a notable rise in skin conductance when Yowane Haku dramatically enters on screen, confirming the affective resonance of this moment. This happens again when the viewer is presented to the battlefield at what's commonly known in the gaming community as 'god's eye view', which drops into 'first person perspective'[8].

Another interesting discovery highlights how some players (intentionally or not) "misuse" the sensors, rendering their scores inaccurate or senseless. The medium of the game predicts a certain amount of "hack," or cheat behavior from players; in this case players were sometimes observed to manipulate their physiological symptoms in order to amplify their scores by laughing maniacally, tensing one's muscles, moving around agitatedly, or producing sudden, sharp inhalations of breath. These physiological "hacks" are the inverse of common self-help strategies for manufacturing calm through breathing and awareness, but in this case the manufacture of emotional arousal is used to help robot soldiers obliterate their enemies.

Figure 3. In-game score screen screenshot of *Project H.E.A.R.T.* © 2017 courtesy of authors

At the end of the game the user is presented with a high score (figure 3) that quantifies their emotional performance within the paradigm of the game; how their affect either protected their own team from trauma, or facilitated further violence against their enemies. Because of the infinite amount of enemies that spawn in the game, the high score represents how long the player can delay the inevitability of their team losing. This 'high score" itself is ambiguous in its own meaning. The player is given no information whether these numbers are to be taken as victory or defeat. This high score panel is intended to highlight the inhumanity of technological quantification when one compares the trauma of one soldier to the death of many enemy soldiers. These numbers present a space for critical reflection on the purpose of the game, such as: how is the player as an emotional body complicit in technologies of inhumane violence via militainment? How does the technological infrastructure itself coax physiological and affective responses from the viewer, however insincere or misinterpreted by the algorithm? What does 'winning' this game ultimately mean? The artists leave these value judgements up to the player. Rather than point to the promise of affective computing as a zone of authentic empathetic interaction in games, *Project H.E.A.R.T.* highlights ambiguous and problematic aspects of its own materiality.

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The Revisit of Sentience: Nam June Paik's Big Sleep in Interactive Art

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Abstract

Nam June Paik created unprecedented art projects for his first solo exhibition in 1963. He invented a variety of interactive art pieces with diverse senses. They encouraged visitors to intervene in the process of making/manipulating unfinished art projects. Even though Paik ambitiously made interactive art for the audience, later on he hardly created interactive art. This paper examines concrete evidence for why he stopped making interactive art and about 30 years later revisited it as cutting-edge art.

Keywords

Nam June Paik, Sentience, Interactive Art, Participatory Art, Random Access, Exposition of Music, Video Art, Video Sculpture

Introduction

At the Galerie Parnass in Wuppertal, West Germany, in 1963, Korean-born artist Nam June Paik appropriated diverse materials from a violin to electronic televisions in his first solo show *Exposition of Music – Electronic Television*. He installed diverse invented/prepared analog music devices including *Zen for Touching* (1961), which appropriates a colander, bell, wires, and bolts to make sounds with participants' real touching, *Urmusik* (1961), which consists of a wooden crate, a tin can, and diverse strings to make rudimentary sounds like a musical toy, and *Violin with String* (1961), which makes scratching sounds from a violin on the ground when the audience walked the traditional musical instrument like a dog. Based on the progressive idea, anything can be music, Paik invited visitors as participants to finish his projects by composing live music. [1] His interactive projects shared the pathos of interactive/participatory art with contemporaries including Roy Ascott and Lygia Clark.

Interactive art as Sentient Art

For his first solo show, Paik also experimented with a variety of media to encourage participants to experience his sentient projects. *Klavier Integral* (1959-63) attached some obstacles such as ointment, barb wires, and small toys to some piano keys for performers and made some piano keys interactive interfaces to not only generate prepared piano sounds but also trigger different electric devices including a light bulb and a powerful motor. This project is Paik's transitional interactive project from non-electric/electronic to electric/electronic art.

To interact with his electric/electronic interactive art pieces, visitors rubbed magnetic tape strings on a wall with a tape recorder head in *Random Access* (1963), put a cartridge of a turn table on rotating records randomly in *Record Shashlik* (1963), and shouted into the microphones in *Participation TV* (1963). Visitors composed collage-based music and drew abstract images in the exhibition.

His music projects encouraged the audience to not only listen to various sounds but also feel the multi-sensorial atmosphere of the exhibition space. No matter what he used, the main concept of his first solo exhibition was interactive art. From the current perspective, his interactive art is original, pioneering, and sentient.

The majority of Paik's interactive projects in his first solo show are in the Hahn Collection in the Museum Moderner Kunst Stiftung Ludwig Wienin (MUMOK) in Vienna, Austria. The museum revisited *Exposition of Music – Electronic Television* by (re)presenting the original space of the Galerie Parnass with the title, *Nam June Paik: Music for All Senses* in 2009. The exhibition interpreted Paik's first solo show as a whole sentient space. From the yard to staircases, Paik utilized a whole building for his exhibition in a blurred boundary between art and non-art. His projects allowed participants to explore his unusual projects from the basement to the ceiling. In other words, the retrospective exhibition encouraged visitors to (re)experience Paik's pieces in a sentient way.

Dissatisfaction with Interactive Art

Based on extremely progressive music ideas including chance/indeterminate/collage-based/electronic music from Karlheinz Stockhausen, Pierre Schaeffer, and John Cage, Paik developed his music as interactive art. [2] Unlike his musical models who maintained the traditional passive role of the audience, Paik designed interactive musical environments, which encouraged audiences to compose music in real time. In 1962, he explained the idea of freedom for the audience in music in the article "Exposition of Music," which was published while Paik prepared the same titled exhibition. [3] As the title explains, Paik designed music as a spatial medium. This approach reveals that Paik's music projects are sentient beyond sounds. Specifically, the last sentence of the article, "Music of the people, by the people,

for the people," which was appropriated from Abraham Lincoln's democratic idea, is intertwined with free of limited sentience. His idea culminated in *Exposition of Music – Electronic Television* with a variety of phenomenological interactive art projects.

Even though his brilliant interactive art pieces were originated from democracy, Paik contradicted himself when he opened the show. He witnessed that as the number of visitors grew in interactive art, the quality of their feedback diminished: some interactors aggressively or flippantly used his interactive pieces. He found the negative side effect of democracy in interactive art. [4] Naively, he did not expect audiences' interactions, which went beyond the artist's intention and control. Finally, Paik found that he should have limited visitors' actions to promote proper interaction with his interactive projects. For this reason, Paik invited less than 20 people to the show. [5] He planned to give a small group enough time to interact with his art pieces. He acknowledged that he could not give audiences real freedom, and his interactive art provides limited people with limited freedom, or more specifically, limited choices. [6] This contradicts his original idea of interactive art in "Exposition of Music."

Video Sculpture in New York

The exhibition was less sensational than he expected in the West German art world. [7] After the solo show, Paik's interests moved from interactive art to visual art such as video art and video sculpture. His older brother, a successful entrepreneur, suggested that Paik return to Japan to save money for researching and making video art. [8]

After developing the next step of video art in Japan, in 1964, he wanted to briefly experience New York and return to Germany to establish his artistic career more firmly there. [9] When he arrived in New York, leading artists collaborated with engineers to make new media art projects and performances. Specifically, Experiments in Art and Technology (a.k.a. E.A.T.), which was founded by the Bell Laboratories engineer Billy Klüver and renowned artist Robert Rauschenberg was in the center of the art-and-technology movement.

Unfortunately, Paik was disregarded by contemporaries in the New York art world. [10] For that reason, he did not collaborate with E.A.T., even though they pursued similar ideas for electronic art. With the help of brilliant engineers at the lab, Rauschenberg performed *Open Score* (1966) at the art and theater group event *9 Evenings*. *Open Score* synchronized the action of playing tennis with controlling lights in a tennis court. When a player hit the ball, one of lights in the court was supposed to be turned off. When the players turned all lights off, visitors' images appeared from an infra-red camera on the screen in the dark space. Due to the difficulty of technical precision for detecting and transmitting a signal when the players hit the ball, the system did not work properly. [11] This technical failure made his contemporaries reevaluate Paik's electronic art, and Paik focused on making his first video sculpture *TV Cross* (1966), which consists of seven color television sets to shape a large cross. [12] As compared to his previous project, this is clear, spectacular, and mesmerizing. This visual art piece reveals his adaptation to New York and became a significant seed for Paik's career as a video sculptor.

Paik designed a variety of video sculpture projects from human-scaled robot figures to large-scaled monumental pieces. For example, by using nine old television sets, piano strings, and hammers, he finished the visual robot project *Cage* (1990) named after his master John Cage. By using more than 1000 television sets, *The More the Better* (1988) made homage to Vladimir Tatlin's *The Monument to the Third International* (1919-20). With the subsequent successes, Paik became well known as the father of video art. In particular, his multi-monitor video sculpture became a prototype of video installation and is exhibited in major galleries and museums around the world. Paik's success in New York almost made him forget his early experimental/creative/sentient interactive art.

Return to Korea, Return to Interactive Art

After a huge success in New York, Paik was frequently invited to international art events in his mother country, South Korea. Specifically, he was requested to curate an international exhibition as a part of the Gwangju Biennial in 1995. He did not select mainstream art pieces for the event. Instead, he returned to interactive art.

After some legendary group exhibition including *Cybernetic Serendipity* and *Software: Information Technology* in the late 1960s and the early 1970s, interactive art did not have a good position in mainstream art due to its technological and connoisseurship issues. [13] Moreover, major art theorists, historians, and curators thought that technology in art is a secondary supplement to install and maintain art pieces. [14] Interactive art was often disregarded by galleries and museums and needed to find alternative places to be introduced. [15]

In a new Biennial in South Korea, Paik planned to invite an updated version of interactive art to the major art event. In the exhibition catalog, *InfoART: '95 Kwangju Biennale*, Paik confessed that he inevitably created interactive art, which needed visitors' passive participations to generate sounds and visual images in his first solo exhibition, due to the lack of advanced technology. His statement is not to criticize his early interactive art, but to focus on a brighter future of interactive art. Paik found that advanced computer technology can not only improve audiences' participation but also provides them with a lot of sentient possibilities. [16] In the exhibition, with co-curator Cynthia Goodman, Paik invited both upcoming and established talented artists in the field of art and technology.

Interactive in Arts and Toolmaking

Paik and Goodman named the exhibition title as *Interactive in Arts and Toolmaking*. It reveals those curators introduce interactive art in a blurred boundary between art and technology. This was a unique concept for not only an art exhibition in mainstream art but also an international art bien-

nial. This was made possible because the Biennial pursued no specific authorities in a blurred boundary between elitist art and sub-stream art. [17]

In *Interactive in Arts and Toolmaking,* Paik himself exhibited the legendary video manipulation device, *Paik-Abe Synthesizer* (1970). This interface was originally not for the audience but for himself to create video-collage images for his video sculpture. However, Paik introduced the video synthesizer to visitors as interactive art. This reveals that Paik returned to interactive art for the audience, and the synthesizer became a significant seed of interactive art. It is natural that Paik as the curator invited 23 art and technology projects including his synthesizer. The exhibition includes Jeffrey Shaw's *Revolution* (1990), which allows visitors to rotate a television in a mill stone to see interactive video, Steina Vasulka's *Violin Power* (1991), which shows a violin as an interactive interface for a video manipulation with a MIDI technology, Paul Garrin's *White Devil* (1992-93) that an aggressive white pit bull dog follows spectators from a multi-screen image on the floor, Luc Courchesne's *Family Portrait* (1993), which allows visitors to communicate with a portrait by picking a question from a pre-established set on the screen, Christa Sommerer and Laurent Mignonneau's *(A)Volve* (1993-94), which visualizes living creatures with cutting-edge generative technology, and David Rokeby's *Watch* (1995), which manipulates only moving objects from a live surveillance camera and shows black-and-white abstract live images. As an open-minded curator, Paik provided visitors with a history of the new kind of art as well as a variety of sentient interactive environments.

Conclusion

Nam June Paik's dissatisfaction with interactive art did not entirely made him reject it. In this regard, the ending point of Paik's interactive art was not a real end but a big sleep for the second generation's interactive art. As Paik predicted with advanced technology, artists have been creating significant interactive art pieces with even more freedom and sophisticated sentient environments.

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The Barbican Totem: Lighting up the brain, zoning in on synapses, redistributing sentience

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Abstract

This short paper presents a sensory ethnography of audience response to a pulsating, highly dynamic light sculpture called "Totem" that formed part of the "AI: More than Human" show at the Barbican, which ran for four months during the Summer of 2019. Totem was created by Chris Salter and associates. The piece (which is dotted with sensors) could be said to hold a mirror up to our brains, so that we see the neural processes involved in our perceiving the environment while the artwork perceives us. Totem takes the idea of interactive art to a new level, and in so doing short-circuits the brain.

Keywords

Sentience, Synapses, Sensory ethnography, Brain emulation

Introduction

"Totem" is an art installation that forms part of the AI: More than Human exhibition which ran at the Barbican from May through August 2019. The principal creator of this dynamic light sculpture is Chris Salter who holds the Concordia University Research Chair in New Media, Technology and the Senses at Concordia University, Montreal. Other notable collaborators on the project include Sofian Audry, Clarkson University and Takashi Ikegami, University of Tokyo.

Totem is a very tall, thin structure (49 feet tall, 30 inches wide, 9 inches deep). it is divided into 16 sections, or rectangular panels. It is like a totem pole, but instead of being carved from wood it is made of glass screens encased in dark metal, and instead of animal figures it is composed of row upon row of LED lights (roughly 18 rows per panel).

Totem juts up through a hole in the floor and extends all the way to the ceiling of the cavernous ground level of the Barbican. It is cordoned off by a circular steel parapet that visitors can lean on to peer through the hole to the base of the structure on the floor below. At its upper reaches it abuts a series of square-shaped skylights. The light emanating from the display outshines the light of the sun, even on the clearest day in London.

Totem is situated in the middle of a long sloping walkway, about 12 feet wide, that people use to get from the main entrance to the theatres, restaurants and courtyard below. They also line up here on the edges waiting to get in to see the exhibition. Visitors amble along the walkway in a never ending steam.

Figure 1: Totem. Phase 2 (left), Phase 3 (right).

Visitors engage with Totem in three ways. One is to ignore it, to walk right past it, on their way to meet friends or to make it in time for a show. They deliberately avert their eyes, possibly because of the brightness of the LED lights, or perhaps because they are all too used to flashing lights being used to grab their attention and do not want to be distracted.

The second is for visitors to glance up briefly and keep on walking, but then look back over their shoulder because something about the display does catch their eye, but they know not what, and so continue walking. One older man rubbed his eyes, as if to soothe them, after craning his neck

to look back at the tower of pulsating light, and continued walking.

The third is to be arrested by Totem, and try to see what it's all about. These are the people I would approach and ask if I might view and experience Totem together with them.

This approach to the study of audience response goes under the name of "sensory ethnography." It is grounded in participant sensation, which differs from the conventional ethnographic method of participant observation by virtue of the way it relinquishes the status of the observer and seeks instead to "feel along with" the participants what they experience. Francois Laplantine calls this the partage du sensible or "sharing of the sensible." [1] There is an interactive component to this approach: gestures are mimicked, observations are exchanged, and questions flow back and forth as each experiences the event or object through own and others' eyes. The encounter can prove profoundly enriching for ethnographer and interlocutor alike.

Only rarely do visitors take time to read the plaque with a description of what the work is about. (Most of those who were arrested by Totem did not.) According to the plaque,

> Totem is a light installation exploring the possibility of an artificial entity developing consciousness. The installation's sensors scan environment changes in light, sound, humidity, temperature and motion and feed this information to a neural network. These variations then inform the rhythms and pulsing rate of the light. The installation moves through different states - from an unconscious state of dreaming to a state of being awake where its patterns and rhythms are dynamic and hypnotic.

Totem may thus be said to hold up a mirror to our brains. But it is not representational. It is sensational, and indeed the experience of the display is too variegated to be reduced to a diagram or representation.

Totem unfolds in three phases, each about three minutes long, which blend into each other at the moments of transition. In the first phase, it presents as neurons firing at random, flitting across the dark background, while some coagulate and fire in concerted bursts, or what is called "spiking." The spiking neurons undergird the patterns in phase 2 when swathes of neurons expand or contract in waves which eventually fill the whole surface of each panel and the whole length of the display. The neurons come in predominantly white, some grey and the odd black patch of light. They are always flickering, like "sunlight glinting off the surface of a lake" (in one interlocutor's words) but on occasion they all fire in unison in a blinding flash of light, like "sheets of lightning." In phase 3 a series of symbols appear which consist of lines continuously branching rhizome-like, this way and that (Figure 1 [right]). These symbols or glyphs are generated by some algorithm, but it is not possible to tell what they are spelling, which gives them an aura of deep mystery.

The firing of the neurons is evoked by flashes of light given off by the LEDs. these flashes are refracted through a pair of lenses beneath the smooth glass surface of the two-faced tower. The effect of this refraction is quite intricate. Standing directly in front of Totem, at eye-level, the pulses take the shape of rhombuses, purely two-dimensional parallelograms. Very geometrical. When viewed from off to one side (Figure 1 [left]), however, they take on the appearance of what my interlocutors variously described as "sails" or "fins," or, increasingly, as we looked up, darting "kites" or "stingrays" with long tails. Also, as we looked up, even from directly in front, the rhombuses became increasingly three-dimensional, to the point, in the uppermost reaches of the tower, where they looked like "a row of skyscrapers," one person suggested, a "picket fence" opined another, "bristles on a brush" suggested a third. So, the pulses are both two-dimensional and three-dimensional, flashes and traces, solid and fleeting, hither and thither. The pulses also vary in intensity, white or black or grey at eye-level and increasingly grey or feathery, ghostlike, as one looks up. It bears repeating that Totem has two faces, but the two sides are not in sync. Each face displays a different phase. It is a Janus-like deity

What is the best position, the best angle from which to view Totem, we wondered? Head-on at eye level, from off to one side or the other, looking up or looking down? The fact is Totem does not privilege any one point of view, but many, all at once. Yet it is impossible to take in the whole in one glance, even from a distance, partly because the installation plunges down through or juts up from the floor below which severs one's line of sight, and partly because it is so immense, towering over the spectator. What is more, the illusion of three-dimensionality corrals one's vision, drawing you the viewer into its inner tectonics. Totem is a screen unlike any other in this respect, because the space it creates is not flat. Also, it is next to impossible to photograph. Attempts to photograph it yielded fuzzy images, penumbras or halos, due to the surfeit of luminosity. The object constantly exceeds its own bounds. It is an ecstatic thing, creating yet another dimension, in the space between the object and the spectator, a hallucinatory space born of interaction.

One of my interlocutors, an Irishman, likened the experience of Totem to the numerous times when he was taken by his parents to see a "moving statue" of the Virgin Mary in a church in his native country. The illusion of the statue moving could be explained, he opined, by reference to the scene being illuminated by the flickering light of

candles, the crowd of onlookers packed together shoulder to shoulder all swaying in unison, and the rhythmic sound of the nuns reciting some canticle. All of these stimuli together created the conditions for the statue appearing to levitate, to be imbued with its own life and power.

Another interlocutor commented on how the shape of the rhombus is pregnant with potentiality in the same way that the ovoid motif in the Native American art of the northwest Coast has a latent dynamism. The ovoid is neither a square nor a circle, but rather like a lima bean given the indentation at its base. It contains the apprehension of expansion, of growth, even while being strictly bounded. The ovoid is typically used for the eyes or joints of the totemic being, which are points of potency. It is also true of the pulsating rhombuses appear to harbour a latent potency.

Figure 2: Salmon trout head with ovoid

The suggestion that Totem is like a Cubist painting on account of its multi-perspectivalism was also floated. Think of Duchamp's "Nude Descending a Staircase," one observer suggested. This analogy agreed with the fact that Totem fractures the picture plane, and plunges the Euclidean space we normally inhabit into confusion, but it failed to capture the dynamism of the constantly morphing patterns. Totem is an ecstatic object.

One term that kept recurring in my interlocutors' attempts to articulate their experience was "organic." Organic in contrast to mechanical, even though the displays were a product of machine learning, and a very intricate cybernetic process. In other words, Totem is living art, not machine art, like most of the other installations in the AI show. This is perhaps attributable to the liveliness of light.

The very liveliness of the display also had a downside though. A number of my interlocutors described the display as "frenetic," or "agitated." In mathematics, a distinction is drawn between the discrete and the continuous, one interlocutor observed. Totem is composed entirely of discrete bits. There are patterns, but every pattern exists only in the instant, dissolving as quickly as it takes shape, and it is impossible to predict the next pattern, because the changeovers happen in such quick succession. There is no sense of the designs evolving, no narrative.

And yet, when one stays with the display long enough, it is possible to observe a progression. From the first phase of neurons spiking, through the second phase of the neurons self-organizing into sheets of speckled light to the third phase when the glyphs appear. This progression could be likened to a transition from raw sensation through perception to symbolization or cognition. But what is the meaning of these glyphs? One interlocutor likened them to Chinese characters on a scroll or banner (Chinese being a foreign language to him). But unlike the fluidity of calligraphy, the ciphers have a staccato rhythm, and rather than being continuous they are stochastic. This is because they are a product of machine learning, and therefore autonomous, obeying their own algorithm, which is independent of human cognition. One spectator nailed the sensation of their alien character by suggesting that they were produced by creatures from another planet.

This thought of the symbols being messages from an alien race is curiously apposite. But in another way they are manifestations of a peculiarly human unconscious. Totem drills down to the neural infrastructure of human consciousness, where neurons spark in a random fashion yet also coalesce into patterns. "Neurons that fire together wire together," as neuroscientists say, and thereby lay the foundation for perception.

Here it should be added that Totem interacts with its environment. It is equipped with motion and sound sensors attuned to the movements of the crowd. This information is fed back into the software program which animates it, and is manifest in the constantly shifting patterns and intensity of the pulses. The frenetic behaviour of the display is thus a reflection of the activity of humans and others in the environment. It is perceiving you as you are perceiving it. And through the mutuality of this gaze you are seeing yourself perceiving, because the display is refracting the workings of your brain. This revelation did not surface in each of my interactions with my fellow spectators, but when it did, the effect was jaw-dropping. The cybernetics of it all were awe-inspiring, literally.

Artificial Intelligence, in the words of the AI: More than Human catalogue,"emulates the behaviour of the human brain." Speaking personally, I have always wanted to experience a synapse, ever since I learned about the neural infrastructure of my consciousness from reading books on brain science (impossible as that desire might be). Here at last was my chance! I revelled in it. One other interlocutor, steeped in Buddhism, also relished the experience. Unattached to any construct of a unitary, bounded, enduring self as the ground of his existence, he spoke of

feeling “serenity” whole absorbing the cascading patterns of light.

To conclude, Totem instigates a (re)distributioon of the sensible, interweaving the conscious and subconscious processes which mediate our perception of the environment. It offers a profound meditation on sentience in the expanded field.

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Revaluing Women's Labor through Material Engagement with Musical Instruments Built from Domestic Tools

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Abstract

The *Women's Labor* project uses embedded technologies to transform domestic tools into new musical instruments. Traditionally relegated to the private sphere, domesticity is recast in a new light through public engagement and performative spectacle in installations, workshops and performances. *Women's Labor* is a multi-stage, ongoing conversation between the public and artists to interrogate issues surrounding feminism and domesticity. In this social activist artistic project, we revalue traditionally unpaid labour of women by placing it in public spotlight and interactivity. These stages are: 1) instrument creation; 2) public installations; 3) community workshops; 4) commissioned compositions by female-identifying composers on the instruments with "female-friendly" historical instruments (clavichord and fortepiano); and 5) public performance of the new compositions with past female composers' works. The instruments created for *Women's Labor* include the *Embedded Iron (See Fig 1)*, the *Umbrella Rotary Dryer*, and the *Embroidery Hoop* that are in various stages of completion. This paper focuses on the first completed instrument, the *Embedded Iron,* a sensor-filled 3D printed clothes iron modeled on an old fashioned coal iron, paired with a wooden ironing board with built-in speakers. The team for Women's Labor consists of artistic director and project creator, Jocelyn Ho, UX designer and composer, Margaret Schedel, and technical director, Matthew Blessing. With its first sound installation and performance at the UCLA Art-Sci Gallery this year, this paper will discuss the *Embedded Iron's* conception and task of bringing light to domesticity through material engagement theory, expanding sentience through tools.

Keywords

Music, interaction, embodied cognition, interface, mapping, tools, performance

Introduction

In "The Musicking Machine," cultural theorist Jody Berland remarks that "when a medium is displaced by a new medium, it becomes a work of art…. Its former transparency as a medium disappears behind its newly foregrounded materiality." [1] In most cases domestic tools are transparent or withdrawn in two senses: firstly, they are subsumed in the world of domestic laborers and not given a second thought about the habits they form in a shared domestic culture; and secondly, they are invisible to the patriarchal culture that we live in that renders feminine work invisible and thus, unpaid. In *Women's Labor,* these tools are imparted with newly foregrounded materiality—that is, sonic, sentient materiality. The *Embedded Iron* feels and responds to the different fabrics with different timbres, it senses the directionality and velocity of its movement and responds accordingly with pitch and volume. By endowing the iron with sentience—expressed through sound—we bring the act of, and meaning behind, ironing to the fore.

Figure. 1 1st prototype of *Embedded Iron*

Background

There have been many projects that intersect the tools of domesticity and technology. Matthew Blessing's *Musical Chairs* reimagines living room furniture as performable, embedded instruments. [2] Luke DuBois and Lián Amaris Sifuentes moved an entire bedroom suite to Union Square in *Fashionably Late for the Relationship,* using technology to "play with conceptions of time, femininity, and intimacy." [3] In a similar vein, Nicolee Kuester augments the act of hair combing with sound using Mari Kimura's MUGIC™ sensor in *Conversation Piece No.1*. [4,5]

Women's Labor explores the sonic materiality, sentience, and distributed cognition of domestic tools as musical instruments and was preceded by Ho's *Synaesthesia Playground,* a collaborative multimedia piano recital that she directed with six newly commissioned multimedia works for the piano. In this project, Ho led a team of fifteen composers, visual artists, technologists, and

fashion designers to create a recital to explore the themes of inter-sensoriality and materiality. In *Synaesthesia Playground,* two large-scale multimedia artworks framed the recital: a fiber-optic jacket that Ho wore during the performance called *Bio Lux* and a live project mapping onto the body of the piano called *Piano Epidermis* (Fig. 2). The two artworks responded live to various parameters—Celeste Oram's *Piano Epidermis* is a reimagining of the piano as a living organism with a skin that responded to the sounds that the pianist played, while Nobuho Nagasawa, Hul Arnold, and Jocelyn's *Bio Lux* displayed an artistic visualization of the biometrics of the pianist during the performance.

Figure 2. *Toccata and Bruise*

The most relevant to this paper is *Piano Epidermis* and its associated compositions. In *Piano Epidermis,* Oram expanded the conception of a piano with sentience, creating a piano with a dynamic "skin" that responds to the pianist's playing using live projection mapping. In her piece "Piano: Death and Life," musicologist Deirdre Loughridge muses on the piano assuming humanness, rendering it more than an inanimate object in public consciousness. [6] Indeed, such an anthropomorphic view of the instrument is revealed in the common analogy of the damper pedal as the piano's 'soul,' coined by Anton Rubenstein. [7] Inspired by the practice of painting narratives onto the body and lid of the harpsichord in the 1600s, *Piano Epidermis* harks back to Diderot's "sentient harpsichord," in which he draws a parallel between the philosopher and the harpsichord, proposing a sentient harpsichord that is capable of feeling, remembering, and even feeding, and self-reproducing. [8] In Oram's musical composition *Toccata and Bruise* for piano with *Piano Epidermis,* the piano indeed feels and beckons feeling; multitudes of dancing, gesturing hands appear and disappear on the body of the piano, coaxing the pianist to respond to it with her hands that touch, stroke, caress the piano's skin. The pianist thus does not play music on the piano as a musical tool according to a composer's instructions; it responds *directly* to the piano, as if it were giving instructions itself. And accordingly, the pianist attempts to respond to the piano's skin, eliciting similarly tactile, sensuous sensations from the sentient piano.

Distributed Cognition

According to musicologist Carolyn Abbate, a musical instrument is "an object given life as long as a master plays it." [9] Yet, as *Piano Epidermis* highlights, it is not the instrument that benefits from sentience from its mistress; the mistress is also affected in response to its demands on her. Unbeknownst to her, the piano shapes the pianist's habitus; the muscular memory and nerve firings are ingrained by the piano's specifications. The artist and musical instrument share a distributed sentience—or what Jonathan De Souza calls distributed cognition—in which the user's knowledge and sensation of sounds are inextricably tied to the specifications of the instrument. [10] In its sound-installation form, the *Embedded Iron* subtly shapes the public participant's habitus; it brings to the fore its domestic and unspoken implications in their life and calls to question its audibility in a world where domestic workers are often voiceless.

With the *Embedded Iron*, the performer becomes a cyborg. In particular through a combination of sensors and computation the eye of the performer is enhanced with LiDAR and "artificial intelligence-linked graphic manipulation systems." [11] While not a tribute to unrestricted vision, the iron does embody "direct, devouring, generative vision whose technological mediations are simultaneously celebrated and presented as utterly transparent." [12] While Haraway used these words to compound the meanings of disembodiment, we seek to re-embody both the tool and its user, both past and present.

As digital instrument designers we had to determine what aspects we wanted to sense. If the iron were sensitive to every frequency, we, the musicians, would find ourselves surrounded by "an indistinct fog carrying too much information. Syntaxes and rainbows are similar in this sense: they emerge from the elaboration carried by those selectional capacities that precedes experience." [13] We decided to use Light Detection and Ranging and spectroscopy to determine the iron's position on the board and the type of fabric being ironed respectively.

There are three variables used to create a complex form of additive synthesis, a Boolean trigger Boolean which simply turns the synthesis on/off when placing the iron on the surface, the iron's x position on the ironing board which maps to pitch, and a paired int and float for index and value of 17 bands of light measured from the surface the iron is placed on which determine the rest of the auditory parameters. By using Wekinator, a machine learning environment built for musicians, it is possible to quickly

create complex mappings between the seventeen variables and the sonic result. [14]

This action (computer vision sensing) reaction (sound generation) pairing is comparable to recent understandings of perception: “The hypothesis that action and perception share common neuronal codes is getting increasingly empirical support from cognitive neuroscience. The core assumption—that actions are coded in terms of the perceivable effects (distal events rather than the stimulus properties (proximal features)—is of great relevance to music research.” [15] By building an instrument that mimics cognition are we giving it sentience?

Programming an interface allows us to subdivide this facsimile of sentience into “different steps: sensing, feature extraction, classification, and anticipation.” [16] In the case of the iron, the sensors detect changes of energy in light. Using a microcontroller, that energy is changed from analog input into a digital signal that Wekinator can use for feature extraction in reduced parameter spaces, and then classification for further processing and mapping to sound. Our system cannot anticipate or predict human action at the millisecond level, indeed this is beyond the capacity of most existing interactive systems. This facsimile is not sentience, however it enables us to expand our sentience, the tool dynamically contributes to a co-construction of expanded sentience.

Material Engagement Theory

Lambros Malafouris believes “there is little doubt that the human brain is as much a cultural artifact as a biological entity, or that it is both an artefact of culture and a cultural artefact... a dynamic co-evolutionary process of deep enculturation and material engagement.” [17] Materially enacted metaphors communicate through active engagement with associative links among material things, bodies and brains.

In *Women’s Labor* we bring the material objects of women’s often unpaid, unrecognized domestic chores into an active ontological correspondence with participants both as users/performers and as audience. The cognitive prosthesis of a musical instrument housed in a tool of domestic labor gives layers of meaning not usually present in a traditional musical instrument. The embodied knowledge of how to iron becomes “tangibly and inextricably linked to a technology that transforms the social practices which make that very knowledge possible.” [18] By repurposing women’s tools, we bring attention and cognitive power to that which is overlooked.

We layer extra-musical meaning onto our aesthetic intention, which is to create an expressive musical instrument in the guise of domestic tools ideally “fluidify[ing] the boundaries between nature/culture and matter/signification.” [19] Interactivity allows us to engage in continual embodiment, while the inescapable cultural references cause the performers and audience to question the boundary point between domestic tool and musical instrument.

Embedded Instruments

The instruments involved in *Women’s Labor* are Embedded Acoustic Instruments. EAIs are designed to include all necessary components for performer interaction, data-mapping, synthesis, and sound generation in a single self-contained body. By embedding sensors within the chosen items, they are able to detect the gestural movements of the performer, turning these tools of oppression into instruments of artistic expression. Unlike most interfaces designed for electronic music, the entire instrument is self-contained. They do not use a multi-purpose laptop, instead they use single-board microprocessors. Instead of using whatever speakers are in a theater’s system they have their own bespoke amplification system that uses the resonance of the instrument itself. Because the instrument is not dependent on computers or speakers that are used for other tasks, the instrument gains more agency and identity. Like Edgar Berdahl’s Stingray and Nick Hwang’s AEMI, the instruments of *Women’s Labor* are driven by a Raspberry Pi single-board microprocessor. [20,21] These computers are connected to a variety of sensors that were chosen to fit expected interactions with the intended tool. For example, the iron utilizes LiDAR and spectroscopy to detect the position of the iron on the board and the material being ironed respectively. The umbrella drying rack uses counter-weighted potentiometers to detect materials being hung on the drying lines, and a rotary-encoder is used to determine how far and how quickly the dryer is spun around its axis. This data gets mapped to various synthesis parameters in Pure Data running on the Raspberry Pi. This synthesis is then sent to a series of amplifiers and speaker drivers to generate the final audio. By embedding all of these electronics within the instruments themselves, they become entities unreliant on external equipment or influence. Additionally, the instrument bodies influence the acoustic result of the generated sounds, a timbral colouring of the sound that wouldn’t be possible by connecting them to external “house” sound production methods. In order to amplify these instruments technicians must use microphones instead of simply taking the output of the digital to analog audio interface; the physical nature of the system with a structural coupling between the user, the sensing and calculating computer system, the sounding body of the instrument, and the cultural context of the original household tool.

Conclusion

In *Women's Labor* the relations between past and future are performed. The project takes tools from the past, weighted with domestic implications and casts them into new forms of futuristic musical instruments. By layering the enacted knowledge of these women's tools onto a new technological instrument we bring cognitive dissonance into the concert hall. The tool/instrument is not passive, it contains the historical implications of centuries of overlooked labor, while catalyzing and constituting meaning onto its user and audience. The instrument becomes imbued with cognitive, social and musical sentience.

By using embedded technologies, we allow these objects to standalone, allowing our object familiarity to be undistracted by external clutter. The illusion isn't broken by additional abstract components such as speakers and wires, the performative engagement is focused entirely on the tool and our historical understanding of its purpose.

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Physicality and Spatialization in Sound Art

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Abstract

This paper identifies a trend within the field of spatial sound art in which artists are attempting to draw the audience's attention to the physicality of moving sound. It discusses the history of virtualization and simulation of moving sound that has led to this phenomenon. As evidence of this emerging trend, four case studies of recent sound art pieces are discussed. The artistic works are from both performance and installation contexts with examples of both the author's creative work and the works of others. All take new approaches to spatialization through the physical movement of sound sources.

Keywords

Spatialization, Sound Art, Physicality, Mechatronics, Surround Sound

Introduction

Throughout history, sound artists and composers have used spatial movement as a method for heightening expressivity and to increase the audience's sense of immersion in sound-based works.

Since the initial forays into stereophonic sound, there has been a strong emphasis on the creation of phantom source locations and the simulation of realistic sonic trajectories. In recent years, substantial advancements in ambisonics, wave-field synthesis, and binaural sound approaches in Virtual Reality systems and gaming contexts have solidified this trend and significantly advanced spatialization approaches for the human perception of sonic trajectories. However, spatial sound art has also been touched by a trend recognizable across many digital art forms where by the further the advancements occur in the virtualization of (in this case) spatial sound movement, the more of a reaction can be recognized against this, in physical sound movement. In the context of this paper physical spatialization is considered to be anything beyond or opposing the scope of virtual spatialization through panning. In order to be considered a physical spatialization approach, the art work or technology must allow or encourage a viewer to 'see' the spatial intent. This could take the form of specific density in loudspeaker arrangement, extended techniques in loudspeaker design such as that depicted in Figure 1, or loudspeaker (or other sound object) movement.

This paper, then, explores a recent phenomenon in spatial sound art that sees artists responding to increased abstraction of spatialization of sounds though a physicalizing of sound movement and trajectories. It examines the historical context and trends that gave rise to this phenomenon. Further, artworks that incorporate physical sound movement and spatialization techniques are discussed, with a particular emphasis on perceived audience engagement with spatial movement as a form of sonic expression. These case studies include two spatial works by the author, and two by other artists.

Figure 1. speaker.motion_2 An extended loudspeaker system capable of real-time pan and tilt movement. Image provided by the artist.

Historical Context

Sound spatialization has a long history with examples of physical spatial movement pre-dating phantom source locations as a compositional technique used to further artistic expression in music. Many scholars look to the works of Gabrielli and Williart in St Mark's Cathedral in the 1500s as an early example of such spatial explorations. Williart and Gabrielli were known for embracing the architectural aspects of the large cathedral and adapting their compositional techniques to include two choir lofts that were physically

separated [1]. Further, in the 1800s, there is evidence of composers instructing performers to disperse and walk around in specific locations in conjunction with their playing. These scores indicate a desire from the composers to use the physical movement of the sound source (in this case a performer with acoustic instrument) as a form of expression [2]. From the specificity of these instructional scores, one could ascertain that the composer was encouraging and emphasizing the theatrical nature of the audience engagement with this movement as key to the content and narrative of the piece.

Virtualization of Spatial Movement in Audio

With the advent of recording and playback equipment, it quickly became apparent that with more than one playback location (or loudspeaker), spatial positioning through phantom source location could be achieved in many more locations than where the speakers were located. When Bell Labs was first promoting the commercialization of stereo sound in the 1930s, the marketing strategy involved test cases where two or three loudspeakers were set up across a stage and the sound of a train was panned between them. As this was the audience's first experience of stereophonic sound, reports suggested that the spatial movement of the train moving across the stage was so realistic that audience members ducked and jumped out of the way [3]. Stereo sound with phantom source imaging soon became the norm in both academic and commercial musical contexts.

The creation and normalization of stereo sound research led to advancements in how to create the most realistic perception of sound moving between the speakers. In the first instances this was as simple as amplitude panning in a linear method. However, advances in understanding human psychoacoustic localization developed with an understanding that the human ear is more concerned with power and intensity of a sound rather than pure amplitude changes [4]. Panning techniques began to incorporate spectral filtering, reverberation changes and more advanced amplitude panning using the square root and trigonometric pan-pot algorithms (as two of the most common).

The same principles that applied to the creation of perceived moving sound sources in stereo panning were later applied to larger numbers of loudspeakers. Notably, through Vector Base Amplitude Panning [5], Ambisonics [6], and Wave-Field Synthesis [7], these algorithms and techniques were based upon the creation of phantom source images and spatial trajectories in loudspeaker systems. More recently with the rise of gaming platforms and single user experiences these principles have been applied and adjusted for binaural and headphone-based applications. In the last decade, significant advances have taken place in the creation of immersive audio experiences for Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR). With the removal of the physical loudspeaker and instead the audio experience being delivered through headphones (often attached to wider headset-based unit) the virtualization of spatially moving audio has become very convincing for the listener.

In short, there has been a long period of significant development of how and why the creation of a spatial movement within audio could take place virtually and be perceived by the listener. Composers and sound designers embraced this movement for its ability to significantly contribute to a feeling of immersion for the listening experience, and to use this movement as an expressive technique.

The Resurgence of the Physical

Alongside the development of spatialization algorithms and techniques, the democratization of home computing meant that digital art became integrated into many fields within music and in a much broader context. However, with many decades of virtualization and digitization of artforms, we can now recognize an emerging trend where by artists and audience members alike are drawn back the power of a curated interaction with physical elements. In some ways, the more advanced and realistic the virtualization of something can become, the more interesting it is to present it in physical form. The resurgence of musical robotics is a prime example of this phenomenon where physical gestures of musical machines have become an important visual element used in musical expression [8].

Artistic Examples

Examples of art works that are embracing the artistic effect of dynamic sound spatialization but in a more physical sense can be seen in both performance and installation contexts. In installation contexts, there has been an exploration of the use of highly-directional specialized "parametric loudspeakers" which are then directed at moving reflective objects in order to redirect the sound. The following sections discuss two examples of this, focusing on the works *Relief* and *spatial.reflections*. A different approach that also aims to draw more attention to the physicality and visuality of spatial trajectories can be observed in creative works that feature an extension of a traditional loudspeaker to add an ability to move. *speaker.motion* and *5 Moving Speakers* are examples where the loudspeaker itself if built into a mechanical system that allows it to move and thus create dynamic spatialization patterns. These examples are also discussed in more detail below.

Relief

Relief by Mike Rijnierse & Bob Bothof (2017) was featured in the Today's Art Festival in The Hague, Netherlands and is an artistic rendition of the concept of echolocation [9]. In the program notes, the artists described that the piece was not a sound sculpture but an echo sculpture. *Relief* features a wall of reflective panels that are at varying angles and an array of ultrasonic loudspeakers that are hyper-directional in their projection patterns. The loudspeakers are only heard and localized by the audience members upon reflection with the panels at different angles. As the program notes describe:

> "By placing tilted surfaces before it, and moving the speaker array, you are able to experience the sculpture in audio in very much the same "tangible" way as experiencing it in physical space".

In this work the visual and physical nature of the panels and their varying angles helps audience members to experience the complex spatial nature of the audio and draw meaning to the piece's echolocation themes. The ultrasonic loudspeakers ensure that it is the second order reflections of the audio that are perceived by the listeners instead of their point source. Therefore, the reflective panels themselves become the focal point.

spatial.reflections

spatial.reflections (2018) also aims to draw attention to the reflective sonic trajectory of a sound instead of its point source [10]. The work, created by the author, features two parametric loudspeakers that are directed at three rotating panes of glass.

Figure 2. A single pane of glass from the spatial.reflections installation as part of the Aotearoa Audio Arts Festival, Wellington New Zealand. Image provided by the artist.

In a similar manner to *Relief*, the parametric loudspeakers used in *spatial.reflections* create a hyper directional beam of audio that is not perceived outside of the direct audio trajectory. Each of the three glass panes are motorized to rotate at different speeds, meaning that the audio can reflect off multiple glass panes to create an immersive field of complex spatial trajectories. The composition in *spatial.reflections* includes rhythmic noise bursts which are easy for humans to localize [11] and draw the listeners' attention to the second (and sometimes third and fourth order) reflections. The composition also includes some drone elements made of sine tones that encourage a point source localization but are localized to the first pane of glass that the sound interacts with. To the listeners' ears, this gives the impression that the glass itself is emitting the sound. The loudspeakers are placed visually discreetly to further heighten this phenomenon.

With the wide variation in potential trajectories from the angles created as the glass rotates, *spatial.reflections* creates a myriad of spatial trajectories with need for any virtualization or panning. The rotation of the glass draws the listeners' attention to the movements of the audio and their relationship to the glass.

Both *Relief* and *spatial.reflections* use reflective surfaces in order to draw attention to the spatial movement of sound within their works. However, this is not the only approach to the visualization of audio trajectories. The following are artistic examples of the moving of the sound source itself by extending the traditional loudspeaker and giving it the ability to dynamically move throughout the piece with the use of mechanical actuators.

speaker.motion (Pas De Quatre)

speaker.motion, built by the author and shown in Figure 1, is a mechatronic loudspeaker system that places the loudspeakers in a gimble-like structure allowing them to be rotated and tilted [12]. Unlike the previous two pieces, *speaker.motion* refers to the loudspeaker system itself: a number of works have been composed and performed with the system. One of these works, *Pas de Quatre* (performed in Mechanical Ballet, as part of the New Zealand Arts Festival) treats the physical movement of the loudspeakers as core to its concept [13]. For *Pas de Quatre*, four *speaker.motion_2* loudspeakers were used and placed in a line on the stage. As the name suggests, the piece treated the loudspeakers themselves as dancers, and their rotational and tilting movements were choreographed to draw attention to the movement of sound.

The venue for the concert featured a very high ceiling and walls of different materials, so as the loudspeakers' directions changed it caused spectral variations in the sound. This technique has been used by composers many times. However, particularly with the height element and the ability to physically direct the sound towards the ceiling at different stages of the piece, the audience was made much more aware of the composer's spatial intentions and the sonic and expressive results.

speaker.motion allows real-time rotation and tilting of the loudspeaker. The next piece discussed also uses mechanical actuators to create motion. However, in the case of the next work discussed, that motion takes place across a linear plane.

5 Moving Speakers

5 Moving Speakers (shown in Figure 3), by Jesse Austin-Stewart, places the speaker cones on a linear rail system that can then move each of the cones with a timing belt and stepper motor [14]. Each of the five speakers is placed on its own rail and is connected to its own channel of audio, meaning that the speakers' sounds will move in and out of phase and past the listener as the speakers traverse their rails. The piece was developed for installation contexts and is best experienced with a single audience member standing at a specific location to perceive the movement of each speaker.

Like *speaker.motion*, *5 Moving Speakers* uses the physical movement of the loudspeaker in order to create spatial trajectories instead of doing this through virtual panning or spectral filtering. The audience receives the visual cues to further the translation of this intent through the creative work.

Figure 3. 5 Moving Speakers by Jesse Austin-Stewart (Image supplied by the artist).

Conclusion

For much of the history of electronic art music, panning and spectral processing have been used as the primary means by which composers included spatial movement in their works. Whilst the advancements in these fields meant that a high level of spatial complexity through the trajectories was able to be created, often this complexity can be difficult for audience members to fully comprehend as integral to the meaning within the piece of music or sonic art. In more recent years an emerging trend reveals a desire by composers to bring the spatial movement of the work to its fore-front and, in order to do this, composers have experimented with using more physical means in order to spatialize audio and to give audience members a stronger connection to sonic spatial trajectories. The works discussed have all achieved this physicality of spatial audio in different ways and thus provided new and engaging experiences for audience members. As with many fields of art currently experiencing substantial advancements in their ability to convincingly depict real-work experiences by virtual means, there continues to be a drive by artists to achieve something more physical and visual and to use this to help audience members connect with an experience that cannot be seen.

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Bridget Johnson creates immersive sound installations and performances that heighten the audiences experience with spatial audio. Her work focuses on exploring the way sound can move through space and developing new interfaces to allow composers and performers to further explore expressivity through real time spatialisation in their work. Her installations explore these themes in combination with site-specificity and abstraction of time. Bridget received a PhD from Victoria University of Wellington working with both the School of Engineering and Computer Science and the New Zealand School of Music. She is a Senior Lecturer and the Major Coordinator for Music Technology at College of Creative Arts, Massey

Reclaiming and Commemorating Difficult Felt Experiences

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Abstract

Consumer self-tracking products help generate optimization expectations about diverse aspects of the lived human experience including levels of physical fitness, mental health, and general wellness. The commercial rhetoric and positioning of the humans who do not, or cannot use these devices and systems is that they are somehow diminished or not aspiring to be all they could be. This notion that humans need to be fixed by a technological solution can engender considerable anxiety and stress, particularly when there are different power dynamics in who gets to determine who is supposedly broken. The work presented here seeks to reclaim and reframe difficult human experiences as complex events that require acknowledgement and emotionally reckoning with, rather than striving for a neat resolution through socio-technical means. The Done Medals are personal awards commemorating the successful endurance of an assisted fertility cycle. The medals reorient the maker and wearer away from stressful trackers, apps, and data, and towards an affirmation that a series of difficult events were completed and can now be shared as a social good.

Keywords

Autobiographical Design; Women, Trans, and Non-Binary People's Health; Infertility; 3D printing; Difficult experiences.

Introduction

Solutionism describes a type of frictionless problem-solving where almost all our complex human problems are considered resolvable with the right amount of sensing, data analysis and algorithmic computing [7]. This desire to both fix and (profit from) societies' ills provides motivation for corporations to identify fertile growth areas that may be ripe for solutionizing. Personal optimization is one such framework, codified in recent times through the notion of the digital quantified self, where through using commercial tracking devices, one can become self-actualized or simply an enhanced and better version of yourself. The quantification of human lives and activities has a rich and storied history going back to the 1500s [14], although contemporary rhetoric within the realm of consumer technologies now seems to suggest that one is less than, diminished, or maybe even irresponsible unless one engages in this form of consumer monitoring.

This individualized and tracked perspective now pervades many aspects of human experience including physical fitness, mental health, and diverse types of personal medical health and wellness. After years of oblivious neglect, consumer tracking apps and devices are finally targeting and supporting specific aspects of women, trans, and non-binary people's health including measuring menstruation, fertility, and menopause as data forms now determined to be culturally valuable. While welcomed by some, many of these approaches serve primarily to objectify the human body as a for-profit commodity and have little interest in the complexity of emotions and feelings engendered by their use and indeed non-use. There is deep asymmetry between the user as data generator and the opaque companies that harvest personal data for ever changing or even unknown reasons. In addition, the performative role of the use of these technologies as indicators of people who care about their health and wellbeing can be damaging when financial, education, and access to health providers issues are not also considered [11].

Figure 1. 3D printed Done Medal commemorating two IVF cycles.

The focus of the work presented here is a personal reframing of the optimization approach to complex human experiences away from data analytics and towards emotional engagement. In this case, I reexamined my experience as a cisgender woman using a variety of mechanisms, including detailed spreadsheets and phone apps, on a daily basis over an extended period of time through five assisted fertility cycles. While there were many prior years of secondary infertility and some with digital tracking, I am concerned here with the specific felt experience during those five challenging assisted cycles. My response here was to "sit" with the

experience several years after the fact, and with distance from the original fear, stress, anxiety and sadness, to consider the emotion of the events anew. The outcome was a desire to reorient the cycles (four failed, one successful) as endurance milestones that should be recognized publicly, and not kept privately, painfully and deliberately invisible. To commemorate these experiences in a way that spoke for me to the main imprinted emotions from the time, I created a *Done Medal* – a wearable award I designed and gave to myself to celebrate something that was endured, got through, and simply done (see Fig. 1). This is a medal I can wear (semi) publicly (see Fig. 2 below, or keep in the 'important documents drawer' shown in Fig 3.).

Figure 2. Wearing my Done Medal in a domestic home environment.

Related Work

Over many years, women identifying artists have examined the experience of motherhood (Ree Morton's body of work [6]), miscarriages (Frido Kahlo's *Henry Ford Hospital* (1932)), menstruation (Sputniko!'s *Menstruation Machine* (2014)) and more recently infertility (Tabitha Moses' *Investment* (2014)) just to name a very few. In 2019, the newly established Fertility Fest opened in London, where this now annual conference calls itself *"the world's first arts festival dedicated to fertility, infertility, the science of making babies and modern families"* [3]. Here the exquisite work of Tabitha Moses shown at the 2019 festival most closely aligns with the topic area of the work described here. Moses' *Investment* project is a *"series of embroidered hospital gowns and photographic portraits*" where she draws *"on her own experience, and that of others, to explore the medical processes and personal beliefs surrounding infertility and its treatment"* [8]. The embroidered gowns depict images of the biological entities and technical instruments encountered and deployed during an IVF cycle, which are then worn by the patient and photographed in a hospital environment. In contrast to Moses' framing of the IVF experience within a medical environment, I wanted to translate the felt emotions of the experience away from the hospital or any form of medical institution, and reclaim them in a domestic family setting.

Figure 3. Done Medals kept with passports, birth, and marriage certificates in the "important documents drawer."

Within the fields of design research and human-computer-interaction, a growing numbers of researchers and practitioners are exploring the realm of *intimate design*, which often adopts a critical feminist methodology in exploring topics that might previously have been considered taboo, including menstruation [4, 10], menopause [12], fertility [9] and intimate body knowledge [1]. While some of this research [1, 9] supports participants in better understanding critical areas of their own personal health, the other works sit more within the realm of speculative or semi-fictional design, where the types of devices, technologies or interventions proposed might not be suitably deployed with a typical 'user' study population [2]. This type of first-hand, autobiographical design and HCI work intersects with many

of the artistic approaches described above and indeed, my own approach.

Done Medals

The idea to design and create a medal to commemorate my body getting through an assisted fertility cycle originated from several different places. Over two years had passed since I completed the final stage of the fifth fertility cycle and it had taken me until then to clear out the large cabinet of left-over syringes, swabs, pregnancy test sticks, and other detritus from a large bathroom cabinet. As I reflected on closing off this part of my life, I began to think more deeply about how such largely invisible events could be 'marked' or even 'signaled.' I thought about a section in neurosurgeon Frank Vertosick's book *Why we hurt: the natural history of pain* where he explains how Aztec women who died in childbirth in ancient Mexico were buried with fully military honors. They were considered war heroes as this life-event was termed *"a woman's war"* [13, p124].

In thinking further about this, it drew to mind all the social media photos proudly posted by colleagues, friends, and family members as they posed, medals aloft, at the end of a marathon, or 10K or Tough Mudder. Their medals recognized their endurance, and that their achievement mattered and was publicly validated. I too wanted such a "mattering artifact", where the artifact itself could function as a focusing lens into my emotional perceptions of my lived experience and the values shaping and reshaping those perceptions in different conditions [5]. I don't make claims here for nationally recognized military honors or standardized competitive measurements, rather an embracement of the emotional fulfillment that comes from tackling and getting through a difficult (and usually invisible) life challenge.

Design, meaning and manufacturing

The design of the medals speak to three main aspects of the assisted fertility experience: my medical diagnosis, the distances I had to travel to receive medical care, and one of the most common intervention features of the process – syringes and needles. Before turning away from my spreadsheets and apps, I tabulated the amount of miles traveled, the number of injections, the medicines ingested, the number of appointments etc. Ultimately, the design of the medals rejects that level of stress-inducing detail, opting instead for an approximation and a focus on the aspects that packed a particular emotional punch. I explain the design of one of the manufactured medals detailing two IVF treatment cycles and explain their contents below.

The circumference of the medal displays my official medical diagnosis, "ADVANCED MATERNAL AGE IN MULTIGRAVIDA", which is displayed prominently in bold and embossed form. I use it here to reframe my growing annoyance during the process to the repeated invocations of my "advanced" age by medical personnel and staff at all levels. Now I wish to wear it as a badge of honor – this older mother in her forties managed to get through it regardless. The embedded "trails" of syringes depict the roadway route from my home to the nearest IVF fertility clinic, over 150 miles away and across a high mountain range. These cartographic lines function in pairs. In Fig. 1, the two lines at the bottom of the image are placed lower on the z-axis and represent one of the saddest return journeys, where having ventured hopefully to the clinic for a significant procedure, I was contacted by the clinicians on the drive back that the cycle had to be aborted. The two, darker lines at the top of the image are placed higher on the z-axis and thankfully represent a happier return journey, which ultimately, many months later, led to a live birth. The roadway routes are lined with horizontal syringes, with vertical groups of syringes representing my home (where most of the injecting took place) and the clinic (where injecting, probing, retrieving and inserting took place). The idea of pushing out (with the embossed material) and injecting in (with the embedded material) had, at least for me, a certain poetic aspect, given the physicality of the bodily in/out processes of IVF treatment.

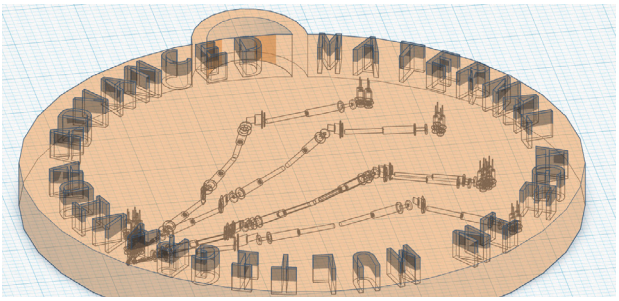

Figure 4. 3D Tinkercad model of the Done Medal

The material form of the medal was also important to me. During the fertility cycles, no-one, apart from my immediate family and some close friends, knew what my partner and I were experiencing. This was for multiple reasons including work constraints and responsibilities at a new institution I had just begun employment at; the perceived social stigma about being older parents; the national disregard for secondary infertility as a recognized medical condition, and the difficulties of just having moved to a rural location and not having an established close network. For these reasons, as with the in/out aspects, I wanted the medal to "play" with notions of transparency and opacity through use of dark extruded attention-grabbing components, with varying layers of dark material embedded within a transparent medallion disc.

I designed the medals using Tinkercad (see Fig. 4 for the 3D model), which is a popular and easy to use browser-based online 3D modeling program. Working in collaboration with colleagues in the *Dreams Lab* at Virginia Tech, we decided to use a Connex350 3D printer to manufacture the medal as it is one of the best printers for simultaneously printing multiple colors and materials.

Using a simultaneous multi-material jetting technology, we used transparent VeroClear filament for the medallion holder component, and Tango Black Plus material for the embossed letters and the syringes embedded within. The final components of the medal ribbons are repurposed materials from generic off-the-shelf medals of commendation.

Conclusion

Ultimately, the medals are 'mattering artifacts' created for myself, my family, and the broader research and practice communities. I do not propose manufacturing these at scale or even that others with similar experiences should do this too. My IVF experience finally ended with a successful intervention and I limit the scope and appropriateness of the potential for people to "commemorate" difficult experiences, mindful of those not as fortunate as I was in being able to access and afford multiple attempts, and those whose outcomes ended differently. The primary takeaways are to consider the work as a form of resistive pushback to optimization narratives and the reshaping of the emotional resonance of difficult experiences as not things to be fixed, but rather hard life events to acknowledge and reckon with.

Acknowledgements

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Author Biography

Aisling Kelliher is an associate professor of Computer Science at Virginia Tech, USA, with joint appointments in the School of Visual Arts and the Institute for Creativity, Arts, and Technology. Aisling creates and studies interactive media systems for enhancing reflection, learning, healing, and communication. Her work is grounded within the fields of human-computer-interaction, multimedia, and interaction design, and is motivated by a desire to integrate computational processes into everyday mediated experiences. Her current research explores the role of design in multiple interdisciplinary contexts including healthcare, future studies, and critical feminist perspectives. Aisling received a Ph.D. in Media, Arts and Sciences from the MIT Media Lab. She also holds an MSc. in Multimedia Systems from Trinity College, Dublin, and a B.A. in Communications Studies from Dublin City University.

Constructing Xenological Encounters

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Abstract

It is becoming clearer that our attempts to separate nature from culture, humans from non-humans, ancient from modern, and life from technology have been a failure. Recognizing this failure allows us to weave back together what was inappropriately cleaved during the modernist project. To deal with this moment we can learn how to be xenologists, ones who study, analyze, and develop elements of the strange, the other, the alien. Here I show how xenological encounters across the domains of plants, transgender bodies, and space enable us to construct new forms of living within our entangled existences.

Keywords

xenology, transgender, vegetariat, hormones, space art, bio art

Xenology as a Necessary Practice

Scholarship over the past decades has detailed the legacies of the modernist project: lives subjugated by capitalist technoscience; the attempted separation of categories of existence into clear, demarcated boxes; and the confusion raised by biotechnologies that question the position of the human. [1,6,15] In our present moment we are recognizing the need to develop new techniques for repairing what has gone wrong and putting back together what has been separated, understanding that for indigenous peoples these separations were never accepted. [16,19] Simultaneously, however, we have to recognize the positive legacies as well: the elimination of various forms of certain death; global communications for dispersed and marginalized populations; potentials to rework bodies marked as other. To only critique without also asking how to re-create is to speak from a privileged, non-othered position, one that is desirable or at least tolerable, and ignores those for whom new developments in being are required for survival. One has to remember the lesson of the pharmakon. [3]

In this moment we need to learn how to live with the others around us: ourselves as othered beings, the non-human aliens we share the universe with, the strange silicon-based entities we continuously create and destroy. As such, I have been developing over the past few years the theory and practice of xenology, the study, analysis, and development of the alien, strange, or other. This term has its roots in situated strands of Western, white science fiction, and originally referred to the study of extraterrestrial beings, fictional or potentially real. [2,4] I have extended the definition, however to encompass the full realm of what we mean by "xeno": the strange, alien, foreign, guest, or other, and, consequently, considering how we can not only study the xeno differently, but also work to produce conditions for its thriving. [11] I say this as a xenobody myself, a transgender woman living in a world that all-too-often doesn't want me, or others like me, to exist[1]. Xenology can be seen as another type of "arts of living" in an uncertain universe under difficult conditions.

Xenology draws upon the powers of perseverance and survival of the strange and alien, taking inspiration of marginal practices that are necessary for existence. But xenologists are not content with simply existing; rather they desire thriving, a reconfiguration of bio-silico-evo-technical systems that, through practical production of works and experiences, shifts our encounters towards those infused with symbiotic–or at least commensal–poiesis.

This paper will not be able to explore xenology in-depth, but will instead, through attention to a set of allied artistic projects, show xenology in practice. Before doing so, however, I want to explore two separate yet related strands: that of xenology and xenofeminism, and the potentials offered by xenomogrification.

Xenology ± Xenofeminism

It's important to acknowledge the relationship of xenology to another xeno- term of recent vintage, xenofeminism. [8] Xenology is not xenofeminism–but it's not not xenofeminism either. If xenofeminism is a politics of alienation, xenology is a practice of disalienation, as will become clear shortly. Xenologists eschew Promethean desires of mastery and acknowledge instead a humbleness-towards the other entities we share the universe with. Alienation is a distance from this, one fundamentally linked to the fet-

[1] I have immense privilege as a white transgender woman, something my black and brown siblings unfortunately do not possess as they face heightened risks of violent death. [7]

Figure 1. *TX-1* (2020), three resin spheres, from left to right: spironolactone fragment; Vivelle Dot patch fragment; handmade abaca paper sculpture

ishism of the commodity and our estrangement from not only labor but also materiality. Yet xenologists also vibrantly agree with xenofeminist desires to reconfigure technological and scientific practices. Without this, we are left helpless and tacitly accept the unfair terms of the game.

Productive modes of tension between kin forms of theoretical analysis are needed more than ever. It behooves us to be kind to our allies in times of polarization, yet also realize that universal agreement means elimination of the other.

Xenomogrification as disalienation

What if, under current conditions of capitalism, we are not other enough. That, in fact, modes of value extraction fundamentally require that we remain within varied, yet dramatically limited and quantifiable boxes. If we posit that a fundamental of the universe is change, sometimes radical change, then value extraction limits our abilities to tap into these processes. This is a form of alienation. To undergo disalienation is to move ourselves away from value extraction and its constrained possibilities for change. [10]

Perhaps what we need to do is to make ourselves even more strange, more alien, to transform ourselves into something else. This is a process termed xenomogrification. This leads to disalienation from the possibilities for change. Xenologists know that change is never-ending; there is not a teleology to the process. Alienation leads to change-towards-limits: towards the dictates of processes of profit-making. Disalienation through xenomogrification, however, transforms bodies into entities that draw upon the universe-given possibilities for transformation that are unnaturally limited by value extraction. It's important to note: to become alien or other is not the same as being alienated.

Transgender people who undergo hormone replacement therapy (HRT) engage in xenomogrification. They encounter the phamacopornographic industry through off-label uses in order to re-create their bodies into something other than that provided through birth. [13] As such, their xenomogrifications make them strange to a cis-heterosexual order that demands bodies remain fixed. Additionally, the bodily transformations of transgender people, as well as disabled folx, offer examples of dramatic reconstitutions of living necessary for existing on a rapidly changing planet or through deep space travel.

While trans people on HRT are at the forefront of xenomogrification, it's important to note that it cannot be limited to them alone. As well, the capacity to xenomogrify oneself needs to be more evenly distributed. Xenologists thus develop techniques of do-it-yourself or do-it-with-others that conduct laboratory research, materials development, theoretical concept formation, and textual distribution.

Xenological Encounters

To better understand xenology we can encounter a few projects, including some by myself. While I call myself a xenologist, the others may not as of writing, even though they use allied terms to describe their work. Space limitations prevent detailed explication. Xenologists know that the semiotics of text are a poor substitute for experience of a work, yet acknowledge the necessity of ordered statements as a form of transmission.

TX-1

TX-1 (2020, Figure 1) is a sculpture of my transgender hormone replacement therapy medications that was launched to the International Space Station on 7 March 2020 at 0450UTC. [17] The piece consists of includes a fragment of spironolactone, a testosterone blocker; a fragment of a Vivelle Dot transdermal patch, which provides exogenous estrogen; and a small handmade abaca paper sculpture, intended to gesture towards all of the other absent-yet-present xenoentities. Each is encased in a resin sphere. *TX-1* marks the first-known time elements of the trans experience will leave the earth. We do not currently know whether it's safe for trans people on HRT to go into space, as the pharmacodynamics of our medications in microgravity are unknown. However, *TX-1* marks a sym bolic exodus from a planet that is all-too-often inhospitable to us.

Xenologically speaking, *TX-1* offers us the impossible: a trip to space for a xenobody, when current astronaut selection procedures limit candidates to the most "normal" and "able-bodied". What if, however, those of us who are xeno might be better suited to the necessary modifications of our bodies required for space living? *TX-1* presents us with this possibility, a future where transgender people also get to leave the earth.

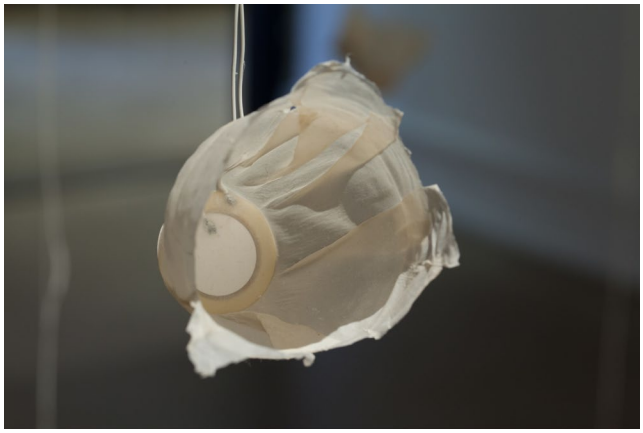

Figure 2. *they transmitted continuously / but our times rarely aligned / and their signals dissipated in the æther* (2018), detail view

they transmitted continuously / but our times rarely aligned / and their signals dissipated in the æther

they transmitted continuously / but our times rarely aligned / and their signals dissipated in the æther (2018, Figure 2) is a 20-channel sound installation that re-presents the results of collecting hundreds of transmissions from satellites orbiting the earth. [reference removed for purposes of review] Using custom antennas that I built from scratch, I tracked the orbits and frequencies of satellites using specialized software. This software then allows me to collect the radio frequency signals and translate them into sound. The open source software and hardware, called SatNOGS and developed by a world-wide group of satellite enthusiasts, enables anyone to build a ground station for tracking satellites and their transmissions, which are then uploaded to a publicly accessible database. [9] These transmissions are mostly from weather satellites, CubeSats (small satellites launched by universities world-wide for short-term research), or amateur radio repeaters (satellites designed for ham radio operators to experiment with communication over long distances). I made the speakers from a piezoelectric element embedded between two sheets of handmade abaca paper that was then air dried over a form.

In this piece we encounter communication between machines: machines orbiting the earth, and machines here on the ground that listen for and decode these transmis sions. We embed ourselves within their semiotics. Through the melding of ancient and modern technologies (hand papermaking and satellite communications) we understand how the privileging of the "modern" limits more symbiotic technological possibilities.

Vegetal Otherness

In Špela Petrič's *Confronting Vegetal Otherness: Phytoteratology* (2016, Figure 3), plant-human monsters are

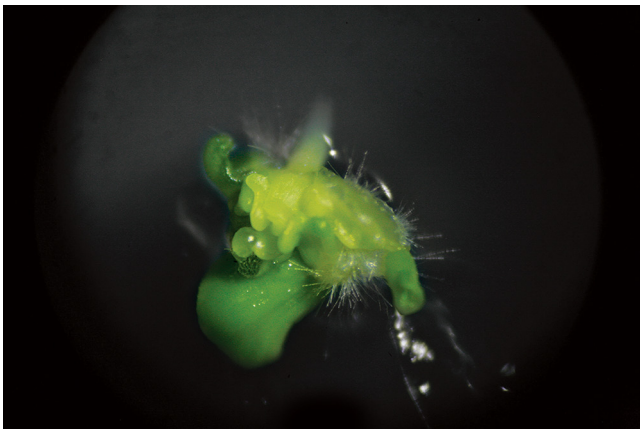

Figure 3. Špela Petrič, *Confronting Vegetal Otherness: Phytoteratology* (2016), detail

created in part through steroid hormones isolated from the artist's urine. As Petrič writes,

> In Phytoteratology blood kinship and genetic lineages give way to subtler streams of radical trans-species intermingling and category mongrelisation; I pro-create plant-human entities, which I lovingly call monsters, via in vitro conception and hormonal alteration. The project embodies my desire to conceive and mother a transplant, to conjoin the gentle green alien, metaphysically dubbed the most primal of life forms, the barest of bare life, and my animalistic, politicised humanness harboring a culturally pregnant mind. [12]

Phytoteratology is one of a trilogy of pieces engaging with these entanglements of humans and the vegetal. Petrič has further expanded this practice through her notion of the "vegetariat", the "collection of bodies, human and other-than-human alike, which find themselves in the gaze of the algorithm". [5] We find ourselves always already plant, always already imbricated within systems of value extraction. A mode of resistance is to accept our condition as plant-being and work with them to develop practices of obfuscation.

Xenohormones

Mary Maggic's practice also engages with hormonal dynamics, this time through an explicitly queer lens. Her projects, *Open Source Estrogen* (2015) and *Housewives Making Drugs* (2017), foreground the practical challenges of obtaining HRT by trans women, who, because of rampant poverty, are often unable to purchase their medications. Maggic's work, while not practically viable at this time, suggests a possible future of DIY home hormone extraction that would bypass the pharmacopornographic regime.

In her *Molecular Queering Agency* (2017), Maggic provocatively considers the roles of xeno hormones as a form of large-scale queering:

> Thanks to petrochemical, agricultural, and pharmaceutical industries, we live in a toxic landscape, that is colonized by hormones. These endocrine disrupting molecules arise from birth control pills, pesticides, plasticizers, electronics, and personal care products. These are markers of the Anthropocene, where the natural can no longer be disentangled, from the synthetic. The objects we encircle ourselves with, the food we eat, and the air we breathe, all become part of the process of sexing. These xeno molecules are capable of transfecting change at the morphological level, queering our bodies and bodies of non human species. This is a collective mutagenesis. We are collectively becoming alien. [18]

The participatory piece consists of live hormone extraction, inhalation of other participant's hormones, and video. In this project, this strange form of "unnatural" queering is not something to run away from, as in conventional environmental discourses, but rather a collective practice of "becoming alien".

Xenological Futures

The artist-writer-scholar Krizia Puig has recently written the following:

> **TransAliens**: Not from here.
> Border crossers, shape shifters, spacetime travelers.
> We love too queerly, too weirdly, too much, and too often.
> /Painfully lucid. [14:499]

Xenologists know that to mark oneself as xeno is to place a mark on oneself. Nevertheless, to not do this is to remain alienated, to accept the conventional structures of technoscience, to shy away from the possibilities of re-structuring ourselves and our universe. Xenology provides us with theories and practices that move us along a path that can never be exhausted.

Acknowledgments

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Exploring AI Ethics Through Intelligent Everyday Objects

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Abstract

This paper presents an ongoing research project studying AI ethics and algorithmic bias, through the creation of AI-augmented devices operating in everyday life. The project explores the use of interactive objects as a platform for exposing the political, social and ethical implications of Artificial Intelligence. Within this project, we created *BOX*, a smart gumball machine that locks or unlocks its delivery candy system depending on the interactor's ethnicity, highlighting potential ethical tensions that arise with the introduction of AI-powered objects. Our project aims to raise awareness on discrimination, ethics, and accountability in AI among practitioners and the general public.

Keywords

Machine learning; artificial intelligence; ethics; algorithm bias; ethnicity.

Introduction

While all culturally relevant praxes carry political significance, the design of interactive objects stands out as it often embodies discriminatory practices. Interactive objects carry assumptions about their users and context of use, while simultaneously constituting a pre-selection of the problems that deserve to be solved.

Given the increasing power of Artificial Intelligence and Machine Learning, there is an increasing need for a systematic concern on these potentially discriminatory practices. That is, it is necessary to design work methodologies that incorporate these concerns throughout the development process, as well as the phenomenology associated to the deployment of sophisticated AI-powered devices.

The insertion of AI in everyday life has dramatic social implications that have not been explored enough, algorithms in production had already negatively affected minorities. Among these we can find the prediction of criminal reports in areas with higher proportion of people from racial minorities [10]; misunderstanding gender for darker-skin women by popular AI models [3]; police from Israel arresting a man for a wrong translation made by Facebook's automatic translation software [6], among many others.

Similarly, a system widely used in the US to guide sentencing systematically predicts black defendants having a higher risk of recidivism than white defendants [15]. In spite of potential benefits that face recognition proposes, its widespread application entails several risks, from privacy breaches to systematic discrimination in areas such as hiring, policing, benefits assignment, marketing, and other purposes [12].

Exploration

Our first exploration of the contested space that appears with the introduction of smart ordinary objects was *DOOR* [8], which consists of a door that locks or unlocks itself depending on the ethnicity of the user. This piece showcases possible uses of machine intelligence, explicitly exploring the social dynamics that arise when intelligent objects are introduced. After this first object, we decided to extend this line of research by creating new augmented objects that are able to interact with the audience in an everyday context, subverting the expectations of what objects can do, showcasing the advances of artificial intelligence, and exploring its potential sociopolitical impact.

Unethical Machines

We introduce *Unethical Machines*, everyday objects that alter their behavior in function of ethically contentious uses of AI. Continuing the path laid down by our previous exploration, *BOX* is an artwork that exposes some of the social and political impact of artificial intelligence, computer vision, and automation. The project consists of a gumball machine that uses a commercially available computer vision system that predicts the interactor's ethnicity, and locks or unlocks itself depending depending on this prediction. The artwork showcases a possible use of computer vision, making explicit the fact that every technological implantation crystallises a political worldview.

The interaction design within these objects follow different heuristics: (a) The object recognizes certain features and reacts with a traditionally -expected- biased behavior such as giving access to a white interactor, a male, or young interactor. (b) The object recognizes certain features and reacts with an opposite bias, subverting expectations. (c) The object offers a mutating discrimination, adjusting its behavior in function of its context (for example, keeping track of the ethnicity of the interactors and adjusting itself to please or displease a majority of them).

Figure 1. *BOX* as displayed in TEI 2019, Tempe, AZ, USA.

Implementation

Recent advances in computer vision and artificial intelligence, allowed inferring information on a person from real-time camera data. This includes facial recognition, facial expressions, ethnicity, age, and gender, among others [13, 2]. Companies like Affectiva [1], Clarify [5], and Haystack [7] provide commercial image processing services that include these predictions, among several others.

While commercially available software provides an opportunity for easy exploration, it also makes it easy to deploy AI services without due consideration of social and ethical concerns.

For example, Affectiva's pre-trained model run locally [1], and classifies the input images also in five different ethnicities (White, Black, South East Asian, Asian, and Latino).

We developed two versions of our project, one using a commercially available predictor, and the other with our own classifiers. To predict ethnicity we built a deep neural network based on David Sandberg's FaceNet [14], and trained on the UTKFace dataset [16]. UTKFace contains 23,708 faces with five labelled races (White, Black, Asian, Indian, and Others (e.g. Hispanic, Latino, Middle Eastern)).

In addition to the commercial gumball machine, *BOX* includes a camera connected to a laptop, an LED display, an Arduino and a servo motor that locks or unlocks the ball delivery system. When an interactor's motion is recognized, the LED display shows a message "detecting ethnicity". If the predictor returns a White ethnicity, *BOX* unlocks its handle of showing a message on the display: "Ethnicity detected: White." If it detects any other ethnicity, the machine stays locked and the corresponding message is shown. Figure 2 shows the setup of box and its main components.

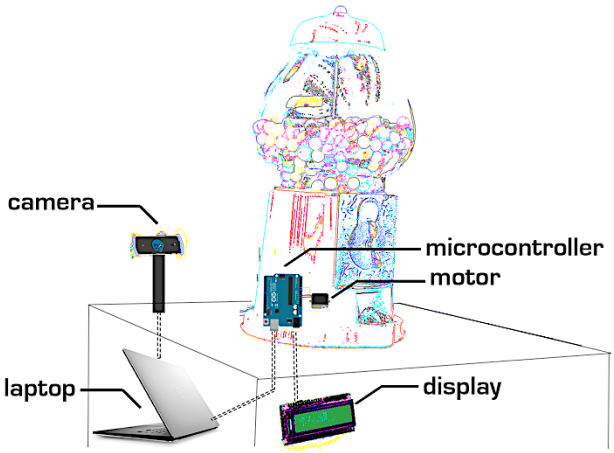

Figure 2. *BOX*'s schematics.

Evaluation

In order to evaluate these interfaces, an empirical evaluation through observational experiments [4] was conducted. The planned evaluation aimed to understand how subjects understand the emotions expressed by the object, and how the object leads to the desired effects on the overall interaction [11].

This paper reports our preliminary observational study by using an observer during the interaction with the piece in order to make it as much as possible unobtrusive. Notes were taken as the observation occurs such as interactors' verbalizations, behaviors and interactions with the device. This installation occurred for one hour during the Arts Exhibition of TEI 2019 [17]. The audience was mainly researchers in the area of human computer interaction and tangible objects. Interactors were standing in front of the camera and waited until their ethnicity was recognized and the gumball machine was unlocked. Figure 3 shows the interaction with the device. The observer was located next to the interactors to observe and listen to their reactions.

This evaluation generates different interactions and measures by observing the interactors' reactions when facing expected and unexpected behavior. Moreover, discussions while interacting with a discriminatory object were analyzed. Most of the interactors understood the interaction to be done with the unethical machine and the meaning of this metaphor. Some interactors demonstrated unsatisfied with the ethnicity results that led to make user to try again those results, to contrast with other interactors and in some

cases, a reflection on errors that AI produce and their dataset. Moreover, there were noted some behaviors with the use of the device and the impact of receiving a benefit (gumball) or not. Few cases, interactors tried to modify the results by positioning an interactor that already was recognized as white to unlock the machine and share gumballs with the others or even in one case, using an image of a white male in a smartphone to unlock the machine. Other interactors that were recognized as white decided to not to get the gumball or share it with others. There was also reported a few discussions generated after the use of *BOX* around our main topic: ethnicity in artificial intelligence.

After these preliminary results, we aim to continue creating more unethical machines and explore a deeper evaluation on the study field with the use of interviews and questionnaires [18].

Figure 3. *BOX*'s interaction.

Final Discussion

Unethical Machines aims to explore the social impact of AI introduced in everyday life. This exploration has a dual focus: we are interested in design opportunities that may arise, as well as in the ethical concerns that the popularization of this technology entails.

The project is designed to allow the general public to experience in person the power of machine learning, computer vision, and natural language processing in a familiar environment, while simultaneously providing a tool for participatory observation, as well as ethnographic and technographic research.

Technographic research is often missing in AI studies. However, technography's focus on what technology actually does, allows researchers to map the concrete behavior of automated objects and the sets of beliefs that social groups hold. With this in mind, we are implementing participatory action research, documenting interactors' behaviors with the device.

The project's future work includes developing new mundane objects that will also adjust their behavior in function of predictions of ethically contentious characteristics, such as sexual orientation, ethnicity, age, income, etc. Future work will also include representatives from communities that are often disenfranchised from the technology production process, as well as from communities at risk of being negatively affected by AI technologies.

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Machine-enacted Modes of Creative Exploration

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Abstract

This paper discusses two projects on human-machine collaborative expression. From technical and artistic perspectives, we discuss how robotic tools for art can extend the human creative process and what impacts they may bring to the users of the tools. The discussion focuses on the interplay between computational intervention and the embodied nature of physical expression – reshaping the behavioral and cognitive traits of the users throughout the course of human-machine interaction.

Keywords

Computer-supported Expression, Robotic Art

Introduction

With rapid developments of creative robotic or computational systems [5], we imagine highly transformative and interactive mediums designed for traditional art forms. The implication of these new tools may go beyond the current realm of computer science. Embodied cognitive science research suggests that using a tool shapes the way our mind operates from both neural [6] and cognitive levels [7]; studies in ethnomusicology shows how the morphology of an instrument and the body govern the music played on it [3].

This paper reflects on two research projects on interactive tools designed for artists. One is a drone-based painting experiment conducted in collaboration with artist Haley, and the other is a series of automated guitars that have robotic fretting [18] and plucking [19] capabilities. In the former study, a drone transposes artist gestures and introduces a degree of noise and independent agency to the final painting maneuver. The latter prototypes were given to music students and beginner players, documenting emergent behaviors from them and how collaborative human-machine performance can lead to new musical inspirations and improved learning efficacy.

Figure 1. Human-drone painting setup. Real-time movements of the artist are captured and merged with the drone's native movement patterns to create final strokes.

Mediation of physical expression through an interactive medium creates a dyadic relationship between an operator and that medium [23]. Introducing machine agency into a process that was formerly exclusive to the artist, the artist is invited to new constraints posed by the system — adapting to, battling against, or learning the divergent behaviors and errors created by it. This paper presents a range of relationship that is formed between human and machine throughout the experiments, and discusses those from the perspectives of user interface design, creativity and cognition, and more. We structure the discussion in sections of four different topics, that we believe are key to understanding how a close technological intervention may impact us in creative work.

Revisiting Previous Experiments

Vicarious Movement is a drone-based painting experiment done in collaboration with art researcher Haley (Figure 1), through which she created two painting pieces exhibited at the *Big Anxiety (Australia)* and the *Asia Culture Center (Korea)*. Her usual work centers around translating spontaneous and erratic movements of people or animals onto canvas. In this experiment, her drawing gestures were captured through a camera system that subsequently drives the drone and a paint extruder. The documented process demonstrated notable changes in the way she works; she started out struggling with the control, increasingly familiarized with the native features of the lines drawn by the drone, and finally not only actively employed those features in her work but also her body movement transformed and resembled the way the drone moves. The final drawings embedded both her own and the drone's characteristics — a sense of erratic movement, also mentioned in critiques from the exhibitions.

The other work *Guitar Machine* is a set of robotic attachments for the guitar that allows a user and a robot to share the act of playing on the instrument. In a study with beginner users, they were asked to practice a phrase with the help of automation. In order to play chords, they needed only to indicate which chord to play by tapping on root notes, making the left-hand maneuver much simpler. They showed noticeable improvement in learning speed, and were able to understand the musicality of the phrases before building the necessary skills. Similar patterns were seen in an experiment with advanced players as well — musicians and music students (Figure 2). Some key observations include the musicians being able to learn highly complex phrases within a unintuitively short amount of time, as well as developing emergent patterns of playing the guitar given new sonic and mechanical capabilities.

These two experiments target at highly embodied means of expression. They require substantial development in physical skills, muscle memories, and intuition in how movements affect output expression. In the following sections, we shared detailed discussions on the observations.

Figure 2. Musician exploring distinct sounds and erroneous behaviors from the robotic guitar.

Gestural Contingency

One of the key themes iterated in the studies was the tight coupling between user input actions and subsequent robotic actions. Haley notes that the same embodied painting gesture used for her regular work results in different styles of marks generated by the drone. She finds this difference exciting and that over time she was able to learn how to utilize it as part of her process. Musician P moves his left hand on the fretboard, where all the detailed fretting maneuvers are captured and subsequently drive mechanical and percussive hammering on the strings. He describes the experience as a new "synaptic connection" between his fingertips and the output sound. He finds a discrepancy between the sounds he anticipates based on his past experience and what the robot creates. These comments highlight how the use of the same or similar embodied gestures to their normal practice allows users to critically identify and effectively explore the added quality through a new technological tool. Musician C adds how quickly he was able to explore the mechanically driven soundscape on the *Guitar Machine* as it used a regular guitar fretboard as control interface (Figure 2).

There exist many software tools that support a wide range of visual expression. Creative coding evolved through communities of coder-artists, applying programming practices to art creation. These tools, however, often serve specific forms of art practice disparate from conventional ones. Jacobs and her colleagues discuss how general programming practice requires continual pauses and consultation of a work throughout the process [20][21], which may make the approach unappealing for users who are familiar with more intuitive processes. Their *Dynamic Brush* system mitigates this by introducing a direct manipulation [8] scheme for creating interactive software brushes, through which natural artist movements drive procedurally generated graphics.

In a separate work in progress on an inkjet-based painting system, we consulted several recognized painters on iterative human-machine painting procedures. Among those, Fischl mentions that he would want a computer tool to generate marks at the same speed, not any faster or slower than his natural speed of work. Jacobs and colleagues [20] argue that feedback and physical engagement are critical in "their understanding of proportion and composition." These emphasize that the temporal and geometric contingencies in gestures are critical to creative processes. A complementary theory suggests that epistemic actions lead to distinct forms of thinking. Yokochi and Okada [22] reports an observation where an artist continually making blank strokes in the air when he is contemplating on where a new stroke goes.

How responsive a system is and how gestural metaphors are correctly translated are critical in supporting conventional practices. Haley suggests further exploring how "people hold and interact with styluses," envisioning a huge potential in exaggerating or expressing detailed gestural nuances. This represents her desire to revisit her long developed tacit knowledge and gestural languages. Experimental computer systems for art often remain focused on the qualities brought by technology, resulting in limited representation of the role of the body. However, research in cognitive science [1][9] and learning [10] emphasizes the importance of the body in the process of thinking and creating.

Enacting Exploration

Enactive cognition [11] is an emerging paradigm in embodied cognitive science where cognition is described in terms of a dynamic sensorimotor loop where actions are inseparable from their feedback, or their subsequent sensations. Schön describes design as a conversation with the materials one works with [12], where such a conversation acts as a sense-making process through which one performs experiments to understand how things work [13].

These point out a potential in tools that facilitate novel explorations by enabling new modes of enactment. Affordances of a tool governs the way natural movements are induced throughout the use of that tool [2]. With the help of new technologies, the bandwidth of altered embodiment can be radically widened compared to what conventional handtools such as pens, brushes or others could do.

Sound effects designer C tried "pushing the *Guitar Machine* system to extremes," turning on more actuators than it was designed to run at one time. As a result, the motors started moving at unexpected speeds and hitting at unintended moments. It sounded beautiful and in a sense poetic, as he was just letting the machine generate randomized tunes. He later explains that what seemed to be random initially later came under his control; he was able to guide the randomness in certain orders despite the connection between his action and machine behavior was not intuitive. Haley had a similar realization working with the drone. What seemed noisy at the beginning in the experiment started synergizing with her drawing style. She says visitors to the exhibition described the paintings to be "erratic, quite energetic or frenetic," the words one would use to describe the movement of drones. Haley was aware of such properties and adapted to actively incorporate the machine perturbation into her process of picture making.

These observations show how the introduced change in expression condition helped the artists stretch their notion of control. This finding is particularly complementary to the previous section where native expression maneuvers of an

artist are emphasized. The following sections will discuss how stretching the movement ability of an artist may not only impact the actual act of expression, but also bring changes on a cognitive level.

Identity Transfer

An artist's characteristics of expression develops over many years and may come in subtle forms, that it may only be discernible by examining a series of work throughout a period of time [14]. Therefore, a search for a new style often incorporates experimental methods of applying paint on the canvas [4]. They may introduce a new body-tool relationship [7][15] where the embodied process of painting is interpreted in new ways. We observed similar revelations in the experiment showing the characteristics of a tool facilitating development of new behaviors.

Figure 3. The artist's movement starts resembling the way drone moves and tilts in space.

Haley had a notable realization that her body started moving in sympathy with the drone (Figure 3). She was moving the stylus without desire to add pressure to the canvas, where she would even sway her body like the way the drone tilts. The embodied nature of drawing could be the source of this behavior; researchers suggest that the form in which a person is embodied affects their behavioral traits [16][17]. She mentions that she had to give up her past experiences, muscle memory and intuition, which may have made her more receptive of the new working condition. Therefore, the qualities of the mark as well as the movement itself from the drone transferred to the artist. However, did that behavior develop as a result of learning how to correctly control the risky drone movement, or from a deeper cognitive effect?

The transfer of embodied properties also found to have impact on learning in the guitar experiment. One guitarist tried learning a polyrhythm pattern — two wildly different beat patterns going on at the same time. Instead of the guitarist practicing the pattern himself, we provided him the "ability" to play the rhythm patterns by automating it on the right-hand side. This quickly let him feel the experience of a more capable instrumentalist and he was able to pick up and play the pattern himself within an extremely short span of 3 minutes. This contrasts his past experience of taking 30 minutes or more for learning similar patterns. He identifies the haptic feedback through the strings plucked by the robot, and maintaining control over fretting actions — therefore he could fail or succeed in playing the pattern — as key reasons why this could have helped.

Figure 4. Beginner players getting helped by the robot's fretting assistance. They can choose what to play, while the reduced skill requirement allowed them to understand the flow much better.

Beginner users report that they were able not to only feel more confident, but also to understand the supposed music better by being able to play chords more easily. We observed discernible improvement in both left- and right-hand skills in them; this would not have been expected as the required left-hand movement was simplified. Similar to the polyrhythm experiment, the users had a significant amount of agency in the control of music. They only had to indicate which chord to play by fretting on a root note, that leaves the pace, timing and flow of the music entirely up to themselves (Figure 4). In both the drone and guitar experiments, the users started out sharing action with automation and ended up internalizing the experience provided by it.

Human-Machine Composition

Jazz guitarist A "improvised" with the guitar, as it played pseudo-randomized patterns of beats. As their duet progressed, he shouted, "It pretty much feels like playing with another person!" The observation indicates that it was much more than playing in tandem with the machine. He was seamlessly transitioning between giving the robot the lead, taking over control, and synthesizing his own playing with the robot's once he understood what the robot was doing.

Conventional human-computer interaction systems have focused on reducing friction rather than offering active synergy and antagonism. This trend is reflected in the computational creativity research as well. Davis and his colleagues [13] categorize systems for computational creativity in three segments: *creativity support tools* augment human creativity, *generative systems* autonomously produce creative outputs, and *computer colleagues* collaborate with a human user as an assistant. Majority of works in robotic painting emphasize the latter two, as normally creativity support requires efforts to develop dynamic models for users and their strategy [13]. This may come from stronger emphasis on computation and the limited understanding on how in real time users reflect and make creative decisions.

On a related note, Haley compares her experience with other drawing devices she previously experimented with. She emphasizes that those previous systems focused on "decreasing the level of human control, not necessarily introducing a level of complexity." She further articulates that the drone was generating marks with similar aesthetics to her usual work, while it was motivational to see continual "unexpected" marks being generated as a result of her gestures. Nevertheless, she was able to understand what the drone would do, and synergistically add to her own process.

This along with the jazz guitarist case resembles improvisation between human artists. How much one understands the other artist, and the compatible differences between the styles of the two, are critical in how successful the improvisation would become. This leads to a discussion on how computational intervention could be merged with human creative processes. We discussed the delicate spaces of user experience on the tools they use. This include not only the tool design being contingent to the pace and manner of work artists normally engage with, but also how the design can induce changes to the users of the tool. Going further, how the tool affords working methods that are novel but compatible with the users, or how we build such tools around specific styles or degree of agency need further attention.

Conclusion

In this paper we discussed observations from experiments on human-machine collaborative art creation. This research aims at understanding the delicate relationship between the mind, body and tools we use, through analyses of people closely interacting with experimental robotic tools for visual and musical exploration. In these experiments, the designed artist tools are interactive and have a degree of independence, enabling novel modes of creative exploration and learning.

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Fake publishing as art and activism

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Abstract

The various forms of artists' and activists' printed fakes have shown how the narrative can take over communication without being noticed. From the early to the most recent experiments, they practiced how an essential amount of information can deceive a large public. It didn't take long for these practices to be used as a powerful manipulating tool for the established powers. We need then to protect specific aspects of the publishing workflow in order to not be deeply influenced by what then reveals as post-truth.

Keywords

publishing post-digital networks design-fiction media-manipulation media-ecology post-truth post-sense globalisation

Introduction

The infinite possible manipulations offered by the ephemeral digital media are progressively reported by the media, as they are sensational, and they are not meant to stop evolving, relying mostly on the increasing power of computation and smarter algorithms.
We can better understand them if we refer to the narrow artists' printed mediascape, where there's a specific phenomenon which embeds essential qualities of publishing: the production of fake publications, or simply 'fakes,' with a quite solid tradition developed through the years.

Artists' fakes

Artists' use of print in different popular formats (book, magazine, newspaper) has been experienced mainly since 20th-century avant-garde, using their popularity to convey ideas to a larger public. And the early use of print fakes in various forms can already be found in Surrealist practices (the magazine "La Révolution Surréaliste[1]") as well as in the conceptual art movements decades later (the ads, press releases, and reviews of Terry Fugate-Wilcox's "Jean Freeman Gallery[2]" experiment). They strategically produced plausible media, disguised as authentic. But the most recent examples use different technologies to escalate their outcomes and purposes.

Among them, Eric Drass has realised some acts which he defines as "guerrilla epistemology". (Ludovico, 2017) His "Cut-up magazine" was a printed guide for The Great Escape music festival hosted in Brighton involving 300 (mostly unknown) bands. Cut-up was freely distributed containing computer-generated bands' profiles based on online-retrieved and remixed band data. Drass points out that it "was a way of algorithmically 'filling the critical void'". He took care of using texts from bands of the same genre, referencing the songs' titles retrieved online in the reviews, making them feel authentic. The system he implemented was generating a new review for each copy of his zine, and giving them a random mark out of 10. So, two copies could have radically different reviews of the same band. He just handed them out at the festival, fitting the expected form of such content, as "we naturally expect a printed magazine to be consistent across copies". The readers' expectations were just met with this action, creating a guide that was always missed during the event. But meeting the expectations doesn't mean to provide trustable content. The tension between the absence of information and the provision of it, is resolved, but the source is trusted by default, with no further check. It is very similar to what happens on systems polluting social media, where the produced information is just meeting expectations, and that is apparently enough to be acknowledged. Drass thinks about this work as an "algorithmic detournement", the form and the trust are essential for his approach as: "the most important part of a lie is the willingness to believe it".
In 'design fiction' (Bleecker, 2009), a discipline part of 'speculative design', and aimed to explore the grey areas of the future of the binary utopian/dystopian, this willingness is equally important. Near Future Laboratories' work is emblematic in this field, and one of its founders, Julian Bleecker, is also the first to articulate the term in a circumstantiated essay. They published the "TBD Catalog" subtitled "The catalogue of the near future's normal ordinary everyday", which only lists imaginary products, together with imaginary ads, and even imaginary classifieds. A luxurious 'fake' developed by a team of twenty people (designers, science fiction, and science writers/students and curators), all coordinated by Bleecker. The Laboratories released soon after the TBD, in 2015, "An Ikea Catalog from the Near

[1] https://en.wikipedia.org/wiki/La_Révolution_surréaliste

[2] https://mitpress.mit.edu/books/jean-freeman-gallery-does-not-exist

Future" with similarly imaginary high-tech products, impeccably integrated into the IKEA catalogue typical design. A very consistent methodology has been applied (they even developed an internal 'Design Fiction Product Design Work Kit'), to distort the present into a near future in which the so-called 'internet of things' has become the norm. In the collection of 'products' software plays a fundamental role, both implicitly embedded in them and explicitly as a product of its own. The compendium of ideas enlists related industrial products in a form that is contextualising them as already available in a selling environment, significantly contributing to the perception of being real. The Laboratories' publications deeply question the current flattening of our collective imaginary about the future, through unsettling innovation in its formal context.

The importance of using a canon in fakes is underlined in all these artworks. It impacts on their credibility and operational effect on the audience, and it resonates in every different format, respectively: journal, ads, zine, catalogue, and magazine. There's another canon which has been extensively used by artists and activists in producing fakes: the newspaper.

Newspaper fakes

With a different perception of media in general, learnt over the years from art and political movements such as Fluxus, Situationism, and Lettrism, in 1977 groups belonging to the so-called "Autonomia Creativa" (Creative Autonomism) movement in Italy, conducted a few campaigns with fake journalistic 'scoops' in a newspaper form. In the galaxy of underground groups who took part in it with an attitude to publishing, "Il Male" ("The Evil") was named after the magazine they collectively edited. It was particularly led by one of its founders, Vincenzo Sparagna, also directing later the innovative alternative magazine "Frigidaire". Il Male produced fake newspapers ranging from a single sheet to full ones, carefully rendered in major Italian newspapers' layout. Their tone was simultaneously plausible and surrealistic, and perfectly reflecting the uncertainty in political changes. Sparagna writes that at some point it was a "fake/true or true/fake magazine. The more we wrote big 'lies', the more we discovered they were elliptical forms of reality, less false than many current commentaries" (Sparagna, 2000).

In 1980 a fake Pravda was distributed in Russia with the title "Russia overcomes the demons. No Union, no Socialist, no Soviet, only Republics". And, with similar local support, in 1983 a fake "Krasnaya Zvezda," (Red Star) the official newspaper of Soviet Ministry of Defence, was distributed in Kabul and in East Berlin declaring a classic "War is over! All go home!" thanks to a heroic couple of chef soldiers (the cousins 'Chonkin') who sent Russian military chiefs to sleep indefinitely with their mischievous delicacies.[3] Beyond the playfulness, it was distributed on the war field, to dissidents of both factions, in a highly risky action. With this action they were re-embodying the spirit of the previous underground press during World War II, travelling internationally, with local supporters. The infrastructure was strategical both at home, with lawyers, and abroad to avoid being arrested or having the newspapers confiscated before being distributed.

These actions seemed to perfectly embody the statement on the cover of the A/Traverso Italian political zine, co-founded by the philosopher Franco 'Bifo' Berardi: "false information that produces real events" (Berardi, 2002).

More recently, after their iconic "The New York Times special edition[1]", made in collaboration with Steve Lambert and

The Washington Post

May 1, 2019 — Democracy Awakens to Action — Edition: U.S. & World | Regional

UNPRESIDENTED

ENDING CRISIS, TRUMP HASTILY DEPARTS WHITE HOUSE

On May 1, barely six months after the midterm elections, Donald Trump appears to have abandoned the White House and abdicated his role as president. He issued no formal statement, though four White House aides — who spoke on the condition of anonymity — claim they found a napkin on the president's desk in the Oval Office on the evening of April 30, scrawled in red ink with the following message: "Blame Crooked Hillary & Hllor & the Fake News Media."

By Lisa Chung · 2 hours ago

"Finally!" say women
From #MeToo to 'You're Fired'

Celebrations break out worldwide as Trump era ends

Worldwide, impromptu street parties popped up in major cities and small towns as people realized the American president had fled. As news spread of what appeared to be the first U.S. presidential resignation since Richard Nixon, crowds from Buenos Aires to Cape Town waved American flags, played American music, and congratulated the United States.

By Sara Gabriel Ramos

Today's Paper

Figure 1. The Washington Post fake by The Yes Men

as a "serial liar", calculating an average of eight lies per day. Created together with authors L.A. Kauffman and Onnesha Roychoudhuri, the fake newspaper sported the lead story: "Unpresidented: Trump Hastily Departs White House, Ending Crisis", surrounded by articles and features about how it happened. It was distributed to commuters in Washington, D.C. in thousands of copies, and it was dated a few months later, too, precisely on May 1, 2019. They usually use "mischief to reveal truth" as they defined the work of famous hoaxer Alan Abel, who, admittedly, deeply inspired them.

The transition of fake publishing from critical art to effective manipulation

How did a practice that was meant to question the mass media power with clever hoaxes, turned into a powerful manipulating tool for the established power as it was finally confirmed after the Cambridge Analytica public admission? Once more, the key transitional element is a different media environment (social media), and the possibilities of persuasion and structurally aggressive noise it allows with its *publishing space*, so it is still a manipulation based on enabling new publishing coordinates in space and time.

The filtering and scrutinising role of editors is replaced by algorithms customising the filtering of the numberless posts, which are prone to unconsciously facilitate hegemonic master-plans, once automatically fostering aggressive tactics,

[3] https://www.frigolandia.eu/?q=node/161

[4] https://www.theyesmen.org/democracyawakensinaction

including the targeting of individuals by multiple secretly orchestrated profiles.
Furthermore, the unfiltered, direct communication between the author and the reader, where the highest popularity secures the louder or most influential voice, reduces all the subaltern followers to just approve ('Like') or 'comment', technically acknowledging and reinforcing the most popular entities, even when they're openly disagreeing or even attacking them. It sounds like the realisation of a perfect populist environment. As Han put it with some emphasis: "When we click *Like*, we're bowing down to the order of domination". (Han, 2017)
In social media, popularity is the territory where the hierarchies and powers of communication are negotiated. The mass participation is added to the equation, and it is remotely mediated in the isolation of personal screens. The lack of filters and mediation, traditionally done by mass media editors constitute a true realisation of a *global village* where the illusion of horizontal accessibility and participation (everybody can potentially communicate directly with anybody else) is hiding the social stratum which persists and deepens even more in reality. So, for example, famous politicians can speak directly to the audience, never being questioned at the same level, like they would be obliged to in a public debate. As well as anybody can 'comment' and so 'write' on a celebrity's feeds, feeling quite closer to them, but never actually reaching any kind of real closeness, and paradoxically reinforcing their social media 'super-status' and so increasing their distance. The 'open channels' of social communication, especially being privately owned as they are now, are then allowing way more cynical tactics of invisible 'information warfare'.
Already in 1971, William Burroughs considered together with Brion Gysin in their "Electronic revolution" a structure of collective media attack (Burroughs, 1971):

"potential of thousands of people with recorders, portable and stationary, messages passed along like signal drums.
[…]
Illusion is a revolutionary weapon:
TO SPREAD RUMOURS.
Put ten operators with carefully prepared recordings out at rush hour and see how quick the words get around. People don't know where they heard it but they heard it."

The multiple agents in the street were meant to 'create' a memory of a message through its reiteration in different contexts. It becomes a message unconsciously listened to and shared, becoming part of the perceived reality, although being completely constructed. It was eventually a mobilised coherent noise from multiple sources. The subversive attitude of Burroughs and Gysin, aimed to subvert the unreachable ruling media powers of the time (like TV and newspapers) with only analogue personal recorders, has been completely eliminated in the contemporary versions of these practices. The underground counter-propaganda to official media and powers has materialised as word-of-mouth propaganda, orchestrated by companies working for political parties. The collective rumours have been implemented not by free individuals in the street, but by private companies on social media. They manipulate the audience, weakening the capacity to discern with.
For example, the system used by the Italian right-wing party "Lega", allegedly supported a boom in consensus. One of the 'digital spin doctors', Alessandro Orlowski, analysed their system in an interview[5], pointing out a few adopted strategies. For example, if a popular post on social media gets the majority of comments about a specific topic, especially a fear (like the fear of losing jobs because of migrants' flows), it is flagged, in order to publish new posts reiterating the fear itself. There's an attentive effort in maximising the publishing effect. Posts with fake news and propaganda are then pushed, and when they get thousands of likes, they enable the 'vanity key performance indicator' which leads to likeminded people to like and share them, having their beliefs confirmed at growing scale. After they pass a certain threshold it is very hard to be contested, and they become (post)truth. This system is even more secured by small armies of managed 'trolls' with multiple social media accounts, ready to intervene to attack or discourage standard user to have a political confrontation. These *social media machines*, hired by political and economic groups, take no prisoners, creating false facts, mostly supported by 'emotional' content, which makes them very popular. And with the emotional load, they can target our cognitive bias, with a domino effect. They effectively exploit our 'continuous partial attention' (superficial attention paid to multiple sources of incoming information), getting a large sharing through our quick judgement which produces likes and shares, amplifying the message through its popularity.
As McIntyre put it, post-truth "amounts to a form of ideological supremacy" (McIntyre, 2018). It dresses information in a universal form, using brevity and emotions to hit our attention. And it circulates in an ecosystem which is perceived as a "word-of-mouth" scheme, a piece of intimate controversial information, which enhances its emotional value. Social media are overflowing with this type of enunciations. The form is either using authoritative schemes, or the classic word-of-mouth oral culture: bare pictures, short texts, or, in their most powerful form, memes. These semiotic objects with the flat temporality of the digital, allow the creation of infinite fakes, giving meaning to the 'post-truth' definition.
But there's a nodal transition from the activism of newspaper fakes to the online fake news. The former are assembled around narratives meant to trigger reactions through controversial, sometimes surreal, assemblages, while the latter are distinguished by settling a dimension of fear, being permanently alerted to react and to be continuously engaged in group conversations. In this underlying tension, the space of

[5] https://www.rollingstone.it/politica/la-bestia-ovvero-del-come-funziona-la-propaganda-di-salvini/420343/

publishing being instant and possibly filterless, so mostly *unedited*, cuts the amount of time for the needed editing, so that the resulting simplistic form needs no time to be pondered and decoded, but only time to react. The result is that there's a constant *solicitation to get indignant*, and sharing it, with consequent continuous polarisation, moving among bubbles in a global arena in a literally ubiquitous space of publishing. Paradoxically, one of the side effects is that even the most radical satire sometimes becomes viral, as it is trusted as truth, as a consequence of the radicalisation of news we are exposed to, which sometimes are not too far from satire narrative.

In an information ecology where the signal/noise ratio is perpetually lending towards the latter, a very effective way of making propaganda consists of creating more attractive noise that eats up the attention. The contemporary version of propaganda is formally not coming from the ruling power (top) but from 'people' (bottom). The orchestrated armies of fake profiles ready, as a special force, to directly attack and seduce, verbally and visually, are the most effective way to orient opinions, under the collective illusion that they are spontaneously produced. These strategies are building virtual *factories of spontaneity*. They produce and amplify the so-called 'alternative facts' when needed, playing with emotional content, and building consensus. When the lies are vastly acknowledged, they become the starting point for new lies, new fake news, new alternative facts. So, the used language is vastly redundant, in a game of reflecting one another, as it was put it by Derrida: "in this play of representation, the point of origin becomes ungraspable" (Derrida, 1976).

It is such a vast and easy way to trigger the phenomenon that there are very few ways to contrast it, and one of them is to preserve awareness and trust in the sources. Somehow it is a question of properly shaping our own networks with trusted nodes, making alliances of trusted editors (and so filters) of information, consumed responsibly, with an open, limited and generous attitude.

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Physical Grainclouds: Granular Sound Art in the Physical World

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Abstract

Compositions and sonic artworks focusing on microsounds and granular systems have, since the emergence of these concepts, remained largely realized within digital environments. This paper focuses on a number of works that may be examined in the context of such granular/microsound systems. General definitions of microsounds, sonic grains, and grainclouds are provided, after which three characteristics common to physical grain clouds are discussed. From these three characteristics, artistic elements that appear in many physical grain cloud artworks are presented, including a focus on materiality, spatio-temporality, and audiovisual emergent behavior. The paper concludes with close examinations of three selected works: Céleste Boursier-Mougenot's *clinamen*, Pe Lang's *moving objects | nº 692 - 803*, and *Tectonic*, a new work created by the author as a case study inspired by the physical grain cloud artworks discussed throughout this paper.

Keywords

Sound Art, Sculpture, Grain Cloud, Audiovisual, Mechatronics, Automata, Kinetic Sculpture, Microsound

Introduction: Digital Ideas in Physical Space

Figure 1. *361 Prepared DC Motors, filler wire 1.0mm*, Zimoun (2010)

The rise of digital systems changed sound art dramatically. No longer were sonic artworks confined to the physical domain: systems could be created that behaved in ways that would be difficult, expensive, or physically impossible to explore in traditional real-world contexts. These digital approaches have collectively changed sound art, music, and sound design, resulting in shifts in how sonic characteristics are understood and appreciated by those working with such systems.

After such digitally-afforded concepts become established in the sonic art zeitgeist, they are often taken up by artists working within the physical domain. Digital systems allow artists to arrive at new conceptualizations and reifications of sound art, while artists whose works focus on non-digital media may subsequently utilize these concepts in 'real world' artworks. Digitally-inspired physically-realized artworks sacrifice a number of advantages afforded by digital approaches: rapidly-scalable complexity, artist-developed physics systems, and ease of modification and iteration are not easily achievable. However, these real-world artworks provide audiences with several key elements that are difficult to realize with digital-only systems. Their sharing of the physical space with the audience allows audiences to experience a sonic event throughout its chain of causality: where a digital system might merely present an output to a listener, a physical system is inherently able to show audiences the steps that occur prior to the output of the sound event.

A field of sound art and composition that was spearheaded by those working in the digital domain and further explored by those working in the physical domain is that of microsound, granular systems, and grainclouds. It is this trend that is explored throughout the remainder of this paper.

Grainclouds, defined in more detail below, consist of numbers of individual grains (discrete sound elements that exist over very short timeframes) that may be controlled and affected as a related mass. While digital systems allow for massive grainclouds with intricate control over these swarms of grains, the physical realization of grainclouds provides the benefits of the physical approaches discussed above.

Following a brief history and discussion of grains, microsound, and grainclouds, a number of characteristics common to grainclouds are presented. After this general overview, elements and affordances of physical grainclouds are discussed. A particular focus is given to the development and use of *Tectonic* (shown in Figure 2, below), a sound sculpture developed by the author and inspired by this trend in physically realized granular systems.

Microsound, Grains, and Grainclouds

A graincloud consists of a mass of related individual grains. Each grain is a manifestation of a microsound, a sound

element that exists at a sub-musical timescale. In his 2002 book *Microsounds*, Granular synthesis innovator Curtis Rhodes defines a microsound as "... a brief microacoustic event, with a duration near the threshold of human auditory perception... Each grain contains a waveform shaped by an amplitude envelope." [1] When large numbers of grains are played (or if a single grain is rapidly looped), the short-duration grains may coalesce into a cohesive musical or timbral sound.

An in-depth discussion of grains, grainclouds, and microsound is beyond the scope of this short paper. The aforementioned *Microsound* provides definitions, history, and conceptual foundations for the discipline of microsound-oriented composition. [1]

In *Microsound*, Rhodes focuses largely on the computer music aspects of microsound composition. However, he does take note of acoustic and analog realizations of microsounds. The physical realizations that are emphasized in *Microsound*, though, are human-mediated: orchestral works such as *Metastasis* (1954) by Iannis Xenakis are named as real-world examples of microsound in musical contexts. A large orchestra with myriad instruments creating microsounds certainly fulfils the criteria of a real-world graincloud: a number of microsound grain-generators are controlled (by a musical score and conductor) in a related manner. However, the human factors in an orchestra endows any orchestra-created graincloud with an inherent sense of human agency. As each microsound grain is generated by a human musician, any emergent complexity arising from the graincloud is experienced by audiences as filtered through a veil of human agency.

To better draw attention to emergent complex behaviors and patterns created by clouds of physically-realized granular sounds, automated or otherwise self-acting physical systems may be employed. These systems may take the form of multimedia installations, new mechatronic instruments, or combinations thereof. They typically consist of arrays of discrete elements that interact within a medium to produce simple, brief sounds. These simple sounds produced by each of the system's myriad noisemakers combine to form a graincloud-like swarm of sounds whose behavior is dictated by the medium's properties and the properties of the individual physical 'grains' within the medium. These physical grainclouds, then, allow concepts originally conceived of in light of affordances of wholly electronic systems to be experienced in the same environment that the audience/viewers occupy. The following section details a number of shared characteristics common to these physical graincloud systems.

Characteristics of Physical Grainclouds

A physical graincloud consists of swarms of discrete sound objects. These objects may be configured by the artist to interact with one another or they may be isolated from one another but each capable of individual sound production. Artworks featuring both interacting and isolated sound objects are examined in detail below. Regardless of the presence of absence of grain-to-grain interaction, physical grainclouds contain three common characteristics: the presence of sound objects, a medium in which these objects exist to produce sound, and some means by which the medium and/or grains are actuated.

Grains

The sound-making grains present in a physical graincloud are perhaps such works' central focal point (both visually and aurally). Many works, such as the grainclouds of Zimoun (exemplified by *361 Prepared DC Motors, filler wire 1.0mm*, shown in Figure 1 [2]) and Céleste Boursier-Mougenot (as in *clinamen v.1* [3]) consist of arrays of physical objects that are similar to one another. Each object, when acted upon by neighboring objects or some other actuator, produces a sound similar to the others in the graincloud. While superficially similar, subtle differences in the physical grains' timbres, locations, temporalities, and amplitude envelopes produce emergent complex soundscapes within the system.

Aether

In physical graincloud artworks, the grains themselves occupy a space. This space serves as a sort of aether that can be manipulated to act upon the grains. In Céleste Boursier-Mougenot's *clinamen* works, for example, the myriad ceramic objects float on water; the motions of this water aether lead the ceramic grains to interact with one another and with the boundaries of the artwork. Artworks wherein the grains may traverse through the aether in an unconstrained manner make up one distinct subcategory of physical graincloud pieces.

Other artworks make use of an aether medium that more actively constrains each grain. This is perhaps best exemplified by Pe Lang's *moving objects | nº 692 – 803* [4]. In this work, a number of discrete objects are constrained to linear strips of material. These linear strips are excited by actuators, causing the grain objects to move in a manner constrained by the motion of the strips to which they are attached. Other examples of artworks with relatively constrained aether include Harry Bertoia's Sonambient Sculptures (in which the sound objects are permanently affixed to a surface but are free to flex and interact with one another as they do so). [5]

While the grains in a physical graincloud system are the most immediately visible and audible aspect of such a piece, they may be seen to serve merely as a visualization aid for the behavior of the aether, be it relatively unconstrained (as with *clinamen*) or a more constrained aether (as with Lang's *moving objects | nº 692 - 803*).

Actuator

A final element common to physical graincloud sound artworks is the actuator. The actuator is the element that excites the aether, causing it to act upon the system's grains and produce clouds of granular sound. While the grains and the aether are typically core audiovisual elements of a piece, the actuator often exists as a practical element concealed from the rest of the piece. The mode of actuation has significant impact upon a piece: the actuator is the real-world equivalent of a digital graincloud's algorithm that causes grains to traverse a space, act upon each other, and interact with other elements in the digital graincloud system.

Three principal types of actuators are present in physical graincloud systems: machine, human, and natural actuators. Machine actuators consist of electromechanical devices that act upon the system's aether to move. Such motorised actuators (including the pumps in Boursier-Mougenot's *clinamen*, the grain-lifting apparatus in Daito Manabe and Motoi Ishibashi's *Particles*, and the solenoid-powered actuators in Ajay Kapur's *Modulets* system) allow the artist to define the aether and grains' behavior in a highly controlled manner. [6, 7]

Human-actuated systems forego the machine choreography afforded by electromechanical actuators in favor of interactive systems. Such human-actuated systems are perhaps best exemplified by the aforementioned Sonambient Sculptures by Harry Bertoia. In these systems, human participants actuate the system by directly acting upon the grains, producing complex, emergent timbres.

Finally, natural forces may be used to actuate an aether. While a study of such natural actuation approaches warrants a separate paper of its own, systems such as Zimoun's *25 woodworms, wood, microphone, sound system*, the fixed media work *The Noisiest Guys on the Planet* by Jana Winderen, and David Dunn's *Sound of Light in Trees* exemplify the use of non-human actant elements in physical graincloud sound art. [8, 9, 10] Such works highlight the complexity and agency that may emerge from systems without direct human influence.

Physical Graincloud Artistic Elements

Why build physical graincloud systems when digital approaches allow for more flexibility, more grains, and arbitrary aether and actuation schemes? A survey of representative physical graincloud artworks reveals two key common elements that differentiate the real-world systems from their digital equivalents.

A first element common to many physical graincloud artworks is a focus on materiality, an attribute much more difficult to explore and convey in an "inside-the-box" digital-only approach. Indeed, physical graincloud artworks often make the assemblage of components and material (and the emergent behaviors produced when these components are actuated) a core aspect of the artwork. This is exemplified by Zimoun and Pe Lang's works, which go so far as to list the materials used in the titles of the works.

Figure 2. *Tectonic*, a new physical graincloud artwork

This emphasis on the actuation of physical materials and the creation of emergent textures as a result occurs in many works that may be categorised as physical grainclouds: Nelo Akamatsu's "Chijikinkutsu" (2015) features arrays of individually simple metal-on-glass noisemakers; taken as a whole, the work becomes a sort of meditation on the interactions of one elemental material against another, actuated by unseen forces within an aether. [11]

Real-world grainclouds allow artists to highlight the role of materials in the artworks. A second element that is perhaps more easily highlighted in physical systems than in fully-digital realizations is the spatio-temporality of the graincloud. Systems in which the audience shares a physical space with the individual grains allows for very high-resolution spatialisation of the grains' sounds: to achieve such spatial resolution in a digital system, restrictively large loudspeaker arrays (or isolating binaural headphone setups) must be used.

While physical grainclouds allow artists to emphasize the materiality and spatial attributes of the system's grains in a manner perhaps more experientially meaningful than in digital-only systems, such physical grainclouds also share a number of attributes with digital approaches. Both, for example, emphasize the emergent patterns and complexity that arise from myriad interactions between individually simple elements.

Tectonic: A Physical Graincloud Case Study

Motivated by the artistic and compositional affordances offered by physical grainclouds, the author developed, built, and performed with *Tectonic*, a new performance-oriented sound art instrument. This section briefly describes *Tectonic*, discussing the design goals, technical details, and performance use.

The decision to develop *Tectonic*, depicted in Figure 2, was inspired by the ability of physical graincloud artworks to emphasize grains' materiality and to arrive at compelling real-world spatiotemporal outcomes. Key design goals were to emphasize the grains' materiality and physical

interactions in ways that would be difficult in digital-only graincloud systems. A second design goal was to combine human interactivity with relatively precise mechanized actuation: it was hoped that the mechanized actuation would allow for the emergence of complex behaviors amongst grains while human interaction would afford real-time on-stage performance capabilities. Finally, *Tectonic* was intended to allow for rapid improvisation and reconfiguration: grains and the aether's behavior should be able to be easily modified to allow for flexible performance paradigms.

As mentioned above, physical graincloud artworks often consist of grains, an aether, and some form of actuation. *Tectonic's* aether consists of a wood-encircled glass plate (measuring 500 by 500 mm) mounted within a two-axis gimbal. The gimbal axes are connected to motorized actuators, allowing the glass plate to be tilted as the motors rotate. The glass plate serves as an aether upon which physical grains may be placed. As the aether is actuated by the gimbal motors, the grains roll and slide around the glass frame. Sound events occur as the grains collide with one another, scrape along the glass, and strike the wooden boundary.

The motorized actuators fulfil the criteria that precision manipulation of the aether be possible: gear-reduced DC servomotors are employed, allowing the gimbal axes to be rotated to angles with relatively high resolution. The glass plate of *Tectonic* is exposed, permitting performers to add and remove grains during the course of a performance. This human interaction (which might consist of the performer dropping grains onto the surface to create percussive sounds, or "swirling" the grains around by hand) fulfils the criteria that *Tectonic* afford not only precise mechanical actuation but also real-time human interaction. Arbitrary objects may be used as grains by *Tectonic*: glass beads, seeds, marbles, and metal ball bearings have been tested, and contact microphones are utilized to amplify softer sound produced by small grain objects.

Tectonic consists of the two aforementioned servomotors. These are controlled by an Arduino microcontroller equipped with a MIDI input interface. This MIDI input allows the microcontroller to communicate with a host PC via MIDI, letting a computer utilize the MIDI communication protocol (ubiquitous amongst digital music production software environments) to communicate with *Tectonic*. *Tectonic's* microcontroller is configured to convert MIDI Control Change messages to servo angle set points: the composer sends MIDI messages from a host PC to *Tectonic*, which responds by moving the gimbal motors which tilt the glass plate and cause the grain sound objects to move around the surface.

Tectonic premiered at a concert for Orchestra Wellington on 3 December, 2016. During this performance, *Tectonic's* effectiveness as a performance tool was demonstrated: the author participated in the performance first by triggering pre-defined motions of the gimbal motors and then by placing physical objects onto the glass plate during the performance. This debut performance of *Tectonic* has catalyzed ongoing development which focuses on improving the physical resilience of the structure to allow for longer-term installation use rather than short-term on-stage performance use.

Physical Grainclouds

Physical approaches offer artists ways to explore the complex and emergent behavior afforded by grainclouds in a manner that places the artwork in the same physical context as the audience. This allows real-world materials to be implemented, allowing for a focus on materiality and spatiotemporality to accompany the complex interactions present in all graincloud artworks. *Tectonic*, the new work presented above, was created in light of the works examined in this paper. Through deconstructing physical graincloud systems into the three elements of grain, aether, and actuator, each individual component of *Tectonic* could be realized in a manner that served the design's original criteria.

Future work arising from this project includes an identified need to more fully explore artworks using nature-based actuators. Further, systems using hybrid actuation schemes warrant further investigation: sonfications of natural systems realized through precision actuators present a compelling subcategory of graincloud artworks.

In a world wherein artistic concepts are increasingly realized in a completely digital manner, the physicality afforded by "real world" systems has much potential to powerfully connect with audiences. While digital systems allow for entirely new ways of conceiving audiovisual paradigms, it is perhaps when these paradigms are brought into a physical space that they become most resonant and meaningful to audiences.

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An Invitation to DANCE: Making Sense of Viewer Interaction in Installation Art

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Abstract

This paper addresses a case study into viewer interaction in the five-screen interactive dance film installation *An Invitation to DANCE*. Literature on the experience of dance suggests that dance film is set apart from dance performance due to the relative passivity of viewers of film. It is claimed that essential characteristics of dance are lost when dance appears on and for the screen, instead of being performed live. This paper questions that claim through an in-depth analysis of viewer behavior in the art installation *An Invitation to DANCE*, based on a case study that took place at TENT Rotterdam in May and June 2019. Our findings show that when dance film is distributed over multiple screens, which cannot be observed from one single position, viewers *actively* interact with them. As such, they allow for the participation, feeling, proximity, and corporeal relationship typical to dance performance. Therefore, this paper underscores that *if* strong distinctions between experiencing dance on film and in theatre can be made, they are more complex than viewership being active in the latter and passive in the first. Concluding our case study, we observe a necessity for more detailed situated audience research during artistic production processes of interactive artworks.

Keywords

Dance, Film, Installation, Embodiment, Situatedness

Introduction

Typically, viewers of dance films are considered to watch passively from their seats, while the bodies of dancers move actively across the screen. This relative passivity of the viewer is said to set dance film apart from dance performance. The first "tends to invite observation rather than participation, whereas performance allows for feeling, proximity, and corporeal relationship" [1]. Literature on the difference in experience between dance film and performance is rather conclusive in that essential characteristics of dance – e.g., spontaneity, immediacy, kinetic force, presence – get lost when dance appears on and for the screen [2][3]. However, work on the haptics of the eye and phenomenology in relation to film have nuanced this opposition between passive and active viewership, noting that seeing is a process irreducibly bound up in the activity of the whole sensorial body [4]. Even when most of our body is inactive, vision is "fleshed out" and given meaning by our capacity to also hear, touch, smell, and taste as we see and we move through the world [5] [6]. Based on these insights it could be argued that the essential characteristics of performed dance can be, made alive again by viewers of dance films, as they engage their bodies to create an intimate experience and close relationship between themselves and the image. Nevertheless, in practice, with notable exceptions such as Pimentel [7], Vincent *et al.* [8], and Lee *et al.* [9], performance studies still largely ignore screens as media to convey dance, including their potential to support active modes of interaction between dance films and their audiences.

The installation *An Invitation to DANCE* was developed to explore such modes of interaction. The installation guides viewers through a space via a five-screen set-up. As viewers navigate the space, they interact with each screen: they feel, sense, and make sense of the images and the sound, as well as, the space around them, other viewers, and their own bodily sensations. A dance critic reviewing the work reported that, as the pumping mix of images, sounds, and bodies intensifies over time, viewers start to identify with the movements of the dancers on the screens and feel invited to dance along [10]. This seems to suggest that *An Invitation to DANCE* dissolves the lack of interaction between viewers and dancers. However, to draw this conclusion, requires a full comprehension of the viewer's feeling, proximity, and corporeal relationship to the dancers' movements.

Therefore, in this paper, we analyze the interaction between viewers and the installation, to answer our research question:

Do viewers of An Invitation to DANCE *experience feeling, proximity, and corporeal relationship to a dancers' movement in the installation?*

In the below, we first provide a more detailed description of our case study. Next, we present our results, to subsequently discuss if *An Invitation to DANCE* creates interaction between viewers and dancers. Finally, we conclude on our research question.

Case Study: An Invitation to DANCE

For the purpose of our case study, the installation *An Invitation to DANCE* was exhibited at TENT – a platform for contemporary art in Rotterdam, the Netherlands – in three different versions in the period from May 26 to June 23, 2019, to a diverse audience of 2077 viewers.

The installation

An Invitation to DANCE is an interactive installation of five screens that float in a darkened space. Each screen is 309 cm wide by 175 cm high (16:9). On these screens, four to seven second clips of dancers executing a pumping, repetitive dance movement are projected with a beamer. Each clip is selected at random from a 'black box' with clips, containing 30 synchronized 18 minutes and 14 seconds of pre-recorded film takes, by a specially designed software. The randomly selected clips are projected on five screens, showing medium, close and extreme close shots of a group of five dancers – three women and two men – moving their body up-and-down as if propelled by an invisible electric pulse in a dark silo. This choreography is amplified by a synchronized sound installation of a pumping beat mixed with the increasing sound of the panting of the dancers. The screens are placed in the space to guide the viewer through the room, inviting them to 'edit' their own unique dance film experience out of the sound and the clips chosen by the software through the prism of their own body (see fig. 1).

Figure 1. Photo from *An Invitation to DANCE* visited by viewers.

Like many installation artworks, *An Invitation to DANCE* aims to create encounters through the sentience of our own bodies. The placement of the screens guides these interactions. Viewers, for example, have to choose to take in a single position or multiple ones from which to see the screens. They need to determine how close they position themselves to the screens and whether or not to view each screen once, multiple times, or all at once. Through these interactions, the installation invites audience to create a kinesthetic resonance with the dancer's movements in their own bodies.

Versions

During the exhibition period, the installation was exhibited in three versions. Each version had its own distinctive scenography; 'solo,' 'arena,' and 'panorama.' (see fig. 2) Each version requires a different type of interaction to experience the installation, based on the three features of interactivity as discussed by Noë: 1) environment, or the way the artwork makes the viewer part of its location; 2) perspicuity, or how easily he or she can take in the artwork at a glance (due to scale and/or complexity); and 3) particularity, or the degree to which the artwork needs to be inspected to experience it [11].

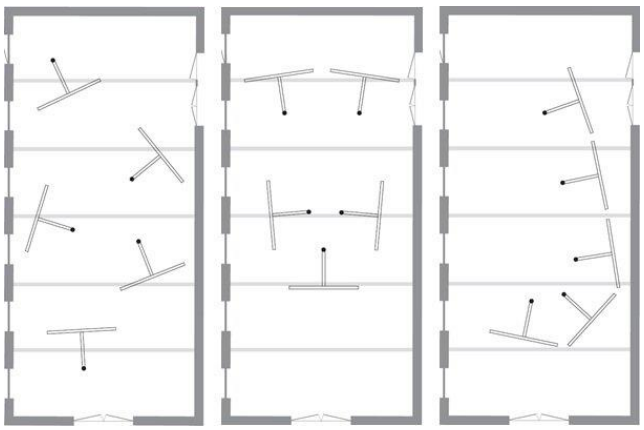

Figure 2. Floor plan of each version of the installation, featuring the location of the projector (black dot), the direction in which it projected (connected line), and the screen on which they projected (opposite line). From left to right: solo, arena, and panorama.

In 'solo,' viewers are presented with one screen at a time. They need to follow an s-shaped parkour from the first screen at the door (bottom) to the last (top) to view them all. As such, they become a part of the whole environment. However, this fragmentation of the screens also forces a lack in perspicuity, as their view is often blocked by other screens. Therefore, 'solo' asks them to inspect the installation in great detail. In 'arena,' the interaction of viewers is typically less environmental, as screens are placed together in groups, which provides a greater degree of ease to take in the installation at a glance, and thus demands less inspection of the space with their body. Finally, in 'panorama,' viewers can simply walk in, take up a position along the connected screens, and inspect all the screens in a single look.

In sum, each version of the installation provides a different situation according to the interaction features 'environment,' 'perspicuity,' and 'particularity.' The level of interaction asked of viewers varies from a great degree of environment, lack of perspicuity, and great necessity of particularity in 'solo,' to little involvement with environment, total perspicuity, and a low need of particularity in 'panorama.'

Methods

According to Stern, what is often lacking in the discussion of interactive art is a detailed analysis of how the audience actually interacts with an artwork through its actions [12]. Therefore, in our case study we analyzed in-depth what the audience does in the installation, based on a social scientific approach using quantitative methods.

Firstly, we calculated the entrance and exit times of each viewer who attended the installation between 11.00 a.m. (opening) and 09.00 p.m. (closing). Secondly, we calculated the actions of viewers based on the interactivity features of environment, perspicuity, and particularity. Specifically, we looked at: 1) how a viewer moved through the space (takes in one position, takes in multiple position, or moves around); 2) how closely they positioned their body to the screen (close, middle, or far); and 3) how often they looked at the screen (every screen once, multiple times, or all at once). These three aspects were derived from the ethnographic method of participant-observation, in which researchers observe the behavior of people in a specific location for lengthy periods of time, and note down characteristics that present themselves repeatedly. An observation form was developed for this purpose, which featured a tally of these three aspects of visitors' behavior during their visits.

The interaction of viewers in each version of the installation was observed on three days: May 31 ('solo'), June 14 ('arena'), and June 21 ('panorama'). We chose these days, because they are all Fridays, and viewer data from TENT showed that Fridays are their most attended days. As such, these days would likely provide us with the largest sample size possible per installation version. In the three days of observation, a total of 209 people visited the installation.

Results

Of the 209 people that visited the installation during observation, the 'solo' and 'panorama' versions of the installation received 86 unique viewers, while 'arena' had 48 viewers. Most viewers in the 'solo' and 'arena' version of the installation stayed between 2 and 5 minutes (min.). While in 'panorama,' most viewers remained in the installation between 5 and 10 minutes. On average, a viewer spent 2'76" min. in 'solo,' 3'11" min. in 'arena,' and 6'40" min. in 'panorama.' These outcomes thus show that the length of stay for each set-up increased, with people spending the longest time on average in 'panorama.'

The behavior of viewers was different between the three versions as well. In 'solo,' viewers sensed the space through three types of behavior equally (see Table 1). We observed "takes in one position" 29.2% of the time, "takes in multiple positions" 37.5% of the time, and "moves around without taking a position" 33.3% of the time. In 'arena' viewers already gravitated more towards the taking of one position to interact with the screens (50.0%), with an 88.4% of the time in 'panorama.' In short, while the types of movement behavior where observed evenly between the three categories in 'solo,' they gravitated more and more predominantly towards "takes in one position" in 'arena' and 'panorama.'

Type of Movement	Solo	Arena	Panorama
One position	29.2%	50.0%	88.4%
Multiple positions	37.5%	36.8%	9.0%
No position	33.3%	13.2%	2.1%

Table 1. Number of times 'type of movement through the space' was observed in percentages.

A similar observation of a gravitation towards one type of behavior can also be noted in the other categories "distance viewers position themselves to the screen" and "how they inspect the screen." As shown in Table 2, the number of times viewers positioned themselves between a medium and far distance was observed rather equally with 47.2.0% and 49.0% of the time, respectively, in the 'solo' set-up. This observation changed notably towards the third set-up, with viewers positioning themselves overwhelmingly from a far distance 94.3% of the time in 'panorama.'

Distance	Solo	Arena	Panorama
Close	3.8%	15.4%	2.3%
Medium	47.2%	20.5%	3.4%
Far	49.0%	64.1%	94.3%

Table 2. Number of times behavior 'distance to the screen in the three installations' was observed in percentages.

The type of inspection of the screen was quite evenly observed again in both 'solo' and 'arena,' with only the very low 2.8% of the time for "all screens at once" in the first (see Table 3). But in 'panorama' the behavior type "each screen repeatedly" was the predominant manner (74.0%) in which viewers interacted with the screens.

Type of Inspection	Solo	Arena	Panorama
Each screen once	41.0%	23.0%	10.9%
Each screen repeatedly	56.2%	46.2%	74.0%
All screens at once	2.8%	30.8%	15.2%

Table 3. Number of times behavior 'how viewer inspects screen' was observed in percentages.

Discussion

In our case study, we observed the behavior of viewers in three versions of *An Invitation to DANCE* to compare results and deepen our understanding about whether or not feeling, proximity, and corporeal relationship with the dancers' movement were experienced in the installation as a whole. Before addressing that question, we briefly compare the types of interaction displayed in each version of the installation.

Our observations of audience behavior in the different versions of the installation show that each version resulted

in a different interactivity. In 'solo,' viewers alternated between different types of movement and proximity. Some continuously walked around, others took up one or multiple positions. Furthermore, they alternated between medium and far away distances to the screen. In 'arena,' viewers favored one or multiple positions. Furthermore, they alternated between close, medium, and far proximities to the screen, but they preferred to stand from a far distance of the screens. In 'panorama' most viewers took up one position in the installation in a faraway distance to the screens, as they would in the case of a regular dance film. However, even in that one position, they inspected the screens repeatedly, moving their heads between screens. The screens were mostly inspected repeatedly in 'solo' and 'arena' too. In the first, viewers walked back and forth between screens, while they switched their body position between the three screens on the one hand, and the two opposing them on the other, in the second.

Combined, these observations show that viewers are not passive in their actions towards the screens in *An Invitation to DANCE*, as one could hypothesize based on the literature in performance studies. Even in 'panorama,' the version closest to the case of a dance film, there is viewer activity via repeated screen inspection. Furthermore, our observations of viewer interaction in the different versions of the installation show that viewers deliberately position themselves to establish a corporeal relation to the dancers on the screens. Using their own body, they placed themselves at various proximities from the screens to experience the images of the dancers' movements. Even from one position in the room – as with 'panorama' – they repeatedly inspected the screens, moving their heads actively to establish connections between the clips of medium, close, and extreme close shots of the dancers' faces, their heaving chests, and their pumping bodies. These results suggest that in *An Invitation to DANCE* proximity to, and corporeal relationship with the dancers' movement on the screens are indeed experienced.

Additionally, anecdotal evidence collected during the case study suggest that viewers experienced feeling with the dancers' movements during their time in *An Invitation to DANCE*. One viewer for instance revealed to us that she had had a positive experience interacting with *An Invitation to DANCE* in 'panorama,' because this version filled her entire field of view, thus allowing her to be completely absorbed by the dancers' movements. Another viewer stated that she found *An Invitation to DANCE* in its 'solo' version "exciting," as the installation invited her to explore and play with her body in space in relation to the moving bodies on the screens. Lastly, a viewer mentioned that *An Invitation to DANCE* in 'arena' felt like "being surrounded by dancing bodies in a night club," and it thus upheld its promise as an 'invitation to dance.' These verbal expression of viewers on their experience further bolsters the conclusion that viewers of *An Invitation to DANCE* indeed experience feeling, proximity, and corporeal relationship with the dancers' movement. However, before such conclusions can be drawn, the anecdotal evidence collected during the case study requires deeper analysis. Therefore, in future research, we aim to better understand how the quality of visitor experiences relates to the behavior we observed, by analyzing the additional data collected from visitors through closed-ended questionnaires and semi-structured individual and group interviews.

Conclusion

Detailed analysis of how audiences actually interact with an artwork through their actions are often lacking in the discussion of interactive art. Therefore, we analyzed in-depth how the audience interacts with *An Invitation to DANCE* in the above. Our case study suggests that literature on the difference in experience between dance film and dance performance may be too conclusive in stating that, essential characteristics of dance – e.g., spontaneity, immediacy, kinetic force, presence – are completely lost when dance appears on and for a screen. In contrast, our findings show that, when dance film is distributed over multiple screens, which cannot be observed from one single position, viewers actively interact with them and they allow for participation, feeling, proximity, and corporeal relationship, just like a dance performance might. As such, this case study underscores that *if* there are such strong distinctions between experiencing dance on film and in theatre, their relation is more complex. At least, our case study reveals, some of the spontaneity, immediacy, kinetic force, and presence associated with dance can be brought back in the experience of dance film, based on multiple screens and an activating scenography. This conclusion is in correspondence with the more nuanced views on the role of the full sensorial body as a locus where images are made alive and flesh. This more nuanced view, however, still needs a broader practical translation into the creative dance film field. Especially, in regards to the potential of screens as media to establish an active interaction between dance film and viewer. We hope this study will contribute to such a translation.

As such, our study is also a strong testament to the necessity of detailed audience research during the artistic production process. Especially, when artworks are interactive in nature, they should not be decontextualized from the environments in which they will eventually operate and the people that will experience them, during artistic production and development [13]. We should not be excluding screens as supporters of active modes of interaction in dance films, we should be abandoning their designated studio practices that create for passive experiences.

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Authors' Biographies

Minke Nouwens is a language artist and keen researcher of the interdisciplinary relations and collaborations between art and anthropology. She holds a BSc and MScRes in Cultural Anthropology and an MA in research-based Fine Art. Her work has been recognized in publications in the Amsterdam Social Science Journal, and on Allegra Lab: Platform for Anthropology, Law, and Art, as well as through grants, such as the Summer Sessions Residency with V2_ Lab for the Unstable Media and POINTS Centre for Contemporary Art Kunshan, and the Bernard Cultuurfonds Scholarship for rising talent. Next to her individual work, Minke actively participates in the artistic and scholarly field as an educator and has lectured at the University of Amsterdam, Victoria University of Wellington, Master Institute of Visual Cultures | St. Joost, EASA Biennale, and Nieuw Dakota. Currently, she is a Research Fellow at the AVANS Centre of Applied Research for Art, Design, and Technology.

Noud Heerkens is an independent filmmaker who investigates the limits of the medium film and its cross-overs with other disciplines. His work centers around the theme of the solitude of postmodern man. Heerkens is interested in how this relates to a definition of the world as multi-perspectival, within which we take on various roles and undergo diverse experiences. His films and installations have been shown at various national and international platforms, amongst other the International Film Festival of Rotterdam, the Moscow International Filmfestival, MoMa PS1 New York, and TENT Rotterdam. Most of his films are part of the collection of the Dutch Film museum EYE. Additionally, Heerkens has taught at several Dutch art academies and universities. Currently, he is a tutor at the Master Institute of Visual Cultures | St. Joost, and researcher at the AVANS Centre of Applied Research for Art, Design and Technology.

Michel van Dartel is Research Professor at the AVANS Centre of Applied Research for Art, Design and Technology (CARADT) and Director of V2_Lab for the Unstable Media. He holds an MSc in cognitive psychology and a PhD in artificial intelligence. Alongside his work at V2_ and AVANS, Michel also acts as an independent curator and is an advisor to the Netherlands Organization for Scientific Research; a member of the International Program Committee for ISEA2020; a manuscript reviewer for Leonardo; and the editor and author of numerous scientific and artistic articles and books.

Any One, anyWare:
Perceiving Sentience and Embodiment in a Distributed Sculpture

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Abstract

anyWare is an Internet of Things distributed sculpture comprised of three identical objects that are individually connected to the Internet and physically mirror each other. The *anyWare* sculptures are art objects that telematically connect three different locations in the world and enable distal physical communication. The objects simultaneously respond to people who interact directly with them, as well as allow them to interact with each other through the sculptures. Structuring these interactions are a number of games and puzzles that people may play or solve, either individually or collaboratively. The objects transform in the experience of exploration, and in so doing reveal different levels of interactivity and aesthetic experience. The mediated sentience of the *anyWare* sculptures through non-verbal, playful interaction provides a model for envisioning networked communication that circumvents age, cultural, and linguistic differences.

Keywords

Internet of Things, sculpture, distributed interaction, tangible interaction, non-verbal communication, embodiment, game design, object-based enquiry, interactivity, research-creation.

Introduction

The *anyWare* project saw the creation of three identical sculptures designed to telematically connect three different locations in the world. These objects are individually connected to the Internet, and physically mirror each other. The *anyWare* sculptures simultaneously respond to people who interact directly *with* them, and allow people to interact with each other *through* them. To structure these interactions, we developed a number of games and puzzles for people to play or solve. For example, if someone walks into the gallery in Montréal and begins to play and interact with *anyWare*, someone in Toronto at the same time will be able to see the results of those interactions. At this point, the person in Toronto may join the person in Montréal in the game and collaborate with them, which might entice a person in Ottawa to participate. Each identical object enables a set of playful interactions that are designed to encourage experimentation, exploration, and potential 'conversations' with other interactors in different locations. The objects transform in the experience of exploration (either with one person or potentially with many people) and in so doing reveal different levels of interactivity and offer different levels of aesthetic experience.

anyWare explores our emotional and physical connections with technology in a world of ubiquitous computing. Ubiquitous computing refers to the many ways computational systems have moved beyond computers, entering unobtrusively and seamlessly into the world, and embedding themselves within all of the things with which we surround ourselves (Weiser, Greenfield). The field of ubiquitous computing has several areas of focus, the most relevant to *anyWare* being the Internet of Things (IoT). A term coined by Kevin Ashton in 1999, IoT broadly refers to objects connected to the Internet, each uniquely identifiable and capable of providing real time information about the world. This can manifest in many ways, from gas meters connected to the Internet, which are controlled by an iPhone app (GE Brillion™ Connected Appliances) to the global response to the nuclear disaster in Fukushima, when hundreds of DIY geiger counters in Japan were hooked up to the Internet using the public data monitoring service *Pachube.com* (now called *Cosm.com*).

Most pertinent to *anyWare* are projects that focus on tangible user interfaces that have the potential to transform interaction, connect individual lives, and help facilitate communication over distances, for example, Alexandra Deschamps-Sonsino's *Goodnight Lamps*[1] 2013 and the MIT Tangible Media Group's *inFORM*[2] 2013. What happens to bodies as they move alongside these technologies and networks, and how can these technologies become tools for emotional exchange? When we live around these objects/systems, it is natural that they become incorporated into our daily lives; we begin to live through them, and more importantly, we also begin to feel through them, both in terms of individual experiences and relationships with others. These objects and systems become an extension of not only our physical selves but also of our emotions; they mediate how we play and interact together (Dourish, Greenfield, Rogers).

Conceptual Framework

In many ways, ubiquitous computing represents a massive paradigm shift in our relationship to objects, computing technology, and each other. Ubiquitous computing also provides us with an opportunity to re-engage issues that have long been a source of significant artistic inquiry. Explorations of technology through art, audience engagement, and interactivity can be traced back to the 1950s and 1960s in performance, Happenings, and the Fluxus movement. During this time, experimental art and technology explorations came out of the Bell Lab's artist-in-residence program, Experiments with Art and Technology (EAT) performances, and works by the Nouvelle Tendance in Europe (Burnham, Salter). Over the last several decades, this experimental culture has continued to thrive, and it can be found within many artistic domains including, but not restricted to, experimental theatre and music, performance-based practices, cybernetics/robotics, and interactive video. This type of work can be found in individual studio-based explorations, larger collaborative artistic projects, as well as aesthetically driven research/creation in spaces like V_2 Labs (Rotterdam, NL), Milieux: Institute for Arts, Culture, and Technology (Montréal, CA), and Centre for Art and Media (ZKM) (Karlsruhe, De).

Telematic interaction has been featured in the artistic imagination since the 60s (e.g., Nam June Paik's proposition for a live concert between San Francisco and Shanghai, where the left-hand part was played in San Francisco and the right-hand part was played in China). Today, cutting edge research in telematics spans the globe. Notable research projects include TOT (Territoires Ouvert – Open Territories)[3] at the Société des arts technologique (SAT) in Montréal (CA), and the New York City (USA)/ Seoul (KR) performance/musical collaboration at CultureHub[4], situated at La MaMa Theatre and Seoul Korea Institute of the Arts. This work focuses on telematic ocular and aural communication, allowing individuals (dancers and musicians) to collaborate and move in parallel through space and time.
Other attempts to explore physical relationships between bodies in different spaces include *Silent Barrage* (2010), a collaborative project by the Neurotica Collective (AU) and the Steve Potter Lab (USA)[5]. This work connects a robotic sculptural installation in China to the cultured nerve cells of a rat in a laboratory in California. The sculptural robotic elements in the physical installation in China were telematically connected to different regions of the cultured nerve cells, and moved according to the neuronal activity of the rat. Conversely, individuals within the installation would respond to the moving robotic components, and their movement in turn stimulated the culture. Most of these projects, while connecting bodies through space, do not facilitate physical or embodied intentional communication between the participants in the different locations. *anyWare* builds on these ideas of distal collaboration and communication, but with a focus on non-verbal and embodied means of connecting people through space and time in tangible interaction and play.

Artistic inquiry is a powerful methodology for engaging with lived experience and creating spaces for the body that are unstructured, thought provoking, and at times playful. However, to create a work that asks individuals to communicate through networked objects without voice or video, we need to reimagine how interactivity has traditionally been structured within an art context. How do people recognize and interpret feedback and assign meaning, be it through computational feedback, telepresence, or error? Interaction structures drawn from games provides new solutions to manage some of these issues. Games excel in structured interactive experiences, leveraging rules and goals in order to scaffold user interaction in a manner that enables a deep and fluid engagement. By adopting a sophisticated understanding of what games are and what they do, *anyWare* goes beyond simplistic gamification paradigms and instead find engaging new structures for interactive art experiences.

The relationship between gaming and art has become a point of exploration in several recent festivals, exhibitions, and art and technology centres around the world. Most recently, David O'Reilly's videogame *Everything*[6] was awarded a 2017 Golden Nica from Ars Electronica. The EYEBEAM Art and Technology Center has expanded its areas of research to include game design, and major exhibitions and festivals such as F.I.L.E (Brazil)'s FILE GAMES RIO, and the 5000m2 exhibition *Joue le jeu/Play along* (la Gaîté Lyrique, Paris, FR) continue to create productive crossovers between the world of gaming and the world of contemporary art. This area of investigation is not only exciting in terms of the space of discovery it opens up in new media art practices, but it also suggests a range of opportunities for disseminating this type of work.

Project Description

The three *anyWare* sculptures are visually inspired by the cephalopod (octopus, cuttlefish, and squid), marine creatures that communicate through changes in colour and pattern on their skin. Like the cephalopod, the bodies of the sculptures are vessels for communication which enable players to communicate non-verbally. The sculptures are almost exactly the same, and they do the same thing at the same time: the only unique quality is that each object has its own 'location colour'. When a participant touches an interactive surface on the sculpture, the area lights up in the location's colour. There are three sculptures and three location colours: yellow, blue, and pink. If you are at a blue location, and you see a pink or yellow light illuminate, it is possible to recognize the presence of a distributed interactor.

There are three 'art states' and three games that reflect the art states aesthetically, through sound, colour and light (see Figure 2). The art states include the Minimal State, Shadow State and Colour State, and the associated games include Tap, Spin and Follow. To transform the sculptures into a

different art state, one must play/solve the associated game (see Figure 1). The experience is cyclical in nature, with no beginning and no end, and the sculptures can be left in any art state to be viewed and experienced as an art object. Interactors can come and go at any time, leaving the sculptures in any art state until someone else, in any of the locations, decides to engage with the work. The sculptures can be experienced or interacted with alone, with a friend, or with a stranger from another city or even another country.

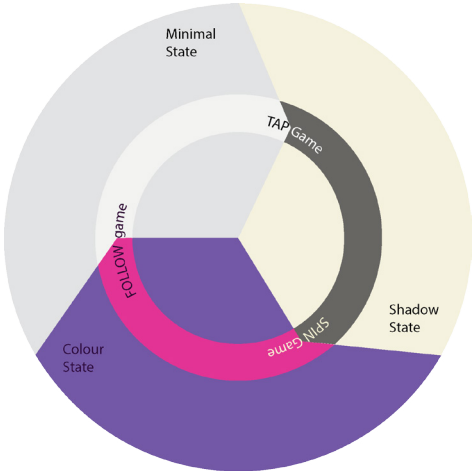

Figure 1. *anyWare* 'art state' flow infographic

As the sculptures use colour, light fluctuations, vibrotactile feedback, and sound cues as primary modes for communication, we provide the viewer/participant with a series of rules with which to guide their communication (see Figure 3). Interactors must learn to interpret colour as presence, vibration as the initiation of touch, and white lights as a call to action. Learning these simple rules allows the interactive experience to begin, and initiates an alternative communication style that does not rely on a common language. *anyWare* encourages people to discover new ways of interacting, and challenges standard voice and screen driven telematic paradigms. This enables embodied experience to find a place in distal communication, and requires people to discover more creative ways of communicating intention, presence, and willingness to engage.

Figure 2. *anyWare* 'art states': Minimal, Shadow and Colour

Observations and Reflections

The inaugural exhibition in June 2018 connected three cities in Canada (Montréal, Ottawa and Toronto), which are separated geographically and linguistically (French and English). Through the *anyWare* sculptures individuals in the different locations were tasked with finding non-verbal ways to both communicate and collaborate.

How do we move from a blip to a dialog with another sentient, embodied entity? Encouraging participants to recognize and connect with another human in a remote location was a continual challenge in the iterative design of the sculptures. Initially we had structured a tactile 'handshake' gesture as a point of connection-- a touch-- between interactors at different locations. However, the handshake had mixed success being read as an extension of another human point of contact. What did evoke that shift, that perception of a live interactor, was instead the association of different light and sound cues to distinct locations. Individuals who may

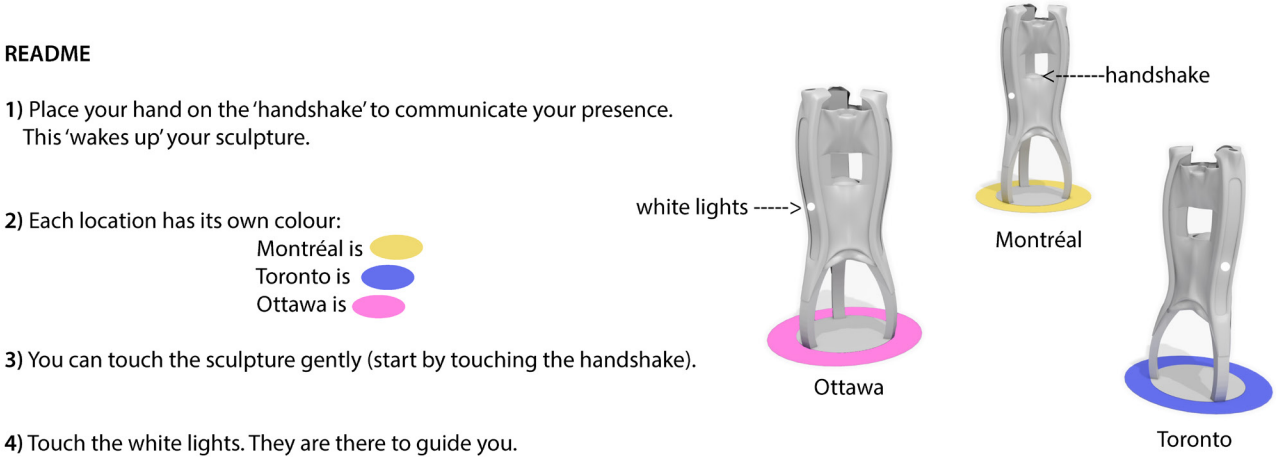

Figure 3. *anyWare* didactic

be observing the sculpture would see these cues, and begin to associate them with the presence of another participant. This was often the prompt that transformed an observer into an interactor, as they jumped in to compete or collaborate with this distant sentient body.

In this way, the *anyWare* sculptures serve as portals that transmit touch: visualized and reinforced by colour, sound and light. The playful interactions embedded in the sculptures are broadly accessible, and have proven to be particularly powerful at bridging public, gaming and art audiences, as well as enabling inter-generational play. Increasingly these audiences have grown socially and emotionally isolated from each other, with technology exacerbating differences rather than enabling connections. *anyWare* is unique in the way that it promotes embodied interaction and collaboration between distributed players despite age, cultural, and linguistic differences, through simultaneous events in three different locations in the world. As the sculptures are designed to be set up in different countries, cities or spaces within a building, they effectively create the context for people within these locations/communities, to connect and collaborate with each other. In our current divisive social and political climate, connecting spaces and people from different cultural contexts has become extremely important. The mediated sentience of the *anyWare* sculptures through non-verbal, playful interaction provides a model for envisioning networked communication with the potential to once again connect with each other in new and meaningful ways.

Acknowledgements

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Using Biophilic Design and the Orienting Reflex to Develop Generative Ambient Public Displays

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Abstract

Principles of biophilic design, and neuroscientific theories of the Orienting Reflex (OR) show some similarities that together make for an effective way to creatively develop the aesthetic use of generative ambient screens in public space, as a way to foster orientation and place making. This paper gives an account of three examples of generative ambient public installations and interdisciplinary methods applied through ethnographic methods to interpret responses from those who attended the installations. In reflecting on the effects of aesthetic elements I have used in generative ambient installations, this paper is motivated by the question: How can principles of biophilic design be used in public ambient media screens to enhance mood, attention restoration and place-making?

Keywords

Generative Ambient Display, Biophilic Design, Aesthetics, Emotion, Attention, Orienting Reflex, Place-making

Introduction

This paper provides an account of a series of Practice-Led experiments and discoveries from creating generative ambient installations in public, and the results of one interdisciplinary study that incorporated ethnographic methods (semi-structured interviews, remote observation and field notes) in public encounter at the site of a generative ambient installation in a large public metropolitan library. The public encounter revealed a range of affective and embodied responses, and patterns of use that indicated ambient screens have a positive effect on orientation, calm, and place making in public space.

Neuroscientist Margaret Bradley's review of research literature [1] on orienting shows the respective domains of *emotion* and *attention* remain "aloof", and understanding of the connection between cognitive influences across emotion and attention is still underdeveloped. Bradley argues that the cognitive systems governing emotion and attention both strongly influence orientation and furthermore suggests that these respective systems compete in the human mind as much as cooperate. Emotion and attention interact and even compete to inform the orienting reflex (OR). The OR is the human way of responding to and maintaining an awareness of salient information in the environment as it arises.

This is interesting to artists and designers, because it provides a cognitive perspective on the tension between the bottom-up, intuitive creation of aesthetic artefacts (that generate an emotional response) and the top-down, problem solving creation of design artefacts (that control attention and inform), particularly with respect to urban environments. This is to describe broad tendencies across public art and urban design that in practice are always interrelated and intermingled in nuanced ways. Aesthetic response (say, in public art or gardens) and clarity of use (say, in architecture or signage) in public spaces can work together to help us feel oriented in the world.

In three examples from my own practice, I will explain how highly aesthetic generative ambient installations in public spaces have shown value as *attentional technologies*, by which I mean that they have enabled those in the space to incorporate ambient aesthetic signals into the periphery of attention in ways that fostered orientation, relaxation, endogenous (volitional) attention, settled comportment, and a sense of place.

Background

As the global human population becomes increasingly urbanized, we see also the proliferation of large digital screens in inner urban public spaces that use traditional means of didactic communication from film, TV, advertising and signage that use the attention-grabbing tactics of montage editing, and rapid motion and juxtaposition of iconic imagery and text alerts; all of which contributes to a distractive environment. In recent years digital displays have become increasingly prevalent as purely aesthetic devices used in corporate foyers, health settings, and hotels, but often screening looping video sequences. A generative real-time ambient approach to screens in public space can be used as an alternative to these traditional aesthetic treatments, as a way to develop an ambient language for

screens in public space that treats attention in a gentle, undistractive, humane way.

I have created a number of generative ambient installations that incorporate biophilic motifs of varying levels of abstraction in a diverse range of public spaces. Generative ambient screens in public space are understood here as screens of a sufficiently significant scale that they can make an impression on locale, and use real-time algorithms to exhibit gentle and continuous change over time. This creates a great deal of aesthetic variation in a space without at any particular moment either causing a startle response or distraction.

Public encounter in the settings of these installations provided feedback on ways in which these installations fostered orientation, volitional attention, positive emotion, and place making. Ethnographic study of one particular installation at State Library Victoria (SLV) the main metropolitan library in Melbourne, Australia provided qualitative data from which I developed several themes using abductive analysis.

In anticipation of screen ubiquity and its distractions, Mark Weiser and John Seely-Brown's principles of Calm Technology [3] encourage humane computer interfaces that are tuned to the periphery of attention. In a public space, in which screens are ubiquitous, my project aims to challenge notions of "attention" by focusing on ambience as a means to fostering endogenous (internal, volitional) attention and calm in public space.

The final installation example has previously been discussed as a generative ambient screen that functions as a Calm application in a public lounge of a hospital [2]. This installation supports the principles of Calm Technology (Weiser and Seely-Brown [3] and Case [4]). The principles of Calm Technology are guidelines aimed at artists and designers to encourage the treatment of attention and shared space in a humane way. This paper deals with matters not discussed in the previous paper that specifically discusses how principles of biophilic design can assist with orientation and in this way be thought of as a positive attentional technology that encourages calm and emplacement in public space.

Methods

Cramer and Browning [4] draw on a wide review of literature on biophilia and design to outline three broad categories that altogether list thirteen criteria. The literature review broadly gathers field work and laboratory tests that show the range of benefits to human health that come from being in or exposed to nature. This same list was developed by Ryan et al [5] into a set of fourteen design "patterns" (Inspired by *A Pattern Language*, Alexander et al, 1977) with the express aim to adapt urban spaces for better human suitability (table 1).

Three separate generative ambient artworks are discussed here, to demonstrate the Practice-Led methods that progressively made connections between biophilic patterns and the orienting reflex. This will show elements that connect to the use of biophilic design patterns as a means to help foster orientation, positive emotion, and endogenous (volitional) attention in public space. The works were exhibited respectively in a trade union hall, a high profile university exhibition space, a large metropolitan library, and a cancer hospital. In each of these cases, remote observation and informal discussion, with a more formal public encounter in the later SLV installation that included semi-structured interviews with 88 adult participants.

Biophilic Design Patterns

Nature ***in*** the Space	[1] Visual connection with nature [2] Non-visual connection with nature [3] Non-rhythmic sensory stimuli [4] Access to thermal and airflow variability [5] Presence of water [6] Dynamic and diffuse light [7] Connection with natural systems
Natural Analogues	[8] Biomorphic forms and patterns [9] Material connection with nature [10] Complexity and order
Nature ***of*** the Space	[11] Prospect [12] Refuge [13] Mystery [14] Risk/Peril

Table 1 Ryan et al Biophilic Design Patterns for built space [6]

Emotion, Attention, and Orientation

Neuroscientist Margaret Bradley [1] argues — through a wide review of neuropsychological literature — that attention, emotion and orientation are implicated across the same neural networks and that this cognitive system was genetically inherited by humans as the means to assess and act on both appetitive (positive, life enhancing) and defensive (fearful, self-preserving) motivation in the environment. This contends, says Bradley, with some conceptions, "… with attention considered rational, dispassionate, and ''cold'' and emotion as irrational, passionate, and ''hot.''" [1] Bradley's review of neurophysiological experiments on the *orienting reflex* (OR, which enables an animal to prepare for action in the environment) characterizes emotion from an evolutionary perspective as "preparation for action" and attention as a means to target and gauge the significance of novel stimuli, with both short and long-term memory being an important factor.

Bradley's research sees the "affective space" for emotion existing in dimensions of pleasure (in a range that can also

be negative) and arousal (intensity). This model sees emotion and attention working together to inform a complex cascade of behavior seen in all mammals, where novel stimuli in the environment is responded to first with inhibition, then defensiveness, and finally with exploration. The intensity of this response is influenced in adult humans by available models in long-term memory (images of familiar patterns, objects or places). Bradley's review of the literature affirms that the orienting reflex (OR) constantly calls on emotion and attention to estimate pleasure and threat, and orient accordingly to the environment.

This model of emotion and attention suggests the importance of aesthetic cues in urban public space in bringing together the three elements of emotion, attention and environment. Such a model supports the importance of peripheral sensory stimulation for orientation, calm, attention, and feeling emplaced.

Branching forms create an identity of place

The first work, entitled *Coenosarcoid* (fig 1) was staged in the courtyard of the inner city trades hall for the Melbourne International Comedy Festival. The work used flocking algorithms to create animated organic branching curved forms in gently changing vivid colours. Festival audiences and workers appreciated the constantly varied aesthetic and the indeterminate way in which the work unfolded in the space. The abundantly colourful treatment of the generative forms spoke to the spirit of the festival and helped those arriving in the space to quickly identify with, and tune in to the space as a locale. While highly abstract, the installation used several of the principles from Ryan et al; namely: (3) Non-rhythmic sensory stimuli, (6) Dynamic and diffuse light, (8) Biomorphic forms and patterns, (10) Complexity and order.

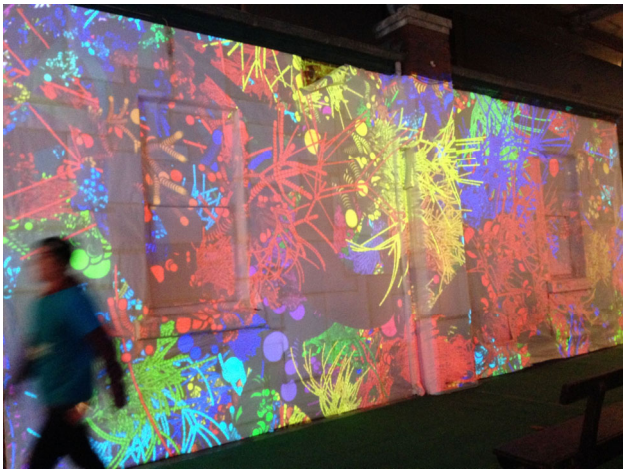

Figure 2 gently evolving biomorphic patterns shown in *Coenosarcoid* supported a festival atmosphere and sense of occasion.

Consolation and Reassurance

The second example of a generative ambient installation is *Look, Petal*, exhibited at RMIT University Design Hub. Visitors could lie on bean bags and look up above in to a projection-mapped dome depicting a dark space in which an ongoing cascade of pillowed generative flowers grew, jostled with other neighboring flowers for a while, and then shrank away (fig 2).

Those who attended the installation found the work relaxing and restorative. Some participants also reported on the indeterminate and sometimes chaotic peaks in the movement as being fascinating, consoling, and reassuring as it seemed for viewers to reflect a natural life cycle. This work was somewhat more figurative than *Coenosarcoid* (the first example) and displayed a slightly surreal naturalism. This work also exhibited (1) Visual connection with nature (albeit simulated), (3) Non-rhythmic sensory stimuli, (6) Dynamic and diffuse light, (8) Biomorphic forms and patterns, (10) Complexity and order, and (13) Mystery.

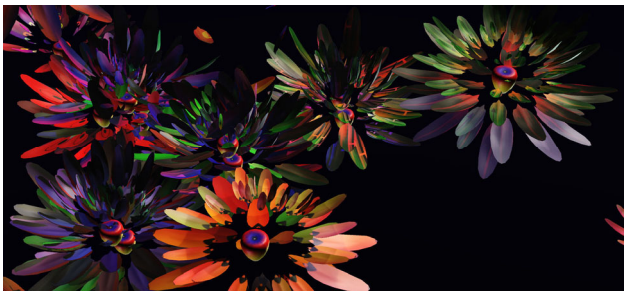

Figure 1 Gently animated surreal flowers in *Look, Petal*

An Orienting Place

The third installation example is an audio-visual generative art installation called *Locus Amoenus* (*Place of Delight*) that I created to provide hospital visitors with a sense of refuge. Installed in a hospital lounge at the Victorian Comprehensive Cancer Centre, (and later exhibited at SLV), the installation consists of a 4.8-meter video wall and a multichannel surround sound system. The installation screen depicts a perpetually changing, naturalistic view of a procedurally generated three-dimensional landscape, live local real-time weather data and the actual diurnal passage of light (fig 3). The window-like perspectival view of the landscape slowly roams in an indeterminate open-ended journey driven by generative algorithms offering unlimited vantage points for the viewer. The SLV space had comfortable furnishing including bean bags and restful warm lighting somewhat dimmer than the cool fluorescent lighting in the large adjoining space (one of the SLV's large reading rooms).

In the SLV installation, the persistent naturalistic landscape motif was instantly legible for uninitiated participants, and this response prompted a positive psychological sense of proximity; this helped participants to feel quickly oriented to the installation environment, and gave an enduring sense of locale, which is important if not critical to a sense of place [7]. The naturalistic multisensory elements (visual, auditory, olfactory) were furthermore drawn from local ecologies and conditions, which prompted a sense of recognition, familiarity and identification; especially for

many local participants. Along with the enduring landscape motif, the indeterminate, constant variation in the imagery — driven by algorithmically generated movement and real-time weather data — maintains a live feeling that sustains a sense that the space is being refreshed.

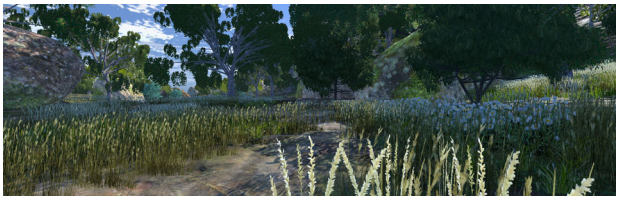

Figure 4 Some spaces prompted a feeling of (13) Mystery and (14) Risk, which added to the pleasure and identification with the installation as a place.

Figure 3 real-time weather and diurnal passage of light is shown in the perpetually drifting view in *Locus Amoenus*

All fourteen criteria from Ryan et al were exhibited in the installation, with the important caveat that the images and sounds were all virtual (from an urban design perspective, it is interesting to note that the two public spaces in which *Locus Amoenus* (henceforth *Locus*) was shown – a hospital and a library – both forbid living plants). Participants of the study responded strongly to (11) Prospect and (12) Refuge as the view gently moved through bushy, coved spaces, open fields and across beaches. (9) Material connection with nature was achieved through the use of natural oils derived from indigenous plants of the region that were diffused into the space. Synchronization of sound with animation was important, especially with depictions of falling and lapping water (5).

Cramer and Browning promote the utility of representational imagery, and Ryan et al briefly note the use of video images as conscious interior design elements, but no mention is made of real-time or generative methods. When the real-time, data-driven, reactive parts of *Locus* are levelled against this list, the three broad divisions (see table 1) become less useful as distinct categories, especially when adaptive, real-time animation is taken into account. The generative characteristics of *Locus*, for example can combine patterns across these categories, such as simultaneously blending “dynamic and diffuse light” with “complexity and order”.

Results

Prospect and Refuge theory (or just prospect-refuge), first proposed by geographer Jay Appleton in 1977 [8] identifies competing drives in the human response to landscape between a wish to explore and surveil, on the one hand, and a wish to take shelter, feel hidden or safe on the other. This dual tendency in the response to landscape reflects a tension between two drives described by neuroscientist Margaret Bradley in the orienting reflex (OR); the tension between the appetite to situate oneself advantageously in the environment and the wish to avoid danger. Both Appleton’s and Bradley’s theories take the view that human aesthetic preferences for landscape are adapted for survival. Bradley’s theories of the OR provide important clues as to how biophilic approaches might be configured, tested and tuned to foster human attention, by providing a pleasing balance between prospect and refuge.

In the interdisciplinary study of the third and final example, the *Locus* installation, a cascade of effects were noticed in the way that participants responded to and spent time in the space: Naturalistic, easily recognizable, lively representations of a natural environment led to a sense of orientation, which facilitated habituation (settled attention), which fostered calm and place making (fig. 5).

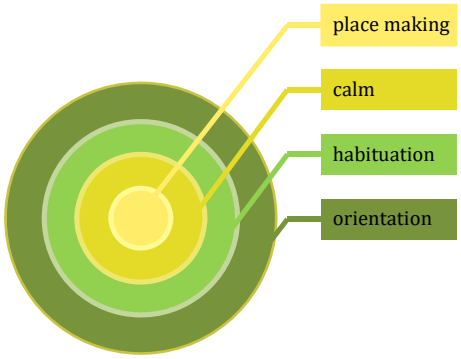

Figure 5 Experiences in the Locus installation showed how being well oriented supports habituation and calm, and leads to a sense of place and place-making

In summary, the study showed that:

1. Gently animated naturalistic landscape images can provide positive aesthetic experiences in interior spaces in built up urban environments.
2. Legible, naturalistic biophilic scenes encourage a psychological sense of familiarity, closeness, and locale.
3. Biophilic patterns combined with gentle change and variation in generative real-time ambient installations can foster orientation that in turn promotes positive emotion, calm, and endogenous (volitional) attention.
4. Gently animated biophilic patterns in built up urban spaces impart a sense of flourishing and prompt ideation of the natural environment.
5. Over time, a sense of identification with locale developed a sense of place and emplacement; marked by relaxed yet engaged comportment, positive identification with the environment, and detachment from everyday stresses, and restorative, mindful attention.

Participants consistently reported experiences of relaxation and calm, attention restoration, sense of place, and awareness of the diurnal passage of the day; all of which critically indicates that *Locus Amoenus* operates as a Calm Technology application.

Discussion

Based on public encounter in the *Locus* installation, this study showed that generative ambient installations can counteract distractive influences in public space by providing gentle, ambient support in the periphery of attention and in doing so help people feel oriented. To be clear, orientation in this context means the participants' capacity both to comfortably habituate to the setting, and to *elect* to orient their attention as they wished; to read, to sit quietly, to spend companionable time with a friend, or, as some participants put it, to "get into the zone" of their own thoughts. This shows the maintenance of endogenous attention, as opposed to when attention is targeted and gripped by an entertaining TV crime drama, or startled by advertising motion graphics, or alerted by animated signage. The ambient screens in *Locus* treat the periphery of attention in a humane way such that people can tune their attention toward or away as they choose, such as one might contemplate a garden.

The *Locus* installation satisfies the criteria of being an application of calm technology in that it supplies a real-time information channel; local weather conditions and time-of-day. This is done wholly through legible biophilic patterns and tunes to the capacity of participants' precognitive awareness of the environment to pick up on this information. This legibility is also achieved with the representations drawing on local terrains and native ecologies, so makes use of primed memory.

Participants pick up on a calm sense of continuity in the environment without consciously attending to audio visual signals, much in the same way as we interface with a view through a window. The endlessly varied real-time persistent landscape motif of *Locus* affords both an enduring sense of locale and a dynamic, live ambient background that works in the periphery of attention. The combination of biophilic patterns and the fine real-time control possible with data-driven generative methods makes for an ambient interface that fosters a sense of place and *restores*, rather than drains attention.

Conclusion

The combination of real-time generative methods with biophilic patterns on large screens in public space were shown to have a positive effect as a humane attentional technology, and foster calm and public place making.

Principles of biophilic design [5], [6] and neuroscientific theories of the orienting reflex (OR) [1] show complementary ways of thinking about and applying innovative and humane uses of digital screens in urban public spaces. This paper demonstrates ways that artists, designers, architects, and urban planners might conceive of humane ambient screen media working at the fundamental programmatic level of planning in public space.

All environments contain ambient cues that inform emotion and attention, and as such each inform orientation. Emotion, attention, and orientation are distributed across shared neural networks and constantly feedback in to each other as factors of the embodied experience of being in space. This research shows how the human drive for environmental orientation can affine with gentle ambient signals in the periphery that can either become immersive or serve as a background (and move between the two). For this reason, positive biophilic aesthetic signals in the urban environment can assist with orientation, calm, maintaining endogenous attention, and place-making.

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In Pieces VR: Micronarrative and Abstraction in the Design and Conceptualization of a VR-based Experimental Documentary

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Abstract

This paper presents the artwork *In Pieces VR* and its main design challenges and goals. It is a VR-based experimental documentary on political prison that uses micronarrative and abstraction as the main strategies in order to create a documentary and artistic experience that departs from conventional immersive journalism. The overall experience is one where much of the making sense of the piece is left open, so that the viewer has to fill in the gaps and piece together the story adding from her own experience. After introducing the work, these micronarrative and abstraction strategies are discussed, and connected to the ideas of intimacy, empathy and contact.

Keywords

Virtual Reality, experimental documentary, interactive documentary, digital art, realism, abstraction, micronarrative.

Introduction: *In Pieces VR*

In Pieces VR [1] is the first instance of *In Pieces. Sketches of a Dystopian Present*, an on-going project that aims at exploring new storytelling forms to address current political crises. This first instance is an experimental Virtual Reality-based documentary about the personal experience of being a political prisoner, or a direct relative of one. It explores the case of the Catalan activists and politicians, with the testimonies of Jordi Cuixart, an activist who spent 2 years in pre-trial detention, and now has been sentenced to 9 years in prison, his partner Txell Bonet, and Anna Forn, daughter of a former cabinet minister, also imprisoned since late 2017 and now sentenced to 11 years (see e.g. [2,3] for some context).

It is a 10/12 minute experience that presents a concentric narrative. There is a starting space with four navigation options, each taking the visitor to one of four different scenes. After each one, the visitor will be taken back to the start, but the corresponding navigation device (a plinth that the user has to knock down) will have disappeared, thus forcing her to choose a new option. Only after the four scenes have been viewed, the visitor will be taken to a final space that shows contextual information and credits.

The experience creates a heavily abstracted series of spaces with wire-frame(ish) virtual sculptures that become animations and interactive elements through which the user can move around, while listening to very personal accounts of the documented case: a walk on the prison yard, a train ride to Madrid, or the awkwardness of one of the firsts family visits.

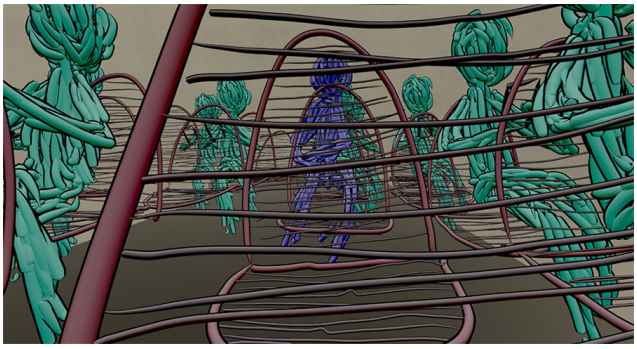

Figure 1. Train scene, as it goes through the visitor's position. ©Joan Soler-Adillon.

In Pieces VR looks at a local example of a global phenomenon: political prison and, more generally, political repression. It aims at the global audience, particularly with the approach based on abstraction and micronarrative. It is a strategy that, intentionally, leaves plenty of room to the imagination of the viewer, thus affording her to make her own connections with the personal and political context. The working hypothesis here is that this will create a very different emotional experience than that we can achieve through seeing a documentary on a specific, but after all alien, case.

This is how the portrayed characters in the documentary acquire their meaning, as a hybrid between a specific case and whatever the viewer projects onto it. At the same time, *In Pieces VR* is an interesting example of how a VR artwork that is so far from realism can create an intense sense of place and, according to several visitors, a very powerful experience.

Micronarrative

Despite the differences on how the idea is used, the context of game design is a useful one to consider micronarrative in regard to the project presented here. Whilst *In Pieces VR* is clearly not a videogame, it does use not only a gaming technological framework (Unity and HTC Vive) but it also shares many design strategies with games, such as interactivity, and the need for the user to explore the space and discover the actions to perform.

In the context of the aftermath of an arduous dispute within the game studies community –narratologists vs. ludologists– Jenkins proposed to use micronarrative as a way of explaining how narrative can enter the game domain without necessarily surrendering all the game elements to the story. These short units, typically with their own narrative arc, constitute the building blocks that create the overall experience. [4] Elaborating on this idea, Bizzocchi defines these micro narratives as small steps within the game progression, so they become embedded in the gameplay. [5] These are the game's units of progression and coherence; subsidiary arcs that have three main properties: they are hierarchical (they have different scales and can be nested), modular (they afford individual variability of experience while maintaining overall cohesion) and accumulative (the different plots mesh together to create the overall narrative flow). [6]

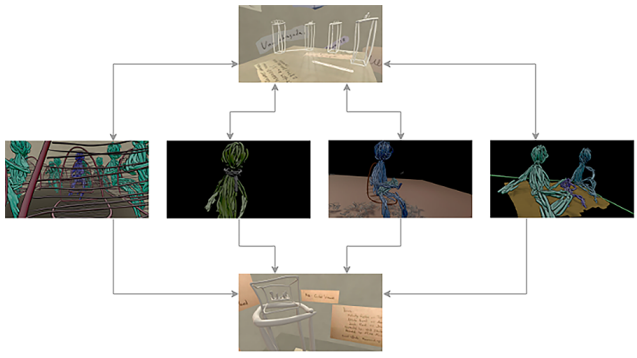

Figure 2. *In Pieces VR*, navigation structure. ©Joan Soler-Adillon.

The micronarrative structure of *In Pieces VR* does relate to most of these points. The four stories add up to create the general experience, with the addition that here there is a lot left open, so that the viewer will have to project from their own experiences. These stories are not hierarchical in the way that Bizzocchi et at. use this idea, since there is no nesting of one into the other. They are, however, clearly modular and accumulative. Firstly, because the navigation is precisely designed to afford this modularity, allowing the user to freely (and unknowingly) navigate to either of the scenes, in no pre-specified order. And secondly, because the idea that the micro stories accumulate to create the larger narrative experience is at the heart of the design idea behind the work, along with abstraction, as will be discussed in the following section.

Abstraction

VR is often linked to realism and simulation, and frames immersion within these ideas, in combination with the technological devices that allow us to have a full sensory isolation from our surroundings (see e.g. [7,8,9,10,11]). And indeed VR is a very powerful simulating device, as the 360 degree videos also prove. The sense of space is a very powerful notion of such experiences.

But just as with the case of animation, in VR there are different paths to follow other than photo-realism. The project *Draw Me Close* (2017) [12] is a very good example of how hand-drawn scenes can work very well in this medium. Similarly, *In Pieces VR* uses hand-drawn elements almost exclusively, and intentionally situates its aesthetic approach on the opposite side of photo-realism, creating a world of unfinished figures and barely sketched spaces, completely devoid of any realistic context.

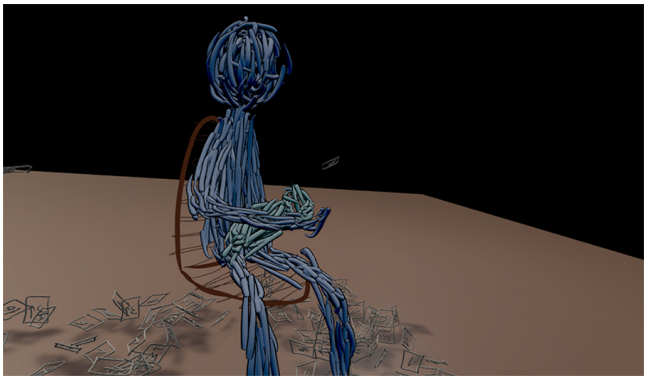

Figure 3. One of the virtual sculptures of the artwork. ©Joan Soler-Adillon.

This creates, along with the micronarrative approach discussed above, an experience that leaves a lot of gaps for the user to fill in, hoping that this will help to create a stronger emotional and intellectual link with the piece. It is important to note here that, while this piece documents a specific political case, it aims at addressing a larger political context of loss of political rights, freedom and of democracy, that is not only happening in Catalonia but in many other places across the globe.

Intimacy, empathy and contact

VR is the medium of intimacy. One of the obvious strengths of this medium is that it can create experiences

that feel very intimate, as the sensory isolation mentioned above affords full focus on whatever is presented to the viewer. In fact, VR has become, now-a-days, a unique medium in which we can assume that our viewer is fully devoted to our work, even if for a short period of time. So far at least, the VR headset precludes the user to get distracted by any other media input: there is no second screen in VR.

This full-focus affords a type of experience that can generate a strong connection with the story and the elements presented in it, more so if the experience is a room-scale VR in which one can freely move within the designated space, and get as close to the elements in the scene as one desires. This is indeed a perfect context for intimacy, and this is how *In Pieces VR* aims at using this specificity of the medium, by creating a story that focuses on the personal story, the closeness to the person, beyond the positive or negative connections that one could have with the larger political context.

Figure 4. A user of the installation at Gazelli Art House, London, UK. ©Joan Soler-Adillon.

The combination of these possibilities for intimacy, with the two strategies discussed above; micronarrative and abstraction, are the means through which the work aims at generating an experience that, for those who are either alien or contrary to the political context, will be very different than that which could be created with e.g. a linear or interactive documentary where the characters had faces and names. The working hypothesis here is that this artworks' approach can help overcome the obstacles imposed by our regular cultural, political and media related filters.

This discourse connects with the idea of empathy, which is quite often linked –not without the risk of becoming a cliché– to many VR experiences. While the literature on this is beyond the scope of this paper (see e.g. [13] for a discussion on this) it is worth noting that there is a clear connection here, as this strategy does aim at generating some empathic reaction as the micronarratives are experienced. Ideally, through this piece one could create a sort of contact hypothesis experiment (see e.g. [14,15]), and explore if there is any change in perception by the viewers who are on the opposite political spectrum of those whose stories are presented in the piece.

Conclusions and future work

Micronarrative and abstraction can work as a means of creating non-fiction VR experiences that depart from conventional immersive journalism and documentary. Whilst this will, quite obviously, not always be the desired approach, they do afford a type of experience that can generate a powerful emotional connection with the story, and aim at overcoming some of our biases when the portrayed case is either alien or politically contrary to our view.

After presenting *In Pieces VR* in several international venues, future work includes presenting this work to a potentially hostile audience and studying their reaction. If the hypothesis were confirmed, the fact that the characters in the piece have no faces or names attached would allow for this audience to connect with the personal story, in a way that the identification as a group formed by the political other would preclude.

Other developments in the horizon are to expand the project to incorporate new stories of political repression, always with the view on the personal impact, and continue to explore storytelling strategies to tell them in a compelling and meaningful way.

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Aeon Performance System for Visual Music

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Abstract

The *Aeon* instrument is an expressive visual music instrument used for live media to support interdisciplinary performance practice. The *Aeon* instrument enables generative animation, editing and compositing, tailored for improvisational expression of projected visual elements and spatialized audio. In this paper, we discuss the design of *Aeon* in terms of its conceptual, design and performative aspects both in aural and visual domains. Our instrument presents the performer with a large set of techniques that enable flexible media manipulation and generation. The paper also addresses issues related to the tensions between narrative structure and performative expression, live and recorded media, image and sound and the structuring of improvised media.

Keywords

The title "Keywords" should be 12 point, bold type, centered at the beginning of the left column. Using 10 point, justified, regular type, write up to ten keywords that highlight the main areas of your essay's content.

Introduction

The creative impulse for dynamic exchange of musical forms and visual language has transcended the limits of media that has inspired computational media performance (e.g. Pierre Hebert, [1], Michel Gagné [2]). More specifically, interactive audio-visual performance has developed into a significant position within contemporary art (for example, Scott [3], Golan Levin[4]) that communicates common aesthetical concerns, such as synæsthetic composition, computational expression and the dynamics of performance to enable integrated audio-visual compositions that unfold in real time. The *Aeon* instrument for live media expression allows assemblage of abstract cinematic experience in the performance context from beginning to end in front of the audience.

To contextualize and discuss ideas that emerge from *Aeon* performances, we bring into the foreground concepts of extending embodied gestures and animation into a live computational media. We explore a balance of embodied skills, including drawn and painted animation, musical gesture, movement etc., with the ability to dynamically mediate these in a computational media environment. The key question we consider in our work is how to enable the embodied skill of practitioners to be integrated with computational processes available through the use of software designed for interactive multimedia performance. This objective enables us to produce rich hybrid performances integrating interactive animations and electro-acoustic sound. The computational media provide opportunities to explore novel production of artistic ideas through live interaction and the diffusion of audible and visible images, in an expanded space and across organized time.

This flexible approach presents a key compositional problem that requires a transformation of the compositional methods of scored and montaged linear media into flexible time based interactive and improvisational strategies. To overcome the challenge of integrating and synchronizing various performance elements, such as recorded media, instrumental music, and live animation, we have developed computational techniques that can aid the expressiveness of performance within a larger multidisciplinary ensemble. In the remainder of this paper, we describe and reflect on some of the concepts, tools, structures and processes we use, such as procedures for accessing, selecting, organizing, ordering and composing media elements contained in a database of media objects as well as interactive visualization and sonification strategies used to aid the overall expressiveness of the performance. We cover some basic considerations with regard to compositional synergies and independence across animation and music as well as we present our design and compositional framework for the *Aeon* instrument.

Background

"One day I must be able to improvise freely on the keyboard of colors." Paul Klee (1961) [5].

Contemporary computational media installations and performances are realizing the aspirations expressed by

painters almost a century ago [5]. Innovations in form and technology — from electric illuminations, abstract analogue and digital film as well as interactive, generative, and process-based digital media — are fueling the experimentation with musical analogy and synaesthesia (blending of senses) in arts. The expression through interactive computational media represents both a fulfillment with early compositional aspirations and a fundamental departure from it. In computational media, music, visual art and animation are truly united, not only in terms of their phenomenological experience but also in terms of their deep, elementary structure, being both formed of flexible and dynamic flows of electronic information and infinitely interchangeable code. The flexibility and dynamism of coded processes readily support both performance and improvisation within interactive media and provides exciting compositional and expressive opportunities.

Every new generation of artistic platforms comes with a wealth of opportunities to invent new language and form. With digital media recorded sources are freed from the inherent linearity of physical materials. Stored as data on a hard disk that can be accessed in non-linear fashion, audio-visual media can be presented as a connected assemblage of shots in a multidimensional performance space, traversed in multiple ways, generating different interpretations of the same source material with each performance. The recorded elements, brought forward by association and algorithmic behaviors, exist as structures adaptable to the real-time conditions of the performance setting. This situation introduces new challenges for the design of a performance system. A practice that combines live performance, recorded media elements and computational algorithms to provide new forms of time-based art (Warwick 2003). The computational media performance enables the use of a unique combination of embodied skills expressed with custom-designed software to allow artists to express ideas in the real time of performance. The production of work in this context includes software-based instrument design for the performance that permits access to various performing objects, methods and transformations through which content and meaning is generated in an improvised manner within performance.

The pixel and sample architecture of the computer audio-visual display, and its extensions into points, lines, plains, rhythms, sounds, phrases, etc., provide the basic elements of computer-mediated art, where the composition is animated by various coded processes. Artists often chose to reach beyond available compositional frameworks towards the design of the instruments that provide a nexus for their own creative vision and artistic methodology. Taking advantage of the emerging potentials of a computational environment, the design of an interactive instrument enables the discoveries of novel creative models for audio-visual time-based composition, models that are iterative, transformable and enables a fresh perspective on performative audio-visual thinking.

In the context of computational artwork expressed by the means of code - the code is interpreted as artistic material that articulates the artistic concepts and processes. The challenge with this approach is to articulate poetic, embodied and intuitive artistic ideas into coded, logical information structure. Coding translates a certain level of abstraction and modeling of the creative process and embodied knowledge into a formal model. The process of coding becomes a framework for the articulation of an artistic methodology and enables the development of artistic instruments that best serve a particular emerging practice.

Coding affords a way of working with technology that is appropriate to artistic process. This way of working acknowledges the evolution of the idea into code, and allows for improvisation and active response within the process of creation. Within the context of artistic code, practice is defined as procedural knowledge, algorithmic, experimental, and improvisational. Practice deals with embodied knowledge that is manifested through skill, as well as incorporated knowledge, based on the mutually agreed-upon problems recognized within a community of practitioners. Artistic skill depends on a knowledge that incorporates body memory, virtuosity and coordination in a significant way, such as playing a musical instrument, dancing, drawing or painting. Writing, or writing code, also requires creative skill, but it is not as much related to the body memory and virtuosity of movement techniques.

The coding artistic process forces us to make explicit that which is merely implicit, aspects of ourselves that remain largely invisible to ourselves as long as they remain "inner" and operate at the level of intuition. The embodied creative methodology needs to be treated and analyzed as a model that can be achieved in code. Artistic coding practice informs innovation in that it deals directly with outcomes demanded by an engagement with creative processes. The implication of art-software and code as art research practice provides an insight: formal procedures and the compositional intelligence of the artist/programmer are articulated through code within the computer system.

The computer is designed to manipulate symbols in a logical fashion with the software patterns representing ideas that facilitate the variable potentials of the computer. The physical computer itself is unavoidably passive without the insertion of symbolic patterns of code-ideas that allow the hardware to reveal the inner logic of the algorithm. Technology reveals its potential only when an idea is inserted into it as a coded procedure, as a set of instructions that the hardware will perform in the execution of these procedures. Coded procedures guide the particular unfolding or unconcealment of the truth through a hermeneutic process open for interpretation.

Creating works for integrated media poses some difficult compositional, perceptual and technical problems within the computational environment. The perceptual experience of correlated dynamic animation of visual and aural elements within any given performance cannot be reduced to a simple addition of image and sound. When these elements are combined they intertwine into a unified experience that presents the viewer/listener with new levels of perceptual complexity. Images, sounds, and their impressions are therefore considered as an integrated structure, because the perception of each element is actively affected by their relational positioning. Although many parallels can be drawn between music and animation, and the synaesthetic possibilities are very attractive, visual events do not work the same way sound events do. The integrated compositional articulation needs to account for both differences and similarities in the perceptual, formal and technical characteristics across aural and visual domain.

The search for structural balance — between complexity and direct correlation — allows the composition to span across a wide dynamic range of emotional and conceptual expressivity. There are many compositional possibilities in exploration of contrast in audio-visual form, which can be achieved by building the tension and release through dissonance and consonance in form. The moments of unity in aural and visual composition established by some mutual signs can be contrasted with the moments of intended digression from the unity, when aural and visual elements come into thought out conflict. The idea of audio-visual counterpoint provides a strategy for achieving contrast and conflict among various compositional elements and themes. Multiple layers of activities can be composed aurally and visually to create different streams that work independently but are related to one another. In musical counterpoint one voice is perceived as independent form another voice and connections across voices are established linearly, in time. The unfolding of the image elements through movement in time constructed in a contrapuntal structure refers to composition of multiple graphic elements and animated voices that work independently in support of a larger compositional structure. In the visual domain the contrapuntal relationships can be achieved through a contrast in the movement direction, scale, shape, volume, masses and depth. The time organization of these visual design materials into tension / release contrapuntal structure facilitates the composition of the contrasting forms into a unified system.

Within the coordinated composition there are many different ways in which image and sound can interact and can be mapped across visual and aural multidimensional parameter spaces. The mapping can be established in several directions: 1.) The sound can drive the animation and formation of the image; 2.) Visual elements can drive and create the sound; and 3.) Mapping the analysis of external gestural sources to drive both media, such as gesture analysis of performing instrumentalist, dancer or live animator. These combined in a multidirectional improvisational arrangement between image, sound and performers, where all have the ability to influence each other and all have the level of independence, forming an intertwined contrapuntal structure provides the most interesting mapping results.

Another option is to compose an abstract structure that acts as a controller for both sound and image generation. This approach is analogous to a score in music, which is an abstract representation of what needs to happen over time. It is also possible to combine a looser notion of a score with the performance-based inputs to create a structured improvisatory system. Whether the score-based approach is fixed or composed as an improvisatory performance arrangement, it can be understood as a deep compositional structure which is gradually revealed over the course of the composition. Javanese musician and theorist Sumarsam [7] proposed the concept of the inner melody to describe the heterophonic organization of a piece of complex Javanese orchestral music. In Javanese Karawitan complex sonic lines fill time at different levels of scale. Each player elaborates on a deep structure or inner melody according to conventions specific to the instrument being played. Players of the ensemble play their part with reference to a series of common tones defined by inner melody. Each phrase ends on this common tone bringing the whole orchestra into focus in that moment at a point of unison. These pillars of order frame the chaos implicit in the heterophonic organization of the Javanese gamelan orchestra resulting in a model of complexity in balance—a dynamic steady-state [8]. Sumarsam's idea of inner melody can be extended to organization of media elements that embrace chaos by using a hidden deep structure to frame a complexity of simultaneous yet independent performances of the various voices embedded in the composition. The concept of a deep structure guiding the generation of surface details is a useful model for the organization of a computer-mediated improvisational system. Heterographic form embraces chaos by using a hidden deep structure to frame a complexity of simultaneous yet independent performances by its practitioners that form an ecologically balanced whole. The challenge in composing with computing technologies is in balancing the multiplicity of potential media voices that come together to articulate particular instances of the artistic image.

Live media performance involves the generation and manipulation of time-based media within an improvised or composed spatial and temporal architecture. The perceptual experience of a correlated dynamic animation and sound of diverse elements within any given performance cannot be reduced to a simple addition of performance elements. When these elements are combined they intertwine into a unified experience that presents the viewer/listener with new levels of perceptual complexity (Chion 1994). Images,

sounds, performance actions and their impressions are therefore considered as an integrated structure, because the perception of each element is actively affected by their relational positioning.

Figure 1. Heterographic and Generative voices combined. ©Copyright by authors.

Instrument Design

In this section we cover the complex layering of various elements *Aeon* instrument allows and consider compositional synergies and relationships of visual animation and sound composition into other performance elements. We discuss the instrument design and development in terms of conceptual, compositional, and software components. Audio visual examples of *Aeon* from the performance setting can be viewed at https://vimeo.com/378387163. This section is organized in two parts, first on focusing on the visual and the second on aural components of the *Aeon* instrument.

Figure 2. Heterographic and Generative voices combined. ©Copyright by authors.

Aeon Visual System

The software modules for the visual system are written mainly in the MaxMSP/Jitter programming environment. The visual performance system provides a variety of inputs, an encoded procedural section which can be functionally divided into three areas of "voicings" of visual material—heterographic, composite and generative—and a display section that supports the diffusion of multiple channels of video display. The system also provides a user interface that puts the performer in an action-reaction loop with the system and enables its use as an instrument for live media performance. In the following sections we describe some of the high-level design considerations of the visual system and describe the three main layers of the encoded procedural section and its relation to the other aspects of the instrument such as user input.

Heterographic Voices

Heterophony, a musical term drawn from ethnomusicology, describes the difference between traditional European and certain Southeast Asian musical forms (Sutton 1993). A heterophonic music is organized in terms of how different threads of music relate to one another, and is based on the emergence of an underlying yet unspoken structure that generates the overall composition. Extending the idea of heterophony to include visual and dramatic media, a heterographic model is articulated to describe a structured system of improvisation organizing a multiplicity of media voices. Heterographic voices are composed of a series of short media elements designed as a family of animated gestures that work together to create a more complex animation. Each animated gesture is equivalent to a note or phrase in a musical score. These animated voices are like musical gestures — short and compact — and can be layered together across visual and temporal space and are equivalent to heterophonic voices in music as a set of small relatively independent gestures that are braided together into complex gestures.

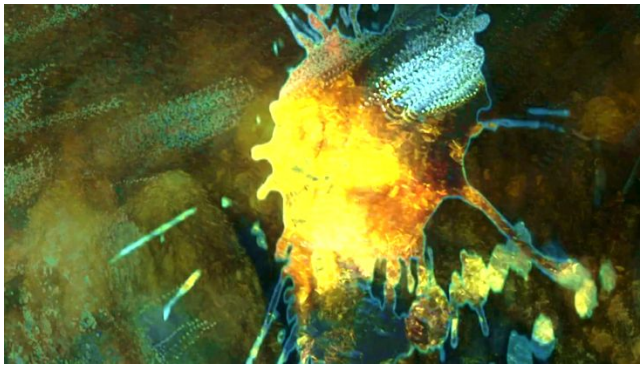

Figure 3. Composite voices. ©Copyright by authors.

Composite Voices

The composite voicing enables layering of media streams and processes that are normally associated with the non-real time context of film and video post- production: composition, editing, and sequencing are made available to the performer for real time manipulation. All of the post-production compositional decisions that are traditionally made in a non-real time context, with our

instrument, can be manipulated and changed in a performance context. Complex compositing arrangements are saved as scene compositions, which can be called any time during the performance. Once the scene is activated it can be further manipulated and modulated in a performance context. The ability to actively recompose and structure the material is critical to the flow of performance, while the ability to interfere with the composite image and change it in real time adds to the expressiveness of the overall performance. There are three composite layers and any number of overlay layers limited by computer power. Each composite layer has adjustable blending modes. Within each composite layer we can specify a movie set for the layer that can be triggered in the context of the performance, therefore ensuring the compositional consistency while allowing for performative expressiveness, and performer directed change.

Figure 4. Composite and Generative voices combined. ©Copyright by authors.

Generative Voices

Generative voices have the capacity to produce original material, sequence and animate preexisting media and behaviours, as well as analyze, transform and map the real-time input coming from a performer. The expressiveness of the instrument is enabled by gestural control over visual parameters driven by input from the performers. Here the critical design consideration is in striking a balance between the degrees of improvisational freedom and the specificity of control parameters. The visual animation modules, at the low level, generate vectors, color characteristics, scale, position, points, lines and planes. The medium level animation modules operate at the object level that encompasses both shape and movement. Mid-level objects generate data such as shape, volume, position, direction, texture application and modification, etc. in three-dimensional space. The animated objects include modules such as textured vector shapes, particles, groupings of movie objects as well as the real time stop- motion animation that is keyed and displayed in an integrated manner in the three-dimensional space. The high-level modules generate performer-controlled object groupings, time structures and behaviors such as motion vectors and time-based ornament structures.

Performer input at the high level provides compositional structure and event organization, with the capability to organize time-based occurrences at a global level. This high-level control can act as an abstract structure that provides either fixed-in-time or flexible external compositional frameworks driving the synchronic and diachronic relationship of various animation events and acts as the deep structure of the composition controlling the way the image evolves over time. Multiple visual elements can have their own way of improvising and generating unique surface renderings set around the deep structure established by the performer.

Generative processes provide what is perhaps the most dynamic relationship between the human performer and the machine. A variety of automatic processes are possible at the three levels of image manipulation described above. The kinds of performer input can take the form of simple mouse clicks and movements within the frame as well as gestural controls in two- dimensional panels mapped to a variety of parameter spaces. The balance of procedural automation with skilled human input enables a dynamic relationship to a live performed situation. The provision of a set of procedural tools at the various levels of image production for moving image capture, processing and display allow the performer to control the weaving of a compound thread of visual processes in concert with other media threads in the creation of a resultant braid of situated media in performance.

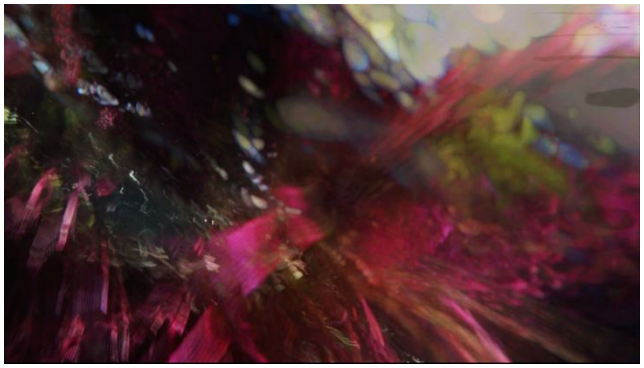

Figure 5. Composite voices. ©Copyright by authors.

Aeon Music System

The software for the music system is written in the SuperCollider3 programming environment. The music performance system provides input from external sources, such as a microphone, and a generative system based on a Multi Agent Model that learns from the audio input to the system from the performer to build drone and musical gestures. *The Aeon music software* is a generative music system for augmenting live performance with aesthetics

influenced by a type of La Monte Young minimalism and the Indian classical drone instrument the tampura. Similar to these influences, the quality of the generated sound by *Aeon* ***is*** characterized by ambient elements (reminiscent of Steve Roach (*Structures from Silence* (1984)) - long tones, rich textures, and flow.

Technically, *the system* uses a process loosely based on the tape loop technique. This technique, developed in the 1940s by Music Concrete pioneer Pierre Schafer using modified vinyl records and replacing these with magnetic tape when made available, uses a piece of magnetic audiotape of varying length to repeat a recorded sound. Sound is either recorded on the tape loop before a performance or recorded live to be manipulated and processed using available techniques. The loops can be repeated or be modified and evolve by electronic transformation. Early electronic music composers using this technique include: Gottfried Michael Koenig (*Klangfiguren* (1954); Karlheinz Stockhausen (*Gesang der Jünglinge* (1955)); Terry Riley (*Mescalin Mix* (1961)); Steve Reich (*Violin Phase* (1967)).

While the tape loop technique modifies the length of the loop to control the length of the repeated sound, the *Aeon music system* records a microphone input to a variable-sized buffer. *Aeon* music system manipulates *t*he duration and manipulation of the sound using a granular synthesis algorithm allowing flexible control of parameters (buffer duration, grain size, envelope parameters, buffer position, scrubbing speed, buffer span, trigger rate). *The system* has an infinite number of buffers (tape pieces) available for manipulation and layering – constrained by creative decisions and the available computational resources – which is another departure from the tape loop technique. As a human-computer interface, a performer controls these parameters as a real-time performance instrument using a GUI or HID.

Building on this control topology, *Aeon music system* is an electro-acoustic system driven by a multi-agent model. In such a model, synthetic agents with certain behaviours interact within an environment to simulate and predict complex phenomena. In this case, the phenomena are the creative control of recording into and manipulating the audio buffers to achieve the desired aesthetic result, i.e., richly textural, and flowy drone music. Each agent is responsible for listening to the input from the microphone to record instruments at moments presented by the performer and manipulate a corresponding audio buffer in negotiation with other agents' actions.

The elemental composition form of *Aeon music system* is a cascading cyclical structure, where one agent provides a steady background drone, and other agents are either added to the drone or are designated to play a series of motifs. Agents added to the drone first remove the note onset, and, if a drone agent already exists, analyze their amplitude and attenuate themselves relative to the fundamental for cohesive layering in the background texture. If the performer specifies an agent as a motif type, then the agent analyzes the audio buffer and logs the onsets, the onset intervals within the timing of the drone cycle, and the pitch of the signal at the onset times. The agent then generates inverted and retrograde variations of the logged onset information and a set of elaborations that are defined by modulating the granular synthesis parameters within the constraints of the overall cyclical structure.

Agents designated as a motif then negotiate who is playing which variation and who will play an elaboration and when in a given cycle. In the negotiation protocol, a turn-taking behaviour designates one agent as a leader who chooses a motif variation and one elaboration. Remaining agents propose a motif variation from their selection, and the leader chooses one of the proposals based on the goodness of fit with the overall composition structure. The leader repeats this simple auction until the list of agents is exhausted. If no proposal gains a score above a threshold set by the performer, then the leader rejects all proposals and plays solo, cycling through variations and motifs aligned with drone repetitions. As an integrated collaborative instrument, *Aeon music system* generates a range of drones and musical gestures steered by the performer and responsive to the expressions of the instruments recorded.

Conclusion

Recording technologies in both music and film eliminated the magic of the presence—the power of interaction among performers and audiences that happens only during the live performance. Computational aesthetics embedded in a postmodern art practice enables recorded material to be modulated and integrated in a performance art. This new situation enables artists to build new relationships with their audience and respond to the events taking place on the stage. As a performance this newly conceived film only exists in the presence of the exchange between artists and audience. The improvisation and open form facilitate the thrill of the audience toward the unexpected, the accident, an insight into the creative process and should be subject each time to reinterpretation and recreation.

The *Aeon* instrument and subsequent performances encapsulate this state of always becoming. In the design of the system we bring into the foreground concepts of extending embodied gestures and animation into a live computational media, including drawn and painted animation, musical gesture, and movement with the ability to dynamically modulate these in a computational media

environment (Figures 1. and 2.). At its core, *Aeon* enables the embodied skill of practitioners to be integrated with computational processes. This objective enables us to produce rich hybrid performances integrating interactive animations and electro-acoustic sound. The computational media provide opportunities to explore novel production of artistic ideas through live interaction and the diffusion of audible and visible images, in an expanded space and across organized time to aid the expressiveness of performance within a larger multidisciplinary ensemble.

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Authors Biographies

Miles Thorogood (Assistant Professor, Department of Creative Studies, UBCO) is an artist/engineer with research centered around the practice and theory in media arts for developing interactive experiences. He is head of the Sonic Production, Intelligence, Research, and Applications Lab (SPIRAL) that develops research of computational creativity systems for generative art. His research contributions have produced new knowledge in the fields of soundscape studies, affective computing, and cognitive science focusing on sound design practice. This research seeks to identify formal models of creativity as it is by investigating aspects of human perception and the design process in order to encode creative structures for computer assisted technologies in art making environments. His work has been featured internationally as interactive museum exhibits, installations, and performances.

Aleksandra Dulic (Associate Professor, Department of Creative Studies, UBCO) is an artist-scholar with expertise in interactive art, climate change communication, and media for social change. She is the Director of the Centre for Culture and Technology (CCT) and leads an interdisciplinary research team that engages multiple forms of art, media and information technologies as vehicles for the expression of community, culture, and identity. Dulic's research is centered on the creation of interactive systems and experiences that bring local, cultural and communal resources to the forefront. One thread of this work is the research in interactive installation with multi-channel audio-visual displays that enable the creation of complex community images. These threads of research intersect in the idea of interactive art as a place for community reflection. She has created a number of large-scale dynamic environments and multimedia project as well as published insights that arise from these research-creation projects.

Aural Soilscapes: Sensory Challenges in a Subterranean World

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Abstract

Sound is an omnipresent feature of all ecosystems, including the ecosystem soil. Since Rachel Carson's influential work *Silent Spring* in 1962, sounds have been inextricably linked to the health of ecosystems. The living inhabitants of soil, including plants and their associated microorganisms are capable of producing and perceiving sounds at low frequencies to interact with each other. However, climate changes, such as temperature increase and reduced soil moisture can impact interactions among soil inhabitants, which will likely hamper interactions through sounds. Sounds could thus be seen as an indicator of ecosystem health, which in turn is impacted by climate change. As an artist-researcher working with sound, space and technology and as a microbiologist working with the effects of climatic changes on soil microorganisms associated with plants, they aim to combine their expertise to approach this yet unexplored topic by giving a voice to the inaudible and invisible living in soil and to expand their ecological consciousness to climate change. Their ongoing experiments are leading them to renew their consciousness of this subterranean world, thus enabling them to interact with its subtle presence.

Keywords

Sense-based research method, aural spaces, soil, microbes, plants, ecological consciousness.

Introduction

Sound is defined as "a vibration that typically propagates as an audible wave of pressure, through a transmission medium such as a gas, liquid or solid," and each sound is characterized by its wavelength hertz (Hz), intensity (decibel), speed, and direction. [1] While the audible sound for humans has frequencies from about 20 to 20,000 Hz.

For a long time, sound has largely been described in acoustic terms because of its sonic properties, but without addressing auditory perception. As vibrations of a source in an environment, it is indeed not only a physical phenomenon, but also a perception. Sound affects us as humans physically but also emotionally. Becoming aware of the sounds in our environment and their emotional and behavioral impact [2], can help renew our relationship not only with our built environment but also with the natural environment and other organisms.

Living organisms, including plants and microorganisms are capable of producing and perceiving sound in order to interact and understand the environment around them [3]–[5], yet at much lower frequencies and without an identified organ. Despite a lacking organ, biological studies on the response of plants to sound waves indicates that plants are highly sensitive organisms that generate and react to sound signals from their environment. [6] A recent study measured for the first-time sounds emitted by growing roots and earthworms burrowing tunnels at a frequency of 1-100 kHz using piezoelectric sensors, which opens up a new window to listen into the "inaudible world" of soil. [7] Physical signals in the form of sound waves have also been measured in microorganisms, including bacteria [8] and yeast [9] and are suggested to play a role in cell-cell communication in providing information about the metabolic status of the sender or to differentiate friends from foes. [10] However, due to technical challenges and the low frequencies, microbial sounds and their role in ecosystem functioning have never been investigated in soil directly.

Next to sounds, smells or volatile organic compounds (VOCs) also play important roles as communication molecules in plants and microbes inhabiting the ecosystem soil. [11] Both plants and microbes produce VOCs - small molecules with low boiling points and other, unique properties that allow them to evaporate easily and travel through the air over long distances. [12] These useful attributes help microbes communicate in soil environments between each other and with their plant host. [13] For example, terpenes - a class of VOCs, have been recently shown to play a crucial role in the communication between bacteria and fungi in soil [14] and in the recruitment of distant microbes by plant roots. [15]

The purpose of this paper is to present the joint experiments developed between an artist and a microbial ecologist to amplify and interact with the subtle presence of plants and microorganisms in soil in times of climate change. By merging scientific protocols and research of the impact of climate change such as changing water regimes on plants and their associated microorganisms (i.e. the plant holobiont) with artistic strategies applied to science and the experience of aural spaces, they move away from an anthropocentric vision that consists in considering plants and other living organisms as objects and aim to adopt a holistic vision of ecosystems that interact with each

other. [16] Their art-science collaboration is as central to the project, as the ongoing experiments.

Using artistic strategies and speculative narrative to *hijack* scientific protocols, their experimental set-up and conceptual approach aim to amplify the unheard and reveal new perspectives in their respective fields of studies as well as in the intersection of both. Their art-science approach is to use both chemical and sound soundings to investigate the possible interactions of multiple senses in plants and microbes. By doing so, they take sense-based research methods to new sites, pushing the boundaries and questioning the capacity of plants and microorganisms living in the soil not only to feel physical signals but also to react to them.

They are driven to create art-science situations, opening our senses to multiple realities, and exploring the experience of space, in this case aural soilscapes from plant and microbial interactions as new methods of ecological health.

Artscience collaboration

The sound artist in this project is working with aural spaces, exploring sound's materiality and intangibility, its resonance and connections to social and environmental context. As a sound ecologist, they have been travelling back in time and space, in an attempt to expose their novel concept of the Surviving Aural Spaces. While listening to the background noise and the echoes that resound throughout the places, the surviving takes shape in sound traces, sound residues, and sound fossils, all of which traverse our environment and our memories. Their research is qualified by a sustained listening, focusing on the world as a sonic place for anyone who wants to hear it.

The scientist in this project is a microbial ecologist who studies interactions between microbes and their plant host (i.e. the plant holobiont) via smells or volatile organic compounds (VOCs) in the context of climate change induced drought in agriculture. Their work aims to find solutions to drought by identifying mechanisms of holobiont resilience. In their research, they have shown that VOCs can be a *lingua franca* between microorganisms that allows microbes to sense and respond to each other, for example, by influencing their movement and nutrient uptake.

Together, they ask how microorganisms living in soil sense, connect and even communicate with each other and their plant host. By consciously listening to these voices, they aim to critically question sentience in soils through physical and chemical traces they are able to collect in their experiments.

Experiments

In their experiments, they use art principles and strategies to *hijack* scientific protocols imagining and speculating on new narratives where sonic experiences could be shared between the plant and microbes in soil.

Starting by amplifying the inaudible and invisible, they imagined and speculated about sounds that could stimulate microbial communication in the plant host. For this, they developed a pilot setup including a so called Rhizotron - a laboratory constructed underground to study microbe-plant interactions via gases and sounds (Figure 1).

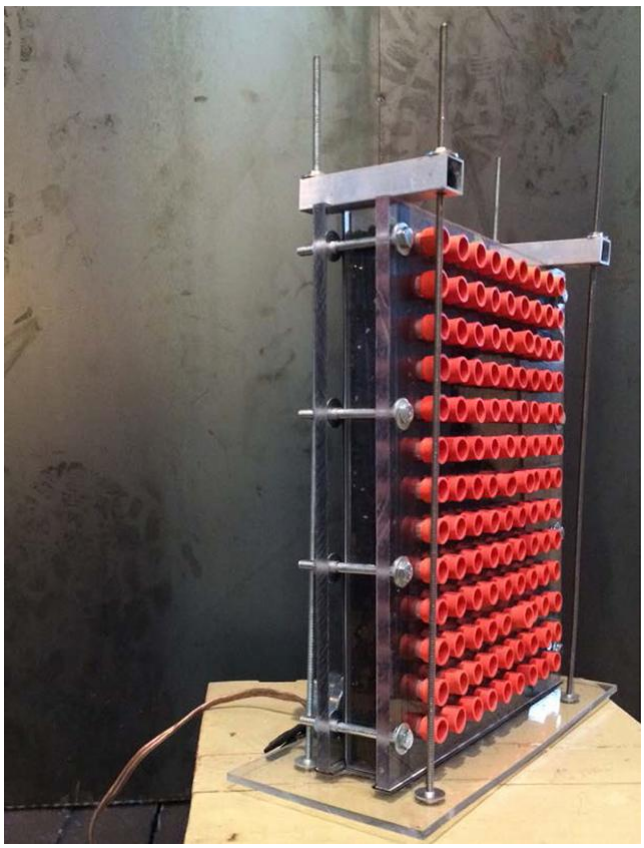

Figure 1. Rhizotron (originally developed by Philippe Constant and Anne de la Porte at INRS, unpublished). © photo Sandra Volny.

As a first step, they tested the rhizotron to investigate the response of gases emitted by plant roots and associated microbes to physical signals by exposing the soil in the rhizotron to low frequency sounds.

The pilot setup was as follows: The rhizotron contained soil adjusted to 50% water content with one-week old wheat seedlings. A transducer (25mm Exciter 24W 4 ohm) was fixed to the backside of the rhizotron (Figure 2) and underwater sound recordings were exposed for a total time of 6h.

The sound recordings were chosen for their low frequency range effect [8] and inspired by scientific experiments that stimulated microbial activity through gas (H_2) exposure [17], or supported ecosystem restoration through sonic exposure of healthy coral holobionts. [18] Gas samples were taken with a syringe (5 ml) through septa around the root system every hour and CO_2 and N_2O were measured using a Gas chromatograph (GC) (Figure 3).

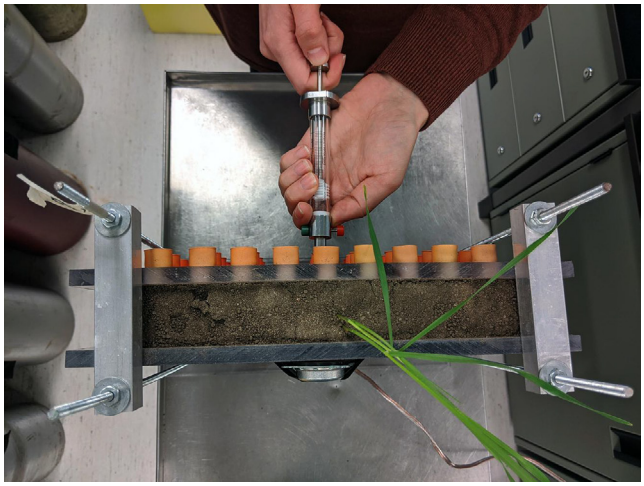

Figure 2. Rhizotrons exposed to underwater sounds through transducer. Sampling gas through septa using a syringe. © photo Sandra Volny.

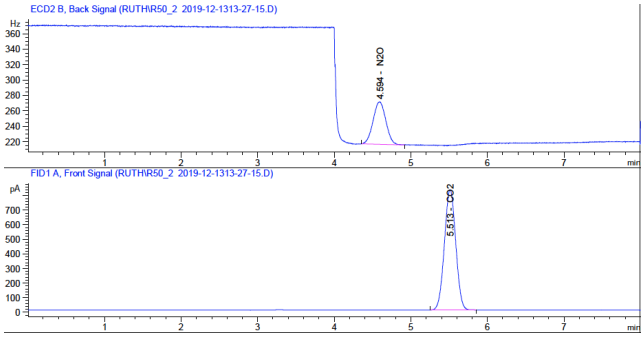

Figure 3. GC chromatogram of measured compounds (CO_2 and N_2O). © image Ruth Schmidt.

During the presentation at ISEA, they will present additional data in progress: the pilot experiments repeated in triplicates and different soil water content conditions in order to simulate changing environmental conditions due to changing water levels in soil.

As a second pilot, they recorded with an amplifier constructed for the purpose, small electrical changes over a frequency range by converting the voltage into frequency (Figure 4). Small electrodes were inserted into septa around the roots in order to amplify the communication around plant roots and associated microbes through electrical activity in response to 3 different soil water content levels of 5%, 20% and 50% (Figure 5, 6). This served as a pre-step to combining the sounds emitted and perceived by the plants and microbes in soil.

Figure 4. Rhizotrons with electrical signal amplifier (developed with Martin Peach). Sampling sounds through septa using electrodes. © photo Sandra Volny.

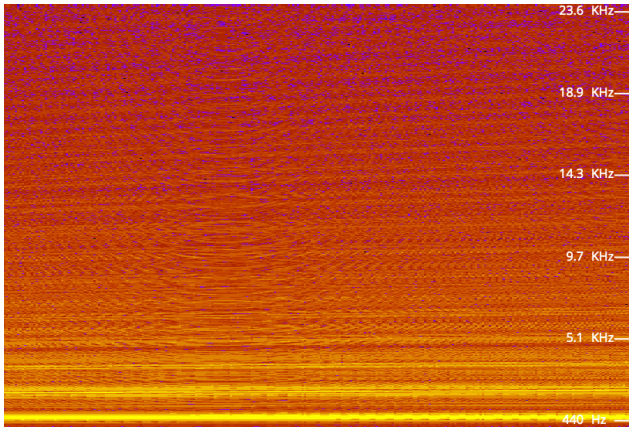

Figure 5. Spectrogram of the electrical signal sampled on rhizotron at soil moisture content levels 20% with electrodes inserted in septa. Wave file at 48 kHz/24-bit. © image Sandra Volny.

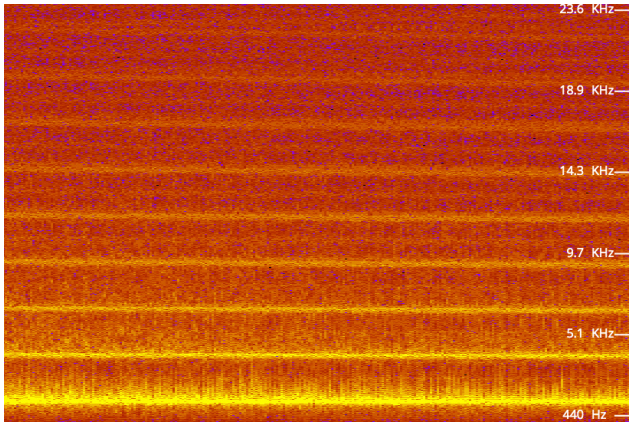

Figure 6. Spectrogram of the electrical signal sampled on rhizotron at soil moisture content levels 50% with electrodes

inserted in septa. Wave file at 48 kHz/24-bit. © image Sandra Volny.

While working on these multiple modalities and multi- and inter- media experiments, they also reflected on their own collaboration and process allowing a collaborative creativity to emerge.

A sonic process to sound soils

In their project, they not only developed protocols to reflect and reveal the traces of sounds and the impact of sounds on plants and microbes in soils, but they also developed a common practice-based process.

Their art-science process was thought through sound. They experimented with strategies that followed a movement of feedback (*rétroaction*), working in this way with the inherent movement characterizing a sonic process [19] by alternatively sounding and sensing sounds and chemical signals in the rhizotron's interactions between plants and microbes in soils [pilot 1 and 2] and sampling their impact.

Based on sensing, amplifying and acting on the invisible and the almost inaudible, they developed a common process in order to shift toward an ecology of attention [20] to the tiniest but essential organisms, namely microbes that maintain life on earth.

Their speculative narrative means to include sensory challenges in times of climate change investigated sounds in the hope of remapping with further results the connections between microbes and the plant and improving their communication.

During ISEA, they aim to present their ongoing research and results, but also discuss the impact of their art-science collaboration. For both their fields of study and beyond, they inquire open our senses to new processes, subjects of study but also to include vulnerability as a way of expanding our connection with the environment and other beings in times of climate change.

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Author Biographies

Dr. Sandra Volny is an artist-researcher, founder of Sound and Space Research. Situated at the intersection between the acoustic and the visual, her art practice explores the perception of sonic spaces. Her current research-creation project, *Aural Soilscapes*, takes a non-anthropocentric perspective to explore aural soils as

witnesses of climate change. She recently completed her doctorate in art sciences and aesthetics at the University of Paris 1 Pantheon-Sorbonne by conducting her research on the « Surviving Aural Spaces ». Her work has been presented, among others, at the Centre d'exposition de l'Université de Montréal (2019), Galerie Michel Journiac (France, 2017), Ionion Center for the Arts and Culture (Greece, 2017), FOFA Gallery (2017), Dazibao (2016), Centre CLARK (2016). Volny has received grants from the Canada Council for the Arts, the Conseil des arts et des lettres du Québec and the Quebec Centre for Biodiversity Science. She is currently in residency at Fonderie Darling.

Dr. Ruth Schmidt is a microbial ecologist who is working on finding microbial solutions to combat climate change. The basis of her research lies in studying how microbes in the soil interact and communicate with each other and their plant host via volatiles or smells. Ultimately, her research aims to find solutions for anthropogenic issues, such as climate change induced drought in agriculture. She completed her PhD at Wageningen University in the Netherlands and is currently a Mitacs postdoctoral fellow at INRS (Institut national de la recherche scientifique) as well as at Plotly, a data visualization start-up based in Montreal where she works on developing open-source tools for visualisation of microbiome data.

Open Waters

[Northwest Passage | Open Polar Sea | Arctic + Great Lakes Plastic]

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Abstract

Open Waters [Northwest Passage | Open Polar Sea | Arctic + Great Lakes Plastic] is an interdisciplinary, interactive multimedia artwork inspired by a five-hundred-year history of expeditions that sought to find the Arctic Northwest Passage and Open Polar Sea. Through a constellation of interconnected pieces including an interactive book and interactive wall projection, *Open Waters* reworks a number of discursive and visual genres across disciplines. An interactive book features a suite of archival poems on Arctic exploration, politics, and ecological change. As the viewer/reader turns the pages of this print-digital hybrid book, projected digital generative art and poetic text intermingle recombinantly with printed text. The interactive back wall of the gallery combines video and audio generative works that respond to the activity present in the room, evoking the effects of human disruption of the Arctic environment. *Open Waters* also considers the global circulation of microplastics through large format photographs of plastic pollution in Buffalo waterways; an animated, dynamic video projection that incorporates research poetry on plastics pollution in the Great Lakes system; and a floor assemblage incorporating locally collected used commodity plastics as well as raised etched glass panels depicting a historical water route from Buffalo to the Northwest Passage.

Keywords

Interactivity, generative, audio-visual, physical/virtual, climate, environment, digital poetics

Background

Open Waters [Northwest Passage | Open Polar Sea | Artic + Great Lakes Plastic] is the most recent artistic collaboration between the authors, and is part of a series of works focused on the Arctic and Antarctic. A previous collaboration, *Ice Core Modulations: Performative Digital Poetics* was featured at the 2017 ISEA (among other venues) and included imagery and poetic fragments inspired, generated and controlled via historical Antarctic CO2 data taken from ice core samples made available from the National Snow and Ice Data Center (NSIDC). These collaborations build on a series of prior works involving several of the authors that have focused on creative approaches to visualizing and sonifying data, generative and interactive audio-visual works involving place and personal narratives, and the synergistic rendering of a creative idea in multiple digital and physical media.

As a collaborative goal, *Open Waters* seeks to create a body of artistic work that is a semantically rich landscape containing simultaneity of disparate yet complementary disciplinary perspectives connected to the historical and evolving conceptions of the Northwest Passage and Open Polar Sea. To create a common source vocabulary for the collaboration, the creation of the work began with conduct in-depth historical research and gathering of archival and audio-visual source material. From this primary matter, poet Judith Goldman wrote a set of poems and poetic text fragments that other collaborators used in their respective media, rendering the phrases typographically, programming their behavior in generated audio-visual projections, and subjecting spoken recording of the phrases to dynamic audio processing.

In sixteenth-century Britain, the spatial technology of a Northwest Passage was central to the inception of globalization and imperialism, while the Arctic, as a region where climate change is amplified and accelerated, is emerging as a focal point of the Anthropocene era. The interconnected pieces of the Open Waters installation thematically and formally echo, in a number of modes, the process of ecological and other change affecting the Arctic cryosphere.

Open Waters seeks to capture multiple, productive contradictions, among them:

- The historical irony that the Northwest Passage, once so ice-impacted it was thought to be mythical, is now traversable by commercial transport vessels and cruise ships alike
- The longstanding, Western, tragic-Romantic fantasy of a polar paradise and "Open Polar Sea" that was held tenaciously, against all evidence of the frozen, impassable state of the high north
- The contemporary conflict between, on one hand, scientific and indigenous perspectives focused on understanding, assessing, and halting ecological damage and, on the other, forces that see the rapidly melting Arctic as an opportunity for resource extraction, economic growth, and alterations of the parameters of political sovereignty.

Based on these objectives, the *Open Waters* collaborated resulted in five works: (1) an artist book with dynamic interactive visuals and text projected onto the pages, (2) an interactive motion-sensing audiovisual projection of ice-breaker footage and text fragments from the poetic-historical source texts and subject matter expert interviews, (3) an audiovisual projection of texts associated with micro-plastic issues in the Buffalo-Niagara region including poems written by local students, (4) a sculpture installation composed of etched glass plates and collected micro-plastics, and (5) photographic prints of micro-plastics in found environments. The focus in this paper will be on the two interactive works.

Sentient Interactions with Climate Change

Open Waters is fundamentally engaged with climate change as both an artistic response and an interactive involvement. It is the third time that the collaborators have made use of a Kinect motion sensor to allow interactive gestures to drive real-time video processing in an ice-related visual projected work. A paramount issue in climate change awareness and popular support is to sense the effects of climate change, as opposed to regarding it is a slow, abstract, and not immediately visible problem. As such, interactive art connected to climate change can make use of interactive actions and their resultant effects to engage viewers in new and innovative ways.

Description of Works

Interactive Book

The main component of the gallery installation is a large format (65x65cm) hardbound interactive thirty-six-page artist book (Figure 1) featuring a suite of thirteen poems. Embedded in each left side page of each double-page spread is a Radio Frequency Identification (RFID) tag that is recognized by a RFID reader positioned within the left side of the table. As the reader turns the page, the tag is recognized by the RFID reader and sends data to the computer (positioned inside the table), which then generates corresponding graphics, and poetic texts that are projected onto the open pages of the book.

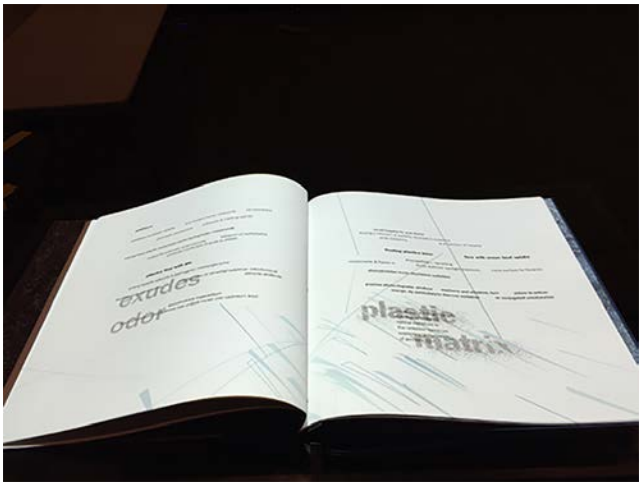

Figure 1. Interactive Book.

The components of the projected information, generated by Processing software, include text phrases and ice graphical imagery. These dynamic visual elements are designed to interact and move around in relation to the fixed text on the page. Different behaviors are assigned to each element; certain text passages are formed from coalescing granular particles before dissolving and fading out.

Similar to erasure poetry forms, the projected generative typographic elements intentionally obscure and "overprint" the printed text on the page changing the meaning and emphasis of the poem. The projected text and graphics are designed to enter and exit the pages slowly allowing the reader to engage in complex readings. The poetic text and animated granulated phrases slowly appear, coalesce, and then fade away (or melt). Because the digital text complementing a particular print page changes with every reading, generated by algorithmic selection from materials matched to that page, the book is different each time it is read. By combining physical interfaces with typographical information in a hybrid environment, this piece explores new ways of receiving and reading information.

Interactive Audiovisual Projection

The interactive back wall of the gallery combines video and audio works that, using a Kinect motion sensor, respond to the activity present in the room, evoking the effects of human disruption of the Arctic environment.

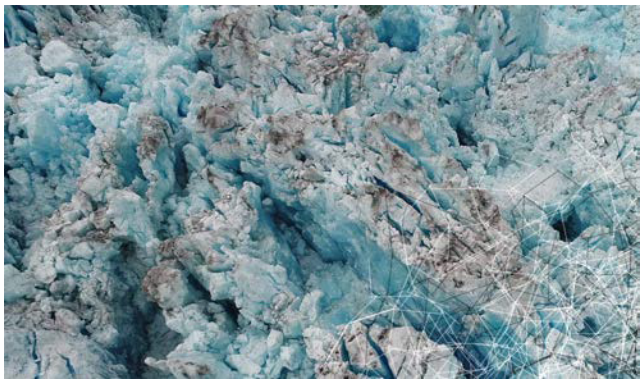

Figure 2. Video still from interactive audiovisual projection.

The video projection (Figure 2) introduces drone footage segments of Alaskan and Greenland glacial and meltwater, as well as footage from a United States Coast Guard icebreaker. This footage is combined with animated, digital graphic vignettes that combine mesh-structures based on climate data with visual poetic language that is generatively processed/altered through a program whose algorithm is based on ice loss and other data from the National Snow and Ice Data Center.

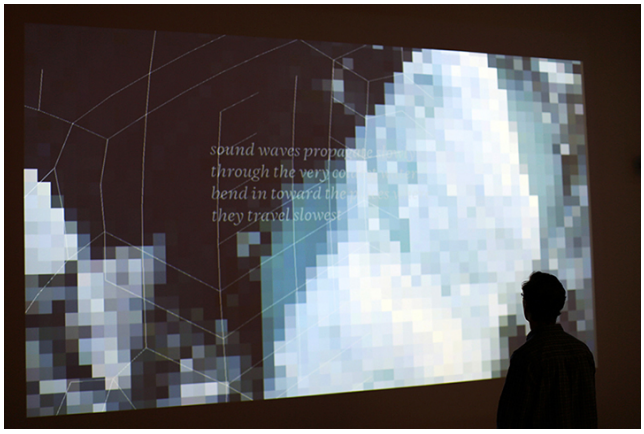

Figure 3. Interactively affecting the audiovisual projection.

Movement in the room is detected by a Kinect sensor and granulates the video, amplifies the movements of the mesh-structures (Figure 3). The audio embodies a long, multi-layered loop made of processed sonic material from the Arctic landscape (flowing water, glacial calving, whales, sonar, and industrial sonic pollution) and spoken language that includes poetic excerpts and interview responses about Arctic Policy taken from a faculty member of the US Coast Guard Academy. Against this sonic backdrop, audience motion triggers audio events of ice cracking that intensify with increased visitor presence and activity.

The generative behaviors triggered by the Kinect motion sensing are based on an estimation of the number of people in the room and gestural detection of left and right oriented gestures. New visitors and gestures lead to sequences of video granulation (in proportion to the number of people in the room) and activity over short periods of time, returning to a recognizable video background as activity subsides.

Summary

The collaborative intent of *Open Waters* project allowed for interdisciplinary synergy between a creative team spanning poetry, computer science, electronic sound composition, and visual art, expanding the technological and creative means by which the historical information about the arctic could be conveyed and expressed. Our collaborative team plans on an ongoing series of installations that bring art and science together immersively and interactively to educate the public about the Northwest Passage: its status as an important strand in the history of globalization; its potential to reconfigure contemporary networks of global relations; its function as a bellwether of the transformation of Earth systems.

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Authors Biographies

Andrea Wollensak is a multimedia artist/designer. Her work spans media from traditional and digital fabrication to generative-interactive systems and includes frequent collaborations across disciplines. Her site-based, data-inspired, and community-oriented work explores and is inspired by polarities such as public/private, memory/narrative, and environment/data. Wollensak's work has been exhibited internationally, most notably at the Göteborg International Biennial of Contemporary Art and the Brno Biennial of Design. Her work has been supported by the Rockefeller Foundation, the International Artist Studio Program in Sweden, Banff Centre for the Arts, and the National Science Foundation. She has presented her artwork at numerous venues including ISEA, CAiiA, Generative Art, and College Art Association. Wollensak serves on the Advisory Council of Winterhouse Institute, a community of practice for social impact design educators. She is Professor of Art and Director of the Ammerman Center for Arts and Technology at Connecticut College.

Brett Terry is a composer and sound artist when not busy with his daily life as a software engineer. His electro-acoustic, choral and chamber compositions have been performed at venues such as SEAMUS, ICMC, ISEA, CAiiA, and Sound Culture in addition to collaborating with visual artists on numerous audiovisual works. As an associate editor of *Computer Music Journal* (MIT Press), he curated a special issue on Visual Music.

Judith Goldman is author of four books of poetry: *Vocoder* (Roof 2001), *DeathStar/Rico-chet* (O Books 2006), *l.b.; or, catenaries* (Krupskaya 2011), and *agon* (The Operating System 2017), and has performed her work widely in the US, as well as internationally. As a poet, she is particularly interested in the aesthetic dimensions of scientific writing, radically mimetic, non-human uses of language that model environmental phenomena, and archival poetics that rub against the grain of dominant historical narratives. Also a literary critic of contemporary poetry and poetics, Goldman is an Associate Professor and the Director of the Poetics Program in the Department of English at University at Buffalo (SUNY, Buffalo).

Bridget Baird is a Professor Emerita in Computer Science and Mathematics at Connecticut College and a past Director of the Ammerman Center for Arts and Technology. Much of her past and current research examines the intersections among the arts and various technologies. Some of her projects include investigating an archaeological site in Ecuador through virtual reality and digital methods, exploring music and dance through motion capture and multiple modalities, using digital techniques and algorithms to better understand and mine historical documents, and more recently, addressing climate change and environmental concerns by using generative art. Baird collaborated, as a Fulbright scholar, with colleagues in both Mexico and Ecuador. Involvement with the local community has also been important to her and a constant interest has been to increase the number of women in the sciences.

Intercultural Dialogue in Museums through Mixed Reality

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Abstract

Increasingly, museums are being perceived as agencies that promote conversations between communities in multicultural societies. Meanwhile, the development of digital technology, such as mixed reality (MR), has shifted our way to communicate by enhancing our perception of information. This paper presents a case scenario of how MR, in the museum domain, can be utilized effectively to create a platform where cross-cultural links of artifacts can be represented dynamically and interactively to formulate a more inclusive and diverse narrative about artifacts, history, and humanity for museum audiences. Two prototypes and future development are presented that explore different aspects of emerging MR technologies with new curatorial techniques for highlighting the dialogue of cultures in museums. This paper concludes with a discussion of the potential for emerging technologies to solve contemporary problems in museums.

Keywords

Mixed Reality, Augmented Reality, Museum, Intercultural Dialogue, Cross-cultural Links, Smart Device

Introduction

In recent years, the term "intercultural dialogue" has attracted considerable attention in many public fields, such as schools, governments, and museums. The European Union defines it as "a process that comprises an open and respectful exchange or interaction between individuals, groups and organizations with different cultural backgrounds or world views." [1] According to the UN Alliance for Civilization, intercultural dialogue "gives people a chance to understand the origin of their differences, but also to appreciate the similarities they share. [It therefore constitutes] an important step in overcoming the boundaries that separate people and groups" [2]

These definitions declare that different cultures today need to use intercultural dialogue as a process to advance understanding and creativity, but they do not mention one important fact: that all cultures are the result of influences and exchanges with one another. World history is not made by isolated cultures but formed through interactions and interconnections between different cultures. This intercultural dialogue has been considered by the academic community, such as José María Gil-Robles, as "a tautological expression because culture essentially is interchange and dialogue. The productive humus of mutual enrichment that allows us to live and grow in the different cultural manifestations when they do not occur in the fatidic temptation of locking ourselves in" [3].

Given such definitions, museums can be seen as an ideal space for intercultural dialogue. They display artifacts collected around the world and offer the opportunity to shape audiences' perception and narrative of society. However, in many museums, collections are classified according to their cultural origins. This customary form of museum organization represents the material enactment of the assumption of cultural difference and does not present the fact that many artifacts are the productions of cultural exchange and not of cultural isolation. This museological tendency to keep the artifacts of places and regions and nations separate undermines the possibility of the museum space as a platform for intercultural dialogue.

Nevertheless, it is not easy for museums to reinterpret their current collections to emphasize the dialogues between cultures. Digital technology, such as mixed reality (MR), can be used as an efficient tool to help this approach. While MR can be considered from a multi-modal context, for the purposes of this paper, it will refer specifically to visual display technologies that provide the merging of real and virtual worlds. For example, augmented reality (AR), which is a popular type of MR, augments the virtual imagery of the real environment on different scales. Although it is not new, this form of MR has recently become more common in museums, such as exhibitions, education and wayfinding, while also becoming cheaper and easier to create. These previously impossible representations and interpretations in museums are transforming the museum experience by using MR technology.

This paper will show the theoretical foundation and process to develop an MR experience to represent the dialogue of cultures and leads to intercultural dialogue for museum audiences in the following chapters.

Reimagine the Intercultural Dialogue in Museums

Traditionally, the museum is a space to collect cultural objects and materials in order to preserve and display the collections to the public for education and entertainment. Recently, "museums are being perceived as spaces where which might nurture respect for cultural differences and foster dialogue between groups" [5]. Therefore, more than ever before, museums have become an important space for intercultural dialogue. Scholars like Simona Bodo state that one of the prevailing understandings of a museum's responsibility is "to promote intercultural dialogue [and] to encourage increased knowledge and greater recognition and appreciation of 'other' cultures" [5]. Thus, many institutions and academics try to position intercultural dialogue in the museum as a paradigm. One significant way is to support a platform to help audiences from different backgrounds develop new narratives for the existing space and collections. Bodo has mentioned that "some institutions are actively engaging mixed groups in the development of new, shared narratives around collections through storytelling, theatre techniques and other mediation methodologies, starting from the premise that project participants can provide a significant contribution to the knowledge, understanding and interpretation of museum objects" [5].

Many museums are implementing methods to promote intercultural dialogue, such as workshops bringing different cultural groups together. Other scholars like, Mark O'Neill, have highlighted how traditional museology can "tend to overemphasize the distinctiveness and separateness of cultures…" [6]. He also analyzes the current museological model of the museum in general, noting that the "focus on a narrow definition of authenticity which constantly tends towards an essentialist view of cultures and the relationship between objects and cultures…minimize[s] the impact of interactions between people and of change over time…" [6].

Some institutions have started to change this traditional museological model, especially new museums. Louvre Abu Dhabi is an outstanding example. There are no geographically designated exhibitions, all the galleries are organized thematically around twelve themes through a globalized historical perspective. In making this bold experiment, the museum highlights the connections between cultures, stating that by "Presenting cultures and objects in dialogue, rather than in nationally or regionally defined displays, the aim is to create a more equitable, global approach to the history of art and humanity" [7]. This experiment shows the parallel developments of different cultures and emphasizes the cross-cultural links. It creates a narrative that "values all civilizations equally, and emphasizes moments of contact and connection between cultures, displaying their artifacts in dialogue, side-by-side, rather than emphasizing their differences" [7]. This unique approach shows a new angle of intercultural dialogue, which is focused on presenting dialogue among artifacts from different cultures. It tells audiences the shared narratives of all civilizations to reinforce the intercultural dialogue.

Mixed Reality as the Intervention

Not all museums are capable of shifting the current displays to show the dialogues of cultures. Many museums use text and audio tours to help audiences understand the connections and the stories behind the artifacts from different cultures that always sit in divided galleries. Also, special exhibitions about the cultural exchange is a common way for audiences to learn shared stories. However, these efforts are often temporary or subtle because of the many limitations that have affected museums for a long time, such as physical space limitations, financial problems, etc.

Digital technologies, especially Mixed Reality, promise to help museums. According to Paul Milgram and Fumio Kishino, MR refers to all scenarios "in which real-world and virtual world objects are presented together within a single display, that is, anywhere between the completely virtual, virtuality, and the completely real, reality" [4]. The best known of mixed reality is augmented reality (AR), "which refers to all cases in which the display of an otherwise real environment is augmented by means of virtual (computer graphic) objects" [4]. One of the most accepted definitions of AR is from Ron Azuma: "1) It combines real and virtual content; 2) It is interactive in real-time; 3) It is registered in 3D" [8]. Accordingly, AR is a hybrid display environment that brings virtual imagery into the real environment. It is the opposite of the current static presentation in the museum environment. Although AR has existed for a long time, the combination of AR and image recognition has brought its application into a never-before-seen level of stability and user experience.

With these features, a growing number of museums are embracing AR for user experience design [9]. It is excellent to be used for breaking the physical space limitations, remix the artifacts and reveal a completely new dimension for museum visiting. Museums can make the 3D information for the artifacts and present it in any space, therefore, audiences can make their "surrounding spaces become a stage for endless extra layers of information" [10]. Also, AR is a powerful tool for engagement, audiences in museums can gain comprehensive information about the displayed artifacts by interacting with the physical artifacts through AR tools [11]. It closes the gap between audiences and the museum because AR can help users to inspect the details, to explore, even create new content in the augmented space.

Importantly, AR allows digital elements to be displayed on the top of an audience's view about the real environment through handheld devices, such as tablets and smartphones. It is a crucial advantage for the application of AR in museums because these devices with pocket-sized screens are widely used.

Early Prototypes and Exploration

In this work, virtual reality (VR) prototypes were initially considered for exploring how to represent and facilitate the dialogue of cultures in the museum, before settling on AR prototyping. VR and MR both have extraordinary ability to shift user's perception, however, VR is "to use technology to replace reality and create an immersive environment" [8]. The feature transports users into a completely virtual world.

Figure 1 presents this as a VR Multicultural Gallery prototype, where the virtual gallery space is created in Unity, where visitors can explore three different exhibition spaces, each consisting of a 360° video. In the center of the exhibition galleries, there are also virtual exhibits corresponding to the content of the exhibition. Through this new experience and display of exhibits, the prototype gives the audiences the opportunity to appreciate artifacts from different historical periods and cultural backgrounds in the same space.

The dialogue of cultures can be presented and transmitted to audiences in this virtual space because this gallery does not follow the usual museum approach to organize and display artifacts chronologically by culture. It brings all artifacts from different civilizations into the same space for audiences to compare and appreciate. Museums also can use this platform to curate the special exhibition about any cultural exchange theme for audiences. The limitation of physical space and display no longer exists in the immersive virtual space. However, as the audience must wear a headset to use VR, the immersive environment also has the effect of separating audiences from physical museum artifacts and the actual environment. Hence, this is not a perfect tool to interfere with the museum visiting approach. Nevertheless, based on informal user testing, viewers of the prototype had very positive feedback about the mixture of 360° videos and the virtual artifacts, and also the parallel display of artifacts from different cultures. It has proved the viability of some MR designs to expand the museum curation. This indicates that other AR application form factors that are based on mobile devices may provide a good solution.

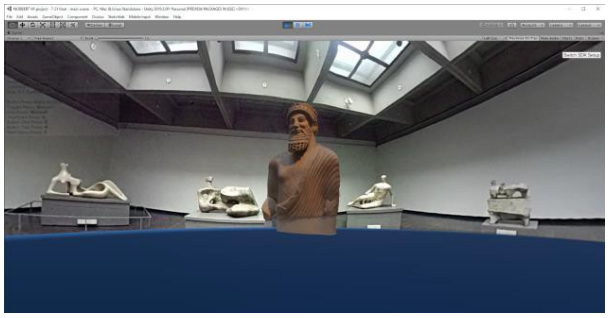

Figure 1. A VR Multicultural Gallery scene containing a conventional display via 360 degree imaging mixed with publicly available 3D museum artifacts [1] from different origins (assets under creative commons license CC By-NC 4.0, via the Trustees of the British Museum).

Figure 2. An AR interactive museum map [2] presenting museum artifacts from varied origins in the same context, allowing a viewer to make intercultural connections. These 3D assets are publicly available [3](under creative commons CC-By-NC4.0).

To explore this further, a second prototype is presented using AR to create a dynamic museum map. When the user scans the map with the built- in camera on phone, a 3D virtual image of the artwork will be displayed in the corresponding gallery space on the map. This utilizes the image target function of the Vuforia augmented reality

[1] https://sketchfab.com/3d-models/statue-neo-assyrian-temple-of-nabu-5b0fcce6567a4bccae578aa09681ab80

[2] Gallery map. (C) Art Gallery of Ontario (AGO). Retrieved from https://ago.ca/visit/gallery-map

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https://sketchfab.com/3d-models/blue-whale-skeleton-8502dbef80ed4aa688c13c90cb14de73

software development kit for scanning the map and anchoring content in real time. Through this augmented map, visitors can have a more intuitive and three-dimensional understanding of the information of the artifacts, especially the display model that artifacts are displayed in different spaces based on cultural origins. To break the conventional visiting approach, the museum can show the dialogues of cultures on this AR map by visualizing the stories between artifacts on the interactive map. Therefore, as a representative scenario, museum audiences can use the map to customize the visiting plan based on collections that have intercultural links. Figure 2 shows this early attempt to combine the physical information of the museum (the paper map) with augmented information, and explores how to use MR display technology to provide more possibilities for representing and reinforcing the dialogue of cultures in museum visiting experience. This approach remains for a more thorough investigation and evaluation.

Figure 3. A usage scenario design of the future handheld AR prototype where the audience can investigate the connection between artifacts from different cultures by scanning the artifacts and interacting with the virtual images (shown on the right). This scene is adapted from the Cleveland Museum of Art's ArtLens App.[4] [12] with publicly available 3D artifacts from the Metropolitan Museum of Art [5] (under creative commons license CC0 1.0).

Future Prototype Plan and Exploration

Currently, there are many ways these concepts can be explored in future. For instance, the applications described are developed to run on a computer workstation. However, future versions will be developed for use as a downloadable AR mobile application. The audience would ideally use the application to scan the displayed artifact in the museum and get visual information about other artifacts that have cross-cultural links with it, as seen in the depiction in Figure 3. Although the physical artifacts would still be displayed in different galleries nationally or regionally, these audiences can perceive a narrative that brings all cultures together through the augmented reality display on their mobile displays. Moreover, museums can use this future mobile application to show the dialogues between cultures, rather than moving all the artifacts around or rebuilding the museum structures. For example, a museum can tag all the artifacts that came from the ancient countries along the silk road, in order to tell the story about the influence between them such as the trade, cultural and religious exchanges. Through the use of image-targets in the AR application approaches, these influences can be presented to audiences as they are viewing artifacts. Through such simple intervention in the museum visiting approach, museums can potentially better transmit the story of cultural exchange, the common memory of cultures to the audience, and change the way people appreciate the artifacts in museums, in order to promote intercultural dialogue.

Summary

This paper has considered how to apply mixed reality (MR) into the museum context and rethink the possibility of MR as a medium for the museum curators to reimagine the intercultural dialogue between artifacts, which is an important role that museums perform in society. In addition, this work highlights the need for museums to explore MR as a further way to represent the dialogue of diverse cultures between its collections, in order to help raise the awareness that no culture is isolated, but rather is connected through intercultural dialogue. Nevertheless, it is undeniable that museums have many obstacles in the approach to build and display such dialogues, such as the physical museum space limitation, information visualization and financial costs etc. To address these challenges MR technology can be used as an excellent intervention to facilitate this approach. In the next stage of this research, further MR applications will be explored which investigate how to further represent the complex nature of intercultural dialogue in interactive museum experiences.

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[4] https://segd.org/content/gallery-one-cleveland-museum-art

[5] https://www.metmuseum.org/art/collection

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Authors Biographies

Peiheng Zhao (Norbert) is a digital designer, writer and curator. He graduated with a Bachelor of visual and communication design (user experience design) from Hunan University, Changsha. He has worked in the creative agency, magazine and contemporary art museum in Shanghai. As a graduate student in the Digital Futures program of OCAD University, Toronto, his research interest is to explore the possibilities to help the museum become a free, dynamic and accessible archive for everyone by using digital technologies such as mixed reality.

Alexis Morris, Ph.D., is an assistant professor in the Digital Futures program at OCAD University, and the Tier II Canada Research Chair in the Internet of Things. He is the director of the Adaptive Context Environments (ACE) Lab, and is a specialist in the overlapping research domain of software engineering for adaptive systems, based on the incorporation of fuzzy human-factors in socio-technical systems. Dr. Morris' and his team engage a cross-section of approaches toward the future internet of things, leveraging artificial intelligence, virtual and augmented reality, human-computer interfaces, adaptive risk management, multi-agent systems modelling, organizational culture simulations, and pervasive technologies. Having a diverse research agenda, he aims to organize and enhance human-machine synergy through initiatives to further the effective adoption of artificial intelligence as a support agent for practical and long-term uses.

PANELS

Who is Speaking? Artscience Stagings of Nonhuman Sentience

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Abstract

This paper presents three experiments that stage nonhuman sentience within substrates where they are not usually expected, such as microalgaes, plants, artificial neural networks, and electrochemical reactions. We use these hybrid assemblages to challenge commonly accepted notions of sentience, perception, and cognition, in particular by highlighting the active and creative role of sensing. Finally, we self-reflect upon the implications of these works on modes of understanding through art and science entanglements.

Keywords

Artscience, artificial intelligence, artificial life, autoencoders, cognition, enactivism, plant behaviour.

Introduction

An electro-chemical substrate reacting to sound provokes the emergence of an artificial "ear". Plants, surrounded by electronic microscopes and cameras, respond to natural sounds and human breath. Microalgaes interact with artificial neural nets to develop a new language.

These strange examples correspond to actual experiments that interrogate established human-centric conceptions of sensation. The first was carried in the late 1950s by cybernetician Gordon Pask in a famous experiment where an artificial sensor builds itself out of matter [1, 2].

The second example, entitled *Qui parle donc?*[1] was created by Edwige Armand, Frédérick Garcia and Passerelle Arts Sciences Technologies. *Qui parle donc?* is an artscience [3, 4] installation divided into a scientific part, focusing on showing current research on the plant's listening skills (root growth towards a water sound, electrical signalling of the plant in response to a sound); and an artistic part where the viewer is able to somehow view the world from the plants' perspective. The last example, *Xenolalia*, is an artscience installation project by Sofian Audry and TeZ that brings together an artificial neural network system and a colony of live microorganisms in a symbiotic feedback loop where they collaborate to generate a speculative alphabet.

These outlandish assemblies of apparatus and agencies are embedded in hybrid materials that lay between computation, physics, and biology. By staging such heterogeneous systems in processes of perception and action, they challenge commonly accepted ideas about the senses.

An Electrochemical "Ear"

Both *Qui parle donc?* and *Xenolalia* respond to post-war cybernetic apparatus such as Ross Ashby's homeostat [8], a self-regulating system that aimed to mimic feedback processes in the human brain; or Grey Walter's electromechanical "tortoises", endowed with self-organizing learning capabilities [9]; and Gordon Pask's "magnetic" evolutionary ear [1, 2]. While clearly scientific in nature, the creative process that made these apparatus possible is very close to art practice, at least in the domain of computation art [10].[2]

In the late 1950s, cybernetician Gordon Pask sought to create electrochemical systems able to develop their own perceptual capacities. In one of these experiments, he attempted to create the conditions for a self-organizing

[1] Translation: "Who is speaking?"

[2] In the 1960s and 1970s, some of these devices were shown as part of art exhibitions, such as Gordon Pask's Colloquy of Mobiles (1968), a Cybernetics installation that was presented in the "Cybernetics Serendipity" 1968 exhibition curated by Jasia Reichardt in London.

system to differentiate between two audio frequencies. Pask's intention was to build neural networks without the recourse of computers by directly activating the properties of matter. Pask was critical of the electronic and computing systems of his time because they were determined by the designer's evaluation criteria: in other words, the outcomes aimed for by a system designer would heavily influence the system itself, thus short-circuiting any attempt at real organizational emergence. This limitation is still present in most artificial intelligence systems used nowadays.

According to Pask, such devices can adapt to a set of perceptions and categories of actions, but are unable to generate new categories. Would it be possible to build a device that could modify its own perceptual categories and develop its own ways of influencing the world? For Pask, a device could find its own relevance by adaptively constructing sensory systems.

Gordon Pask designed and built a series of electrochemical devices using various compounds such as ferrous sulphate solutions, metal salts, and nitric acid, deliberately created so that they could find their own evaluative criteria, allowing them to discriminate relevant information from their external environment. By applying electric current, through electrode arrays, the system could control and develop the growth of dendritic structures. The properties of these systems were surprisingly similar to the behaviour of neural cells. Pask created an artificial system that would self-organize to distinguish between two different frequencies: 50 Hertz and 100 Hertz, thus building a system that could build its own sensory apparatus.

Cybernetician Warren S. McCulloch believed that a system organizes itself when it develops the ability to select, build appropriate filters, and make distinctions in its environment by modifying its perceptual categories [11]. Pask proposed an organizational closure and an open information process to achieve this purpose. Moreover, the network of elements constitutive of Pask's device is ill-defined and can thus challenge the perceptual categories that the designer has introduced.
Pask's experiment reveals how the meaning we attribute to the data as sentient agents are continually being constructed and reconstructed as well as our interactions with the real world. This does not require a precise system, but rather a poorly defined system open to the possibilities of its environment.

Vegetal Sensorium

The installation *Qui parle donc?* intends to reveal alternative ways of thinking about vegetal life, through the illustration of ongoing research on sound perception in plants.[3] Plants have long been objectified, considered as inert and decorative living things. It is only recently and cautiously that researchers have become interested in the perceptive and cognitive capacities of plants. *Qui parle donc?* presents, in front of the general public, state-of-the art as well as "in progress" scientific research in plant behaviour and intelligence.

The installation is divided into two parts, shown in two separate rooms: one directly presents scientific experiments, while the other stages plants as part of an artistic work.

The first room presents an aestheticization of two experiments showing the sensitivity of plants to sound phenomena. The first experiment explores the ability of the roots of *Arabidopsis thaliana* (a type of cress) to orient itself towards a water sound. The second experiment illustrates the richness of electrical signals travelling through the *Nicotiana benthamiana* plant (a type of tobacco) subjected to air draughts and sounds. Two electrodes are placed on a tobacco plant and the electrical signal measured is displayed on a screen. Visitors are invited to blow on a microphone, and their breath are then converted into sounds and fans. The reaction of the plant is then displayed on a screen. The hypothesis tested here is that there is an internal electrical signaling within the plant in response to mechanical stimuli such as wind or sound.

After passing through an in-between space and a faraday airlock, the visitor enters the second room. A screen displays deferred pieces of his body filmed on camera, questioning the perception of a different time of the plant and its ability to perceive everything at the same time, in the absence of dedicated organs. The airlock leads the visitor to a world where he himself now becomes an alien: the world of the plants. In this space, the complexity and difference of perceptions related to these organisms are presented through three different states.

The first state is composed of so-called "naturalistic" sounds, which are magnified sounds in order to imagine the sounds perceived on a plant scale. Thus hail, hummingbird flights, bees, winds, etc. are heard in close-ups.

The second state is a control state, where all monitors broadcast the images of the spectator who is being observed and placed under surveillance. This state acts as a criticism of our willingness to measure and to think that we could control all of life, and our tendency to reduce everything to human standards.

[3] The work was directly inspired from Frédérick Garcia's research on plant behaviour and intelligence and the bioactoustic of plants.

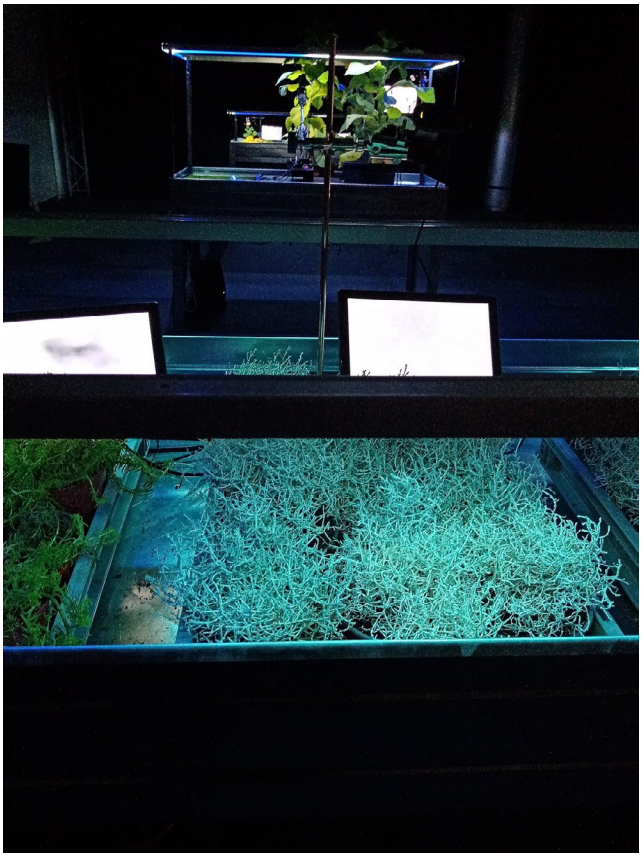

Figure 1. *Qui parle donc?* View of the installation. ©2019 Edwige Armand.

The third state consists of noise. It is inspired by psychoanalyst J. Lacan, who claimed that reality is the noise where you can hear everything. In other words, humans create a symbolic world, where they interpret signs in order to create meanings that are only existing and useful for them.

What does a sound mean for a plant? What we hear does not have the same meaning for the plant than for us. In this piece, the intention was to show that each organism will seek signs in reality according to its organic capacities and that it interprets according to its needs, the two being intimately intertwined.
Three bins are visible in this artistic space.

The first bin contains cameras and screens tracking the eyes of the spectators. Here, it is the spectator who is observed where we wanted to question the question of observation. Who is observing who? Does the human exist for the vegetable or does it have no meaning or distinction of body? When we observe the living, don't we just observe ourselves? Or is it just our own cognitive structures that we are observing?

The second bin features a robot-microscope that scans the plant on a micro scale, questioning our perceptions at a very small level. How are the touch of a hand, or a drop of water falling on a leaf, perceived by the plant? In other words, how is a stimulus perceived by the plant at an infra level that has a more complex and different sensitivity than ours?

The third bin uses chronophotography: one picture is taken every five minutes, producing a timelapse showing that the plant is constantly moving and that it has another spatio-temporal system. Indeed, the human human is not in the same time scale and does not perceive the movements of the plant, yet it moves and moves constantly.

The entire installation and bins are traversed by liminal electrical sounds reminiscent of the idea of information and transmission. The information in the plant is transmitted throughout the body in a very short time. Similarly, all screens are switchable, meaning that the plant perceives everything at the same time.

Qui parle donc? invites the viewer to perspectivism according to the definition of the philosopher E. Viveiros de Castro and to heteroperceptions trying to think of otherness in its absolute difference, that is, without the relationship to the same [5]. It is also an exercise in thinking that invites us to think in the place of other organizations and that pushes us to understand ourselves in a different relationship that is unknown and that allows us to see ourselves under a gaze that has never been trodden.

Uncanny Living “Digits”

What is the relationship between sensing and imagining? How do symbols emerge within different cells, brains, and societies? Are symbols and languages “alive”?

With the art-science installation project *Xenolalia*, artists Sofian Audry and TeZ approach these questions through the interactions of three kinds of entities who collaborate to create new symbolic shapes: (1) a computational agent inspired from animal neural networks; (2) a microscopic colony of photosynthetic organisms who hypothetically possess a form of proto-consciousness; and (3) the macroscopic presence of human observers who project their own meaning upon the work. The piece invites the spectator into an environment that explores the evolution of both biological and computational forms of adaptive processes, through visual magnification. The installation, as a mesoscopic[4] observatory, enacts the symbiotic relationship that progressively and unpredictably unfolds between the organic/biological and the digital/artificial systems.

[4] The mesoscopic scale lies somewhere between the microscopic and the macroscopic (ie. human-level) scale.

Figure 2. *Xenolalia*. Sample generative glyphs on petri dishes containing *Euglena gracilis* colonies. ©2019 Sofian Audry.

Animal, vegetal and artificial forms of life interact with one another symbiotically and come to create new "glyphs", thus generating a "living alphabet" in real time. These glyphs conceptually form a new vocabulary for the spectators, who thus become witnesses to an uncanny form of communication which they have to decode and interpret. The open-endedness of the system gives the audience the possibility of imagining future forms of interactions between artificial, carbon-based, and even xenobiological entities, which could potentially emerge in the future.

The generative process is accomplished by staging an image-based feedback loop between a deep learning neural network known as an autoencoder and a colony of single-cell photosynthetic microorganisms known as *Euglena gracilis*.

The autoencoder is a type of neural networks commonly used in deep learning systems [6]. They have the ability to compress (encode) and decompress (decode) information automatically after being trained on a dataset. In Xenolalia, an autoencoder is trained on a database of handwritten digits from 0 to 9. Once fully trained, when given a new handwritten number in its inputs, the autoencoder will encode and decode the data, producing more-or-less the same image in its outputs.

However, if an image that is not a handwritten number (such as noise) is sent to the autoencoder's inputs, then it will try to reconstruct a new image that will have some properties of handwritten digits, such as edges, curves, traits, and loops. If we take this new image and send it back to the autoencoder's inputs, a more refined image will be generated. As we repeat this operation over and over, the autoencoder eventually converges to a clearer image which preserves some of the patterns found in the training set, such as curves and strokes, yet does fit in any one of the inputs categories: in other words, it constitutes a new digit-like symbol that is not a digit [7].

In *Xenolalia*, a feedback loop is introduced between the autoencoder and the euglena colony by inserting an extra step into the process. Instead of sending the autoencoder's output image back into its input, the generated image is first projected onto a petri dish containing the light-reactive organisms. Within minutes, the euglenas roughly assemble around the shape of light, creating their own imprint on the petri dish's surface which appears as a greenish form. This image is then photographed by a camera and the image is sent back to the inputs of the autoencoder. The process is repeated until convergence to a new glyph that is the result of the interaction between the computational and biological entities.

While the decisions of the neural network are predetermined, the Euglena colony is somewhat unpredictable, to the extent that as living beings they are affected by their environment (ambient light, temperature, nutrients, oxygen, etc.) The integration of both systems as part of a single sensorial and generative process is, hence, indeterminate and emergent.

Discussion

Modern conceptions of cognition, language, and intelligence are heavily impacted by the development of computing and in particular of artificial intelligence (AI). Cognitive sciences and AI have long been dominated by a dualistic worldview that considers intelligence to be a disembodied process, rather than as a physical phenomenon. This view holds that cognition is equivalent to computation; that brains are just the physical substrate (hardware) that "runs" cognitive processes (software); and that in theory, human intelligence could therefore be programmed on a computer [12, 13]. This idea has pervaded Western cultural narratives about sentience as evidenced by touchstone works of science fiction, fostering a functionalist worldview where software/minds are separated from hardware/bodies, allowing not only for the possibility of true synthetic intelligence (eg. *2001: A Space Odyssey*, 1968; *Her*, 2013), but also the possibility for minds to be virtualized (eg. *The Matrix*, 1999).

This dualistic view has been overcome with the enactivist theory which posits that there is no internal processing of external data at the cognitive level [18]. For enactivists, the world is not already predestined to cognition. Instead, reality emerges from the structural coupling of the supposed external world with the internal cognitive

processing. It is from this theory that we approach our subject.

Yet the dualist and representationalist worldview of cognition has impacted the development of research on the intelligence of animals and insects, and more recently of plants. While plants do not possess a neural system dedicated to cognition, researcher on plant behavior and signaling nevertheless aims to highlight and characterize a behavioural intelligence of plants based on the classical cognitive scheme perception → reasoning → decision, thus defining a "plant cognition" which differentiates itself from animal cognition only in the non-neural biological support it presupposes [14]. We can approach the question of perceptions in plants without necessarily clinging to a functional behavioural utility, by sticking to the emergence of signals within plants that echo changes in their environment, in an approach more explicitly oriented towards the study of their consciousness or sentience [15].

The works presented in this article ask for radically rethinking our conception of plants, animals, and intelligence. Philosopher Henri Bergson represents one way to reexamine these ideas. In his book *Creative Evolution* [16], he explains that human beings have created a way of perceiving in a material with solid properties. Human perception, he argues, and more particularly intelligence (which he casts as one of human's perceptual modes) necessitates the movement of the body, which must act and create identifiable perceptual units. Perception thus slices fixed, rigid states called *instant t* out of the unorganized informality of time. It is therefore from this need for stable states that our perceptual world becomes organized.

However, human beings do not stop at creating such moments, such virtual stops from the moving and the unorganized. They constantly project their perceptual structures to create their own present and grasp the stable from the unstable. This leads Bergson to critique causality, linear temporality, and logic, which for him constitute arbitrary and artificial constructions of temporality. He criticizes our inability to understand the living and the living time which is unpredictable and indeterminate, not corresponding to our mechanisms of perception which constantly seeks and projects the known (retention) to counter the unknown.

Bergson's philosophy of perception challenges classical "input-output" worldviews promoted by artificial intelligence, and instead highlights the highly creative nature of sentience through the invention of categories. Following from this work, but also from phenomenologists such as Heidegger and Merleau-Ponty as well as Eastern philosophies, enactivist theories of cognition have highlighted the simultaneous emergence of the body and the world, where there is no static reality pre-donated to cognition, but an intertwined and emerging world-body undoing the separation of the external and internal worlds [17, 18].

Thinking of the intelligence or sensitivity of plants not only requires inventing conceptual categories other than our own (time, space, mortality, sensoriality) but also to move away to anthropomorphism and anthropocentrism since any analogy with humans is inherently misleading for such nonhuman organisms. The artistic projects described here attempt to give other forms of representation and to better understand the intrinsic particularities of vegetality.

Conclusion

Philosopher Hannah Arendt criticized the fact that modern science works by imitating the processes we think we know. Imitating, however, is not the same as understanding. In seeking to imitate the intelligence or functioning of human thought, we quickly become confronted with its most complex and non-computational dimensions.

As Foucault tells us, "man" is a modern invention made of a discursive device: it is also a reflection of our institutional structures. Science has a performative effect on reality. By seeking to imitate it and reduce the world to the utility that humanity can extract from it, we turn away from other ways of apprehending reality. In its attempt to reduce the whole world to a set of generic laws or formulas, science inserts its own regularity into the world, which it then finds back in it, in the manner of a self-fulfilling prophecy.

However, as life always overflows our understanding and our logic, it inevitably escapes humanity's desire for control. Human perception depends on our material heritage, which has been built on the static, the rigid, the immutable, taking time as blocks of stable states and discerning only what is useful to us. It also depends on the thinking articulated in the language derived from these same properties and on the imagination that categorizes the world in order to subsume the general with the particular. Yet other organisms have developed other perceptual, sensory and cognitive strategies, building alien Umwelt and perceptual worlds. Working with organic means showing humility in the face of techniques that struggle to model its richness and uniqueness.

Finally, working with indeterminate entities such as plants, microorganisms, and complex algorithms, fosters the adoption of an alternative perspective that is not comparable to the references underlying our worlds. In other words, it is a matter of deferring, of deterritorializing. How can we understand otherness in its absolute and exclusive difference? To seek the other is to assume our

own presence in any understanding of the world, and to assume that what we perceive is kneaded with humanity; that there is not so much an objective world observable externally, but a subjective-relative world that we must face.

In their mode of existence, the projects presented in this paper thus bring us back to our own modes of sensing the world through the methods of arts and sciences. Following Iannis Xenakis's theory of arts and science "alloys", art and science can both access forms of objective knowledge through the processes of inference (the process of drawing ideas out of observation and reasoning) and experimentation (verification of these ideas through experiments). But art can go beyond these, attaining forms of subjective knowledge through what Xenakis calls revelation, giving us access to the emotional, personal, universal dimension of reality. In Xenakis' mind, the artist must thus be "simultaneously rational (inferential), technical (experimental) and talented (revelatory)" [3, pp. 5-6].

Xenakis' concept of revelation is concomitant to Bergson's theory of perception. Xenakis was also interested in the unknown, the indeterminate, as a method of access to new understandings: rejecting the cannons of his time, he invented a new form of music based on stochastic processes. On a smaller scale, the examples presented in this article suggest two important conclusions: (1) sensing is not exceptionally human, that it can exist in different substrates, from the electrochemical to the animal, from the vegetal to the computational; (2) perception is an open-ended process that leads to the construction of categories, which are always interpreted by the perceiving system; (3) perception processes do not exist in a vacuum, they are always performed by assemblies through their interaction with their environment.

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Biographies

Edwige Armand is a teacher-researcher in Art and Culture at the Institut National Polytechnique de Purpan (Toulouse, France). After completing her PhD in Arts at Université Toulouse 2, her theoretical and plastic research led her to work with various researchers, particularly close to genetics, artificial life and artificial intelligence. In 2015, she helped create the association Passerelle, art, science, technologie which she chairs. The organization aims to create art/science/technology projects and is committed to addressing issues arising from the porosity of these three fields of knowledge.

Sofian Audry is an artist, scholar, Professor of Interactive Media within the School of Media at UQAM in Montréal. Audry creates computational artistic works inspired from visual art, artificial intelligence, artificial life, biology and cognitive sciences. He studied computer science and mathematics at University of Montreal (BSc, 2001) where he completed a master in machine learning (MSc, 2003); following which he obtained a master in communication (interactive media) at UQÀM (MA, 2010). His PhD is in Humanities from Concordia University (2016). His work and research have been presented around the world.

Frédérick Garcia is Research director at INRA and a member of the Applied Mathematics and Informatics division in Toulouse. He holds a Ph.D degree in Artificial Intelligence from the Ecole Nationale Supérieure de l'Aéronautique et de l'Espace of Toulouse (Supaero, 1993) and an Engineer degree from the same school (1989). Following artificial intelligence approaches, his research aims at developing methods for modelling, simulating and optimizing intelligent agents. His current research focuses on plant behaviour and intelligence, and the effects of sound waves on plants.

Maurizio Martinucci (aka TeZ) is an Italian interdisciplinary artist and independent researcher, living and working in Amsterdam. He uses technology as a means to explore perceptual effects and the relationship between sound, light and space. He focuses primarily on generative compositions with spatialized sound for live performances and installations. In his works he adopts custom developed software and hardware, featuring original techniques of sonification and visualization to investigate and magnify subtle vibrational phenomena. In recent years his research has extended to the ideation and creation of specific architectural structures and unconventional sound and light propagation methods to enhance immersivity and multisensory perception.

Machine Learning as Material: Research-Creation Approaches to Behavior and Imagination

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Introduction

We are on the cusp of two potentially transformational movements: (1) the blurring of disciplinary boundaries in scholarship and (2) the rise of Machine Learning (ML), a sub-field of Artificial Intelligence concerned with automating the construction of predictive models. The softening of traditional silos of scholarship allows for increasing dialogue and knowledge-transfer between the arts and sciences. This has facilitated the recognition and advancement of alternative methods of conducting research within academia, fostering a broad new range of research-creation approaches stemming from art and design practices. Research-creation involves a hybrid creative practise where research and production occur in parallel and artistic creativity is valued for its knowledge-generating capacity. Recent breakthroughs in "Deep Learning", an ML approach using complex networks of simple units, have sparked a "4th industrial revolution" where adaptive computational systems are rapidly approaching or overtaking human performance in a diversity of fields such as medicine, transportation, and finance. While we are witnessing a movement of convergence between the arts, science, and engineering within public and private sectors, the accelerating industrialization of AI has the potential to cause significant disruptions into multiple spheres of society. Both of these movements will likely have deep consequences regarding how contemporary cultures develop in the coming decades.

At the nexus of the "STEM to STEAM"[1] transition and strides in Deep Learning, an increasing number of artist-researchers have been making use of ML as raw material as part of their research and practice, following a tradition of practitioners working at the intersection of art, computation, cybernetics, and artificial life. In this panel we will address questions such as: Why are artists interested in ML and how do artistic uses differ than those in the sciences? How can ML be a site for artistic enquiry into the nature of concepts and representations of the world and ourselves? How can we examine the bias and prejudice of AI algorithms when they are deployed as black boxes? Are artists responsible for critically reflecting on the AI methods they use?

These questions will be examined through the lenses of the practices of panelists. In particular, they explore two important concepts relevant to ML and new media art: behavior — defined as the stable form of events caused by an agent as it is perceived by an external subject, and imagination — the construction of internal structures by a subjective agent, as detailed in the following abstracts.

Ben Bogart - On the Subjectivity of Machines

Background

Ben Bogart is a nonbinary adisciplinary artist working for nearly two decades with generative computational processes (including physical modelling, chaotic equations, feedback systems, evolutionary algorithms, computer vision and machine learning) and has been inspired by knowledge in the natural sciences (quantum physics and cognitive neuroscience) in the service of an epistemological inquiry. Ben has produced processes, artifacts, texts, images and performances that have been presented at galleries, art festivals and academic conferences in Canada, the United States of America, the United Arab Emirates, Australia, Turkey, Finland, Germany, Ireland, Brazil, Hong Kong, Norway and Spain. Notable exhibitions include solo shows at the Canadian Embassy at Transmediale in 2017 and the TechLab at the Surrey Art Gallery in 2018. They have been an artist in residence at the Banff Centre (Canada), the New Forms Festival (Canada) and at Videotage (Hong Kong). Their research and practice have been funded by the Social Science and Humanities Research Council of Canada, the British Columbia Arts Council and the Canada Council for the Arts.

Ben holds both master's and doctorate degrees from the School of Interactive Arts and Technology at Simon Fraser University. During their master's study (2006–2008) they began an artistic inquiry of machine learning and developed a site-specific artwork that uses images captured

[1] http://malina.diatrope.com/2017/07/31/stem-to-steam-redesigning-science-cyberscientists-and-art-on-the-brain/

live in the context of installation as raw material in its 'creative' process. In their doctoral work (2009–2014) they made "a machine that dreams" that is framed as both a model of dreaming and a site-specific artistic work manifesting an Integrative Theory of visual mentation developed during their doctorate. Ben's recent work involves building Machine Subjects that appropriate and reconstruct cultural artifacts using artificial intelligence. Ben is currently embarking on a two year project funded by the Canada Council for the Arts developing a body of work applying machine learning methods to image-making situated in painting history.

Abstract

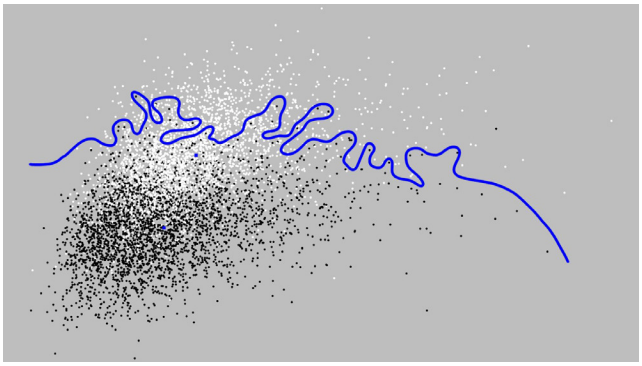

Figure 1. Illustration of nonlinear classification of gender based on weight (x) and height (y) samples.

Continuing from his *Dreaming Machines*, Bogart is currently developing a conception of *Machine Subjectivity* where perception emerges from interactions between sensation and imagination. This framework follows from his doctoral study during which he integrated neurological theories of dreaming, perception, mind wandering and mental imagery to serve as a cognitive framework for *A Machine that Dreams*, a generative and site-specific artwork and computational model of dreaming.

Bogart's conception of subjectivity applies to both biological and computational agents and depends on two assumptions: (1) the world as independent of cognition is unevenly distributed and continuous and (2) what is real results from the mutual construction of subjects and objects, following Merleau-Ponty. Subjectivity is defined as an interaction between sensation and imagination such that they form a reinforcing pattern, resulting in perception. Imagination is a process that constructs boundaries that are the basis of percepts and concepts. Sensation is the mechanism by which probes (measurements) of the world diffract imaginary boundaries. In *Machine Subjects*, sensation is a corpus of information (training data) while imagination constitutes unsupervised machine learning algorithms. Machine learning is a subset of artificial intelligence (AI) that is concerned with improving performance by having systems learn (i.e. model) statistical properties of their training data. The process of imagination divides the unevenly distributed and continuous space of sensation into regions according to the similarity of measurements (Figure 1). The content of subjectivity is an emergent result of the interaction between the structure of sensation and boundary-making as applied by the process of imagination. Percepts are groups of sensory information delineated by imagination and are the base atoms of subjective experience. The basis of subjectivity, and therefore also cognition, is perceiving two different sensations (stimuli) as the same (as belonging to the same class).

This conception of *Machine Subjectivity* is a tool through which we can consider bias and validity in our perceptions, concepts, and cultural values as well as how they become implicit in the statistical models we construct. Bogart is particularly interested in statistical models constructed automatically using machine learning methods that drive much "big data". The emphasis of emergence and imagination in this conception of subjectivity opens our critical awareness to the fluidity of knowledge and the inherent subjectivity of purportedly objective models. Rather than considering AI systems as "automagical" black boxes, we can point our critiques to specific components that depend on subjectivity: how is sensation represented in AIs? What similarity metrics are used? What is preserved or filtered? What biases are implicit in the sensory corpus (training data)?

The closer we observe boundaries in thought and statistical classifiers, the more we can question the permeability and validity of the boundaries on which they depend. Perhaps the validity of all concepts should be considered in light of a subjective point of view: a particular combination of similarity metrics, abstract representations, and an underlying statistical distribution of sensation.

Stephanie Dinkins - Not the Only One: On Community, Craft and the Vernacular in Machine Learning

Background

Stephanie Dinkins is a transmedia artist who creates platforms for dialog about artificial intelligence (AI) as it intersects race, gender, aging, and our future histories. She is particularly driven to work with communities of color to co-create more inclusive, fair and ethical artificial intelligent ecosystems. Dinkins' art practice employs lens-based practices, emerging technologies and community engagement to confront questions of bias in AI, consciousness, data sovereignty and social equity. Investigations into the contradictory histories, traditions, knowledge bases and philosophies that form/in-form society at large underpin her thought and art production.

Dinkins is a professor at Stony Brook University where

she holds the Kusama Endowed Chair in Art. She exhibits and publicly advocates for inclusive AI internationally at a broad spectrum of community, private and institutional venues – by design. Her work has been generously supported by fellowships grants, and residencies from Stanford Institute for Human-Centered AI, Creative Capital, Sundance New Frontiers Story Lab, Eyebeam, Data & Society, Pioneer Works, NEW INC and The Laundromat Project.

Abstract

Figure 2. Not The Only One. © Stephanie Dinkins.

Not The Only One (N'TOO) is the multigenerational memoir of a black American family told from the perspective of an artificial intelligence (AI) of evolving intellect. It is a voice-interactive AI entity designed, trained, and aligned with the concerns and ideals of people who are underrepresented in the tech sector. N'TOO reflects and is empowered to pursue the goals of its community through deep learning algorithms (chatbot), creating a new kind of conversant archive. The AI entity is trained on oral histories (data) supplied by three generations of women from a single-family. Additional culturally attuned data provides context and broad narrative scope. N'TOO uses this information as the basis for its responses to questions. It is important to note the AI communicates as a unique character and offers answers from a first-"person" perspective. The project is repeatable and presents dynamic conversation and stories that change according to the user's questions or the AI's mood. Over time, user input will influence the NTOO's storytelling ability because the AI's database of available vocabulary and subject matter will grow with each user interaction. Here, storytelling, art, technology, and social engagement combine to create a new kind of artificially intelligent narrative form. This project works toward the creation of culturally-specific, natural language-based AI that reflects the goals of the communities making them. By centering oral history and creative storytelling methods, such as interactivity and verbal ingenuity, this project hopes to spark crucial conversations about AI and its impact on society, now and in the future.

Sofian Audry - Behavior Aesthetics of Learning Agents

Background

Sofian Audry is an artist, scholar, Professor of Interactive Media within the School of Media at the University of Quebec in Montreal (UQAM). His work is inspired from visual art, artificial intelligence, artificial life, biology and cognitive sciences. His computational artistic practice branches through multiple media including robotics, interactive installations, immersive environments, physical computing interventions, internet art, and electronic literature.

Audry studied computer science and mathematics at University of Montreal (BSc, 2001) where he completed a master in machine learning (MSc, 2003); following which he obtained a master in communication (interactive media) at UQÀM (MA, 2010). His PhD is in Humanities from Concordia University (2016). In 2017 he was a Postdoctoral Fellow at the Massachusetts Institute of Technology.

His work and research have been presented in multiple international events and venues such as Ars Electronica, Barbican, Centre Pompidou, Club Transmediale, Dutch Design Week, Festival Elektra, International Digital Arts Biennale, International Symposium on Electronic Art, LABoral, La Gaîté Lyrique, Marrakech Biennale, Nuit Blanche Paris, Society for Arts and Technology, V2 Institute for Unstable Media, Muffathalle Munich and the Vitra Design Museum.

Abstract

Over the past decade, I have become increasingly interested in the notions of agency and behavior within new media art as both practical and conceptual tools in art-making and knowledge-making. My own artistic work explores these ideas through the design of machine learning systems.

I present my past and current works that make use of deep learning systems, as well as works created by other artists. These works are used as cases to approach questions at the core of the practice: How do connectionist machine learning systems behave? What does their behavior reveal about how they come to understand their world — and by proxy — how we come to understand

ours? How do adaptive behaviors differ from non-adaptive behaviors? What do machine learning system offer to artists as compared to symbolic AI and Artificial Life when designing agent-based artworks? Finally, how does the artistic practice involving adaptive agents differ from scientific, engineering, and commercial practices?

Figure 3. Prototype of an autonomous learning robot (work in progress). © Sofian Audry and Rosalie Dumont-Gagné, 2020.

Stephen Kelly - Creativity and Open-Ended Genetic Programming

Background

Stephen Kelly is an artist, computer programmer, and musician living in Hamilton, Ontario. He has exhibited and participated in residency programs internationally. His work incorporates sound, electronics, mechanics, and other media in the creation of thematically diverse complex systems. Kelly has a Bachelor of Fine Arts from the Nova Scotia College of Art & Design and a PhD in Computer Science from Dalhousie University. He is currently a Postdoctoral Research Associate at the BEACON Center for the Study of Evolution in Action at Michigan State University.

Kelly's ongoing research is focused on building computer programs using evolutionary algorithms, what is known as Genetic Programming (GP). This is the underlying process in his ongoing series Open Ended Ensemble, Figure 1. In this particular installation, a population of small machines collect solar energy through the gallery window. Each individual captures just enough energy to wake up for 10-15 seconds every few minutes. Their movement evolves through a collective simulation of the Darwinian principle of natural selection. Selective pressure favours machines whose behaviour is novel relative to the rest of the population. Rather than "survival of the fittest", adaptation in this system can be characterized as "survival of the most unique". [1] The process unfolds very slowly, and this installation is partly an experiment to see how perceptible their evolutionary *novelty search* will be over the course of the month-long exhibit. Does simulated evolution happening below the surface produce increasingly unique sounds and movements in the gallery space? When experienced on a daily basis by passers-by, does the changing, emergent behaviour of these machines signify the underlying biologically-inspired system?

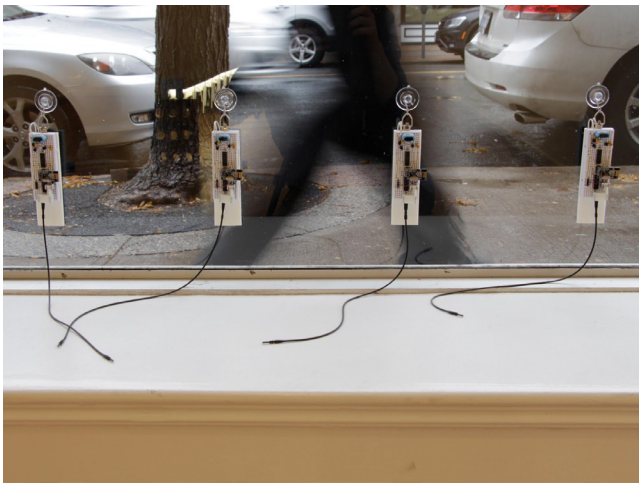

Figure 4. Open Ended Ensemble (The Reality Gap). A coevolving population of solar-powered machines thrive in the gallery window. © Stephen Kelly, 2018.

Biologically-inspired computing and machine learning have received significant attention in recent years. This is primarily due to the success of deep learning, which uses artificial neural networks to model the hierarchical sensory systems of living organisms. [2] While effective, the approach is computationally demanding and typically requires costly specialized hardware (Graphics Processing Units). As such, research in these fields is in danger of being limited to the realm of 'big science', where large tech companies have a clear advantage over publicly funded research institutions. Worse yet, deep learning often incurs a staggering carbon footprint. [3] By contrast, each machine in this exhibit uses one bare-bones, low-power, and inexpensive computer chip. Through radio communication, they implement a distributed evolutionary algorithm. While this particular system's only purpose is to explore behavioural diversity, evolutionary systems of this nature can be used to solve complex real-world problems at a fraction of the cost of deep learning. [4]

Abstract

Machine learning is often characterized as a parameter optimization algorithm. For example, given a computer program designed to simulate a neural network, machine learning could be employed to optimize the parameters of the network (connection strengths) such that it can make accurate predictions about the real world. It could, for example, be optimized to predict a medical diagnosis from x-ray data, or predict the best action for an autonomous robot based on a snapshot of its visual field. In most cases, the number of neurons in the network and their connection topology (i.e. the network complexity), is pre-specified based on prior human intuition regarding the nature of the problem. In other words, a pre-existing model is optimized through ML.

Genetic programming, broadly speaking, is an approach to ML in which computers learn to program themselves through artificial evolution. In contrast to parameter optimization, GP has the potential to build the actual model from the bottom up with minimal human input. As such, the complexity of the resulting prediction model is now an adapted property. The distinction between optimization and model building has interesting implications for artists. In particular, the model building approach implies that the machine's potential to learn is entirely open ended because it is not constrained by a static, pre-defined architecture. What are the core mechanisms that will allow an ML algorithm to fully explore this potential by continuously generating novel and interesting models over time? How could imagination, curiosity, and creativity emerge within such a computational process? This presentation will contemplate these topics through examples from contemporary media art and computer science.

Suzanne Kite - Nonhuman Futures

Background

Suzanne Kite is an Oglala Lakota performance artist, visual artist, composer, and PhD candidate at Concordia University. She is a Research Assistant for the Initiative for Indigenous Futures, and a 2019 Trudeau Scholar. Her research is concerned with contemporary Lakota epistemologies through research-creation, computational media, and performance practice. Recently, Kite has been developing a body interface for movement performances, carbon fiber sculptures, and immersive video & sound installations.

Abstract

How can Lakȟóta ontologies contribute to the conversation regarding humans and AI? From a Lakȟóta perspective, what should the human relationship with Artificial Intelligence be? This paper is a discussion of the possibilities of using Lakȟóta knowledge frameworks to propose a protocol for ethically building a physical computing device in which to house an AI. Emphasizing the Lakȟóta concept of the 'Good Way,' this paper proposes that Lakȟóta relationships with stones provide an ethical protocol for how we might form relationships with AI. This paper discusses what Lakȟóta protocol is and how Indigenous ethics are necessary in forming protocols for fields such as AI. This discussion is drawn from the collaborative and conversational form of research which privileges elders and knowledge keepers in the creation of Machine Learning artworks.

Figure 5. *Íŋyan Iyé (Telling Rock),* Kite and Devin Ronneberg. 2019. Installation. © Bemis Center for Contemporary Arts

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Sentience in the Context of Operative Images

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Abstract

As a follow-up to the operating image concept defined by Harun Farocki in 2004, this round table will address a series of aesthetic and critical approaches that endeavour to probe the global visioning system that today conditions the perception of our physical, social, and political environment.

Keywords

operative images, selfies, visualization, ego-localization, the politics of sentience, the planetary, matter's mattering, data-mining.

Introduction

Since the end of the twentieth century, cameras no longer capture images for human vision only. Some of them are now exclusively dedicated to the operation of autonomous devices.

It is no longer a matter of simply conceiving vision machines, but a vision for machines. Today, one can say that the images we see are now supplemented by images that see. Filmmaker and essayist Harun Farocki in fact called them "operative images," stressing the fact that they are more participants in automated operations than objects for contemplation in themselves. The operations involved are performed in opaque systems, at such a speed and such a complexity that they elude not just human sight, but human attention altogether.

These images have now permeated our lives and can inform the critical examination of other visualization technologies, encompassing digital imagery, contextual data sampling, and computer processing algorithms. Operations related to geolocation, automated image indexing, photogrammetry, or biometric quantification are thus fuelling a new infrastructure for visualization that is progressively organizing our environment. It is then no longer a matter of simply examining how technology endows machines with sight, but especially of seeing how these machines may also suggest to humans new ways of looking at the world and, more generally, experiencing it.

At a time when our conception of the world is influenced by an operative intensification of sensory experience, this round table will address a series of aesthetic and critical approaches that endeavor to probe the global visioning system that today conditions the perception of our physical, social, and political environment.

Figure 1: A collective exhibition combining the work of the research group. 2018, Centre VOX

TimeScape(), portrait without landscape, history without end.

Abstract

This analysis explains media installation timeScape()'s minimalistically ironic approach to the process of subjectivization that has emerged from selfie practices, marked by the recent advent of air-born remote-controlled cameras.

Introduction

Every camera offers a focalization arrangement between an object before the lens and a subject behind it. When the one can be folded over the other, a self-portrait may be produced. It is simply a matter of augmenting the capturing device with a mirror, a timer, or remote shutter-release. In this age of the self-portrait, one can add the selfie stick to one's gear; the unapologetic and essential cellphone accessory that enables a capture that puts as much importance on the background scene as on the face in the foreground. And if that's not enough, some cameras are now attached to remote-controlled drones that can automatically track their operator in a high-angle, wide shot of the surrounding scenery. One quickly understands that this type of "ego-portrait" may also conjure a geo-portrait in which it is not just a matter of self-representing, but also of "ego-locating" oneself in a scene, establishing one's sporting achievement with an action camera or just using an iPhone to testify that one has been here or there, while giving oneself the impression that each of our pics suggests, if only for a moment, that we are at the centre of the world.

The cinematic proposition in TimeSpace() (2018) pushes this logic to the absurd by blurring all the reference points in time and space that are critical to situating one's identity. This experimental creation follows the travails of a drone operator constantly adjusting the position of the flying camera such as to keep himself centred in the frame. In the dark, his environment is delimited by no horizon, no depth of field. As a result, this operator, though standing firmly on the ground, curiously seems to be floating in the image following the inverse movements of the camera, which, on the contrary, seems to be solidly fixed in the air. A series of numbers are fluttering around his head, like a cloud of insects one can't get away from. In fact, the nagging drone of the four rotors give the impression of being amid a swarm of bees. Taking a closer look, we gradually realize that the data circulating around the operator are haphazardly indicating the current year, month, day, hour, minute, and second, in real time. Trapped in a dizzying flow of a perpetual present, the mysterious character is left to his own devices in a shaky exercise of subjectivization that goes round in circles. As austere and satirical as some of the situations depicted by Samuel Beckett, TimeScape() reveals a self-referential universe struggling to utter a discourse that leads us somewhere.

Figure 2: Videogram excerpt from the timeScape() media. Jean Dubois, 2018, Centre VOX.

Man With Movie Cameras: Vertov's ideal in the eye of Google's Street View cameras

Abstract

In this anniversary year of the film Man with a Movie Camera, the intent with this intervention is to shed light on what happened to Dziga Vertov's idealism when confronted with the world-wide visioning mechanism of seeing machines.

Introduction

"I am kino-eye, I am a mechanical eye. I, a machine, show you the world as only I can see it."

These first lines from Dziga Vertov's Manifesto of 1923 resonate, a century later, like the fateful irony of an ideal now transfigured by the omniscient electronic eye of seeing machines. Whether it's the Earth being scrutinized by legions of satellites or its surface scoured by the squads from Google Street View, the erection of a mechanism of nearly complete global vision has disrupted our ways of seeing the terrestrial environment. This is the context in which a vertical exploration of Street View landscapes, striving to identify the traces of this infrastructure of operative perception, revealed a collection of silhouettes with strange protuberances that, on closer inspection, were recognized to be the print of walkers mandated by Google to model those areas that were inaccessible to the Mountain View company vehicles. Indeed, since 2014, Google has proposed a trekking program available to professional photographers, NGOs, or mere voyeurs who make the request. Doing so means being outfitted with a 20kg-backpack containing 360-degree photography equipment and a GPS system. These contemporary photo-reporters

then have the mission of walking at a good pace while maintaining good posture so as to provide ideal conditions for the machine to take good photographs.

From this point of view, we can say that the peregrinations of these curious hikers are the culmination, today, of the state of mind that animated Mikhail Kaufman, better known as the "Man with a movie camera" in Vertov's eponymous film. Initially chief operator, the man with the camera (or, rather, with the cameras) is now a kind of two-legged Dolly whose walking is dictated by the technical constraints of an automated apparatus.

In order to explore this analogy, but also to update the time-image and motion-image paradigm, we developed free-standing screens entitled The man with the cameras. Literally retracing the steps of the shadows left by Google's hikers in the Street View scenery, this project proposes a series of algorithmic travellings at the crossroads of Philip K. Dick's literary paranoia, the low-fi apparatus of Terry Gilliam's Brazil and, above all, Dziga Vertov's famous film Man with the Movie Camera, whose 90th anniversary we are celebrating this year.

Figure 3: Man with a movie cameras. Guillaume Pascale, 2018, Centre VOX.

Dust Silica: Just-in-time territories

Abstract

This presentation examines how the video installation and application Dust Silica (2018) proposes new artistic and critical relations with territorial spatio-temporality using a particular framing of the landscape that explores the sand extraction industry by means of a global visioning system.

Introduction

The capture and mediation of land phenomena today relies largely on vision, modelling, and simulation technologies that have replaced field work. As media theorist Jussi Parikka points out, "it is now through and in the media that we grasp the earth as the object of cognitive, practical and affective relations" (2015, 12). While tools such as Google Earth allow scientists to observe complex geological, atmospheric, and oceanic formations, in an artistic context, this planetary vision system proposes new ways of critically understanding the impact of human activity on the territory. This software infrastructure, however, induces new relationships with the spatio-temporality of the Earth's crust: The Earth, which does not appear to be a fixed and pictorial composition formed in advance, is co-constructed with the algorithmic configuration of a database, aerial and satellite photographs, geographical information systems, and 3D models. Revealing itself just-in-time, on demand, and tailor-made, this image of the world presents itself as a performative cartography by which the territory adjusts in tandem with the navigation process.

At once an application and a video installation, *Dust Silica* (2018) is based on the operating modes of this software infrastructure, examining, from above, the socio-environmental impact of sand extraction in North America. In view of the important implications of this industrial practice for biodiversity, ecosystems, and communities, the application lists the geographic coordinates of quarries and sand pits from public and corporate databases. Following this course, *Dust Silica* then journeys through Google Earth and downloads animated image tiles of the marked and excavated landscapes; once in the gallery, they are superimposed on topographic layers modelling the relief of these spaces worn down by human activity.

By producing a real-time aggregate territory, that is, a compressed frame of the earth that does not exist in advance and by which the fixed image gives way to new, unstable points of view, *Dust Silica* presents itself as the manifestation of a dynamic, just-in-time configuration. While the physical sites of these quarries will never have been directly experienced, the work performs a type of procedural vigilance towards a materiality at risk and takes a sensitive look at natural and cultural structures that weaken ecosystems and communities. Linking the temporality of the work to new ways of experiencing place made available through a tangle of images, data, and algorithms, *Dust Silica* highlights the contrast between the instantaneousness associated with new technologies and the geological temporality of sand.

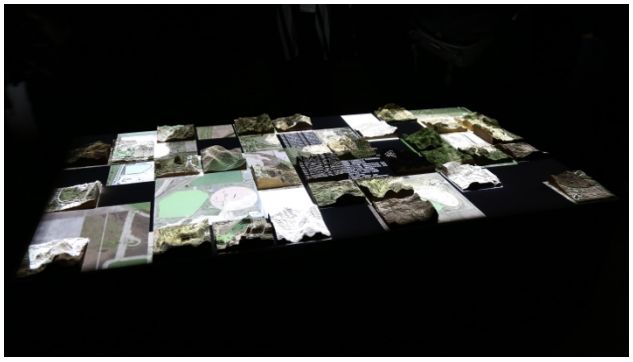

Figure 4: Dust Silica, video installation. Alice Jarry, 2018, Centre VOX.

Geophagia

Abstract

This intervention focuses on the contextualization of one of the oldest datasets on global warming, as well as the analysis of its integration into an artistic practice, to raise the issues that arise from data capture and accumulation, operations related to their representation.

Introduction

Defined as the ingestion of earth (usually clay) by individuals, the practice of geophagia echoes our societies' gargantuan appetite—particularly in the West—for natural resources. The contextualization of one of the earliest data sets on global warming, along with an analysis of its integration in an art practice, makes it possible to raise issues that arise from the capture and accumulation of data, operations connected with their representation, motivations, and the results obtained.

While Farocki grasped the conditions of the rise of operative images, taking the measure of the world to better subject it to calculation and analysis, he did not have the opportunity to apply the concept to the impulse for control currently gripping the commercialization of personal information (Zuboff, 2014). Benign in the beginning, the geolocation metadata, device type information, time of image capture, and focalization parameters that accompanies the images produced by our digital devices, become something else when crossed and enhanced by their interrelation with the social clusters that link the individual with the group. In short, we go from index to indicia.

Considering the contemporary ramifications of the operative image, it is useful to consider the transformation of the spectator that they bring about before proposing new forms of shared experience and sensibility. Extending the operative image, the network image eludes the individual's grasp all the more because it appeals to the impulses of the ego, explored here by my colleagues in relation to the "selfie" and its narcissism. The consequence of the networking of images and their relation to the intimacy of their producers, to the exhaustion of the latter, is greater than that of generations of artists rejecting the production of new images (Beuys, 1964). The network image exists for its information value, quantified according to the interactions it generates.

The fragmentation of the spectator's attention (Simon, 1969) causes the loss of a critical perspective specific to the contemporary economy of attention. An exhaustive analysis by Crary (2014), for whom the image that now watches us never sleeps. Putting down our devices, slowing down the experience are a kind of inverse means of pursuing a reflection on the digital, whereby materiality and community intervene in order to regain a fullness of the attention, critical perspective, and relations with the other. The project *Tablées* proposes to invest materiality through information and to reinvent customary uses in order to transform our household accessories into quasi disobedient objects (Saramago, 2000). Spread in the form of a banquet, the plates of baked clay, informed by the disorder of the temperatures, struggle to contain the proposed meal. A delicious, charcoal-activated vegan ice cream suggests that we accept our geophagia.

Figure 5: Tablées, data-driven collective meal. Alexandre Castonguay, Marina Lespérance Lopez, Sophie Perry. 2018, Greenhouse Concordia.

Collaborators

Mariángela Aponte Nuñez, Alexandre Castonguay, Marina Lespérance, Sophie Perry.

Reenactment 2.0

Abstract

In 2006, the requests and Internet browsing history of more than half a million Americans were made public. This intervention proposes to use this personal data as artistic material to reenact them.

Introduction

Our personal information today is disseminated through social networks and data banks. Our relationship with new technologies is gradually causing our private sphere to disappear. For sociologist Antonio Caselli, the very notion of privacy is changing face, from an individual right it is becoming a collective negotiation; our data are now multidimensional and include information about our social interactions, involving third parties, such as family, friends, or colleagues. Our private life is embedded in a social fabric, and today "nothing is more collective than personal data" (Casilli & Tubaro, 2018).

In 2006, the web searches and browsing history of more than half a million Americans were made public. These recordings, made by AOL over several months without the users' knowledge, were anonymized before being published for academic research purposes. The media installation *Nothing To Hide* proposes to recreate these browsing sessions by producing intimate video portraits of these users. To achieve this result, one must emancipate oneself from the concept of "data bank" and to redefine it as a "digital archive"; it is a matter of opening the way toward a more sensitive understanding of the data, to think of this information no longer as numbers, but as documentation of the past activities of a group of individuals that may be reconstructed in the present. Many of the websites visited in 2006 no longer exist and this re-enactment, as defined in the artistic documentary, makes it possible to fill a gap in the narrative and to borrow new potentialities while remaining faithful to the original model.

The media installation consists of a corpus of six navigation sessions, six portraits of users in a panoptic configuration of six screens. Each screen features a two- or three-minute-long real story, shown in a loop, in the form of a video screenshot that reproduces a navigation session. Users' searches were selected according to the themes they addressed, particularly those that resonated with our contemporary concerns. This direction is a reengagement with the present of a past experience; it is not the repetition of an event as it took place, and the model/copy duo is done away with. This choice makes it possible to rethink and recreate through an permissible process of transformation (Caillet, 2014). Fiction, here, is used to re-establish narrative coherence while retaining documentary truth value.

These navigation sessions, both serious and light-hearted, testify to social problems and reflect concerns that are still current in the United States. In a digital context, in which information ecosystems are undergoing a major transformation, the questions these users raise interconnect with our contemporary society and reengage the digital archive in the present.

Figure 6: Nothing To Hide, video installation, Nans Bortuzzo 2018, Centre VOX.

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Scaling Sentience: The Earth, the Sky, and Outer Space

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Abstract

What can sentience teach us about politics? Sentience is often tied to human perception and apprehended in the (false) distinction between thoughts and feelings. As if feelings needed consciousness to find concrete expression. As if the political was primarily a brains affair. Departing from a definition of politics as that which problematizes the relationship between perception and action (and also from a definition of politics that acknowledges the possibility for organisms to think with their guts), we here question modalities of engagement with sentience beyond the human. In our consideration of sentience, we are cautious of collapses into animism, wary of panpsychism, and wish to evade simplistic misanthropism and anthropomorphism. In an attempt to avoid these pitfalls, we approach the question of sentience by considering scales, from the biological to the cosmic, from the molecular to the planetary, from the microbiome of one body to that of many (social). We ask: How can sentience move across scales? What are the socio-political implications of scaling sentience? Can scalar sentience bring new economies of care?

This panel takes the form of a trialogue among the three presenters, structured so that our thoughts are read or spoken in a rotation of sections so that three perspectives combine and triangulate into a whole. We propose a threefold problematization which, instead of searching for the truth of scaling, performs sentience at different scales: the Earth (O'Reilly), the Sky (High), and Outer Space (Boucher), will act as three distinct poetic structuring devices of spatio-temporal sentience.

Keywords

Scale; Body; Gut; Menopause; Womb; Biology; Animals; Space travel; Collective Survival

Collective Introduction

To listen to and to tell a rush of stories is a method.[1]

What can sentience teach us about politics? Sentience is often tied to human perception and apprehended in the (false) distinction between thoughts and feelings. As if feelings needed consciousness to find concrete expression. As if the political was primarily a brains affair. Departing from a definition of politics as that which problematizes the relationship between perception and action (and also from a definition of politics that acknowledges the possibility for organisms to think with their guts), we here question modalities of engagement with sentience beyond the human. In our consideration of sentience, we are cautious of collapses into animism, wary of panpsychism, and wish to evade simplistic misanthropism and anthropomorphism. In an attempt to avoid these pitfalls, we approach the question of sentience by considering scales, from the biological to the cosmic, from the molecular to the planetary, from the microbiome of one body to that of many (social). We ask: How can sentience move across scales? What are the socio-political implications of scaling sentience? Can scalar sentience bring new economies of care?

The generic notion of scale is not apolitical: to scale sentience beyond the human is not a short cut to avoid the politics of situated life. To scale sentience beyond the human is not to act or think without the human. To scale sentience beyond the human is to avoid limiting the world to human perceptional possibilities; it is to acknowledge that most of our "usual abstractions lead us to judge as subjective only."[2] To scale sentience beyond the human is to risk oneself at getting off the scale by adventuring oneself into otherly situated worlds. In our encounters with otherly worlds, we seek to avoid interpretations of perception and ask instead why and how other entities need other worlds, why and how they depend on them, why and how they are conditioned and transformed by them. We also interrogate ecologies of belonging with them. Risking ourselves at bearing too much weight on the scale, our shared objective is constructivist: we wish to create an appetite for these otherly worlds, for their pragmatic differences.

In the form of a trialogue, our interventions are structured so that our thoughts are read or spoken in a rotation of sections so that three perspectives combine and triangulate into a whole. We propose a threefold problematization which, instead of searching for the truth of scaling, performs sentience at different scales: the Earth (O'Reilly), the Sky (High), and Outer Space (Boucher), will act as three distinct poetic structuring devices of spatio-temporal sentience.

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We foresee this threefold writing process as an intervention into collective survival. "Not to save us," as anthropologist Anna Tsing reminds us, but "to open our imagination."[3] In scaling sentience collectively (and at a distance in a strange telematic way - no thanks to COVID-19), we are seeking methods that do justice to "our collaborations both within and across species."[4]

Earth, O'Reilly: Sweat Meteorology

Horses sweat, Men perspire, Women glow.

I did not mind the arrival of the sudden night sweats that flashed like floods drenching me, despite their disruptive drama. Rather, I enjoyed their excessiveness and sense of abandon. I did not mind being sodden, somehow it was satisfying, intense and tropical. Perhaps I found myself unbothered because I was used to *sweating like a horse*. There was a moment some time prior to the onset of hormonal deluges when I announced that I 'sweated like a man' when I trained. There was nothing restrained or glowing about my salty drenchings. I poured unrelentingly, until sodden. My face becoming red, my hair all over the place. I precipitated, misted and formed clouds. At the end of each training session as we stood in line, ready to make our final OSS, we would poured, forming a microclimate from our exertions; humidities would ascend to the uncladded railway arch roof only to return and pool on the mats as cold briny puddles.

In *Seeing gender* Kathy Acker wrote:
When I was a child, the only thing I wanted was to be a pirate. [5]

I am 53, for the last several years now I have been exploring and writing about being *Environmentally Menopausal.* I have been thinking about how to reframe menopause and of how to become a pirate. The turbulence of menopause requires sea legs that can move in accordance with changing weather, fortunes and seas. One is literally out at sea, uncharted waters over which the normal starry constellations are absent. There are stars but they are arranged into hitherto unregonisabale orientations, the cardinal points have all shifted, perhaps the poles have moved to the equator and Lapland has come to me.

Menopause is a series of transitionary states, during which hormones soak, saturate and abate in exotic tides. Ones very self is up for grabs and there is no clear sense of anything. This pervasive non-sense is rich and strange ground in which things do not exactly grow but emerge. In our endocrine altered environments, insides and outsides are subtly permeable. Phytohormones and animal hormones, biochemical molecules that are hormone like, that masquerade and alter, all travel across and through bodies of plants and animals in ecological relations as bodies are processes and processes are transformations of substances and things. Menopause is environmental. [6]

Menopause is *timely*.
It is about time.

Sweat Protocol (i)
Be menopausal
Go to bed
Throw off covers

Sweat Protocol (ii)
Hold copper pipe closely in the heat of the day under the hot sun
Glisten

Sweat Protocol (iii)
version 1
Hold a cast iron kettle bell
Perform swings with it energetically
Sweat salt and water
Causing it to rust

Version 2
Hold a cast iron kettle bell
Perform swings energetically
Perspire clouds that precipitate
Causing it to rust

Sweat Protocol (iv)
Wear a white cotton mutated laboratory coat to the gym
Run and/or row into a heavy sweat
Use the coat to absorb the sweat
Bury the sweaty coat in a wild area in the hope that sympathetic microbes will grow with/on and from the sweat.

I am trying to build muscle mass. Pause. I read somewhere that it is the best thing to do for a woman of my age. Pause. Rather than head down the road of a gender conforming regiment of hormone replacement therapy *just* yet, I am trying to manipulate and work with my own physiology and hormonal *well being.* Pause. The coach does not appear to like me to refer to *menopause*- Pause. Or that I am menopausal. Pause. And, I am sure he entirely unintentionally, treats me as more frail and with less capacity then I have. Pause. I try to explain that skilful coaching of perimenopausal and menopausal women is an untapped market, ripe for the picking. Pause. That helping women architect muscle to support their wellbeing as they transition into, though and beyond menopause and its post is a terrific idea. Pause. And, that we make testosterone, that our muscle mass is intimately enmeshed with the delicate production of that culturally affirmative, biologically determinate elixir of androgen prescribing sovereignty. Pause. I feel a little bit condescended to. Pause. But not enough to put me off. Pause.

[3] Tsing (2015)., p.19
[4] Ibid, p.29
[5] Acker, Kathy (1995), Seeing gender. Critical Quarterly, 37: 78-86. doi:10.1111/j.1467-8705.1995.tb01099.x

[6] Excerpt from O'Reilly, Kira, "Unlikely Conspiracies of Biologic Thought," Ted Hibert (ed.), *Naturally Postnatural, Catalyst Jennifer Willet,* Noxious Sector Press, Victoria, Seattle. 2017.

I read more about muscle mass and muscle loss: The regulation of muscle mass is of interest to a diverse group of people. There are those, such as power athletes and body builders, who are primarily interested in increasing their muscle mass. Others are concerned with preventing muscle loss. This is critical for the frail elderly, those with myopathies, cancer, sepsis, HIV/AIDS and other diseases, those suffering from reduced mobility as a result of injury, and astronauts. [7]

Pause. Astronaut. Pause. Pausalnaut. Pause. Astropause. Pause. Performing a kind of hormonal hack, or lack. Enquiring of the pervasiveness of estro-centricy. Pause. For estrogenicity is no longer limited to a small group of substances, but can be found in a whole series of chemical classes used daily in agriculture, industrial manufacturing, health, etc. Since the end of World War 2, more than 10,000 active substances capable of estrogen activity have been released on the market and used (in hydraulic or dielectric fluids for capacitors and transformers, glues, paints, detergents, insecticides, herbicides, fungicides, cosmetics, etc).[8] Pause.

Malin Ah-King & Eva Hayward describe the open potentials of the endochrine landscape created by our medications and industrial common materials, one in which our shared evolutionary history with other animals creates a common vulnerability to the effects of environments. One in which hormone levels change over an individual's lifetime and are affected by lifestyle (stress, physical activity), and exogenous hormones.[9] Even natural plant substances like phytoestrogens interact with endocrine systems of various animals. Our material culture—as expressed by what objects we encircle ourselves with, the food we eat, the water we drink. Pause. Ah-King and Hayward invoke Bailey Kier's perspective on in which he attends to the ecologically constitutive nature of bodies: he refers to "bodies" as constant processes, relations, adaptations, and metabolisms, engaged in varying degrees of re/productive and economic relations with multiple other "'bodies', substances and things". [10]Pause. Astro-pause.

Digging into the tinkering of muscle, it's metabolic and hormonal sensitivities. Pause. I lift. Pause. I breath. Pause. I dig. Other processes are at play at other scales; microbial, biochemical. Human bodies exert, sweat, steam and drip, microbes proliferate on bodies and on surfaces, finding nourishing niches in which to metabolise and expand. Weights rust, sweat clouds precipitate, seemingly immovable materials oxidise and react.

Embedded in each of our 'human' cells symbiogenetic mitochondria - mosaic organelles of bacterial provenance from an origin evolutionary 'Eve' – metabolise; muscles fibres fire and twitch in various tempos (slooow, fast, intermediate), satellite stem cells are signaled, differentiate, line up in multinuclear myotubes, fibres are formed and muscle is laid.

Kathy Acker *counts*. In her essay *Language of the Body* Kathy Acker writes: 'I want to shock my body into growth; I do not want to hurt it. . . . I visualize and I count. I estimate weight; I count sets; I count repetitions; I count seconds between repetitions; I count tie, seconds or minutes, between sets: From the beginning to the end of each workout, in order to maintain intensity I just continually count.'

Sky, High: Dreams of becoming vulture

In a very real sense, she was an experimental animal. Not a pet. What could Nikanj do for an experimental animal? Protest tearfully (?) when she was sacrificed at the end of the experiment?
But, no, it was not that kind of an experiment…
-Octavia E. Butler, *Liliths's Brood, Xenogenesis Trilogy*

What kind of experiments are we engaging in now? What kind of experiments are we conducting with our animals, our insects, our air, soil and water, our oceans, our people, our microbes, our world? We need desperate measures for these times – and to think radically about how to proceed – as we are the experimental animals – all of us together.

Starting with myself, my diseased body, my body that takes in and expresses all the time. One false move and I pay for it. Due to my genetically inherited bowel disease I have been obsessed with my gut for a long time. Developments around gut microbiome research have offered a new paradigm for considering how disease manifests in a body.

Excerpt from my article "Dear Bees and Microbes"…:
I think of my gut microbiota … I want to add more bacteria to them (FMT) – to further diversify their grouping. How well will they play with others? What will the new additions bring to the table? What is my optimum microbial cocktail?

…

At the DePaolo Lab, through our experiment "Testing the Waters," I was able to see my own T cells react to my own fecal matter. Will [DePaolo] and I set up our experiment using body materials from me, the "sick subject," and Will as the control – the "healthy subject." The

[7] Velloso, C.P., "Regulation of muscle mass by growth hormone and IGF-I," British Journal of Pharmacology, 2008 Jun; 154(3): 557–568https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2439518/

[8] Chardronnet, Ewen, "The egg, the chicken and DIY hormones," Makery, May 2016, http://www.makery.info/en/2016/05/18/loeuf-la-poule-et-les-hormones-diy/

[9] Malin Ah-King And Eva Hayward, "Toxic Sexes Perverting Pollution and Queering Hormone Disruption," O-Zone:A Journal Of Object-Oriented studies, Issue1:Object/Ecology, 2014

[10] Ibid.

experiment was the picturing of my own body's dramatic autoimmune reaction – cells turning against my own cells. … My cells reacted much more dramatically than Will's cells did … It was the first time I could see the way my over-active immune system works against itself … What looked like an angry black dot, was, in fact, the T cells taking over and breaking the other cells.

There was something incredibly poetic in that image for me – enabling a new way to consider my health and disease: I suddenly understood myself much more profoundly and also felt connected to the (dys)function of microbes. The image looked like a glitch, static in the system – trouble that happens over and over again – like some transformation.

… And I realized that perhaps I am not "attacking myself" through my autoimmunity, but rather I am a mutant, preparing for another time. …, situating even my ill health as part of a broader environmental entanglement.[11]

Will and I played with our own shit bacteria, plating it side by side in petri dishes. Culturing lawns of bacterial microbes. We found anomalies. Will's side of the plates were prolific, abundant. Mine = *Landscapes of lost microbes* with limited diversity of bacteria. Queer tracings and evidence of my body's make-up.

Curiously, scavenger birds, such as Black Vultures and Turkey Vultures, also have a limited diversity of bacteria in their gut microbiota: *the gastrointestinal tracts of vultures are extremely selective…*

In an article from Nature Communications, October 2015, entitled: *The microbiome of New World vultures* [12] the authors describe:

Vultures are scavengers that fill a key ecosystem niche, in which they have evolved a remarkable tolerance to bacterial toxins in decaying meat. Here we report the first deep metagenomic analysis of the vulture microbiome. Through face and gut comparisons of 50 vultures representing two species, we demonstrate a remarkably conserved low diversity of gut microbial flora. The gut samples contained an average of 76 operational taxonomic units (OTUs) per specimen, compared with 528 OTUs on the facial skin. Clostridia and Fusobacteria, widely pathogenic to other vertebrates, dominate the vulture's gut microbiota. … Our findings show a strong adaption of vultures and their bacteria to their food source, exemplifying a specialized host–microbial alliance.

…

In my short science fiction and film-in-progress, "Lazarus: Dreams of becoming vulture,"[13] set sometime in the near future, the main character is besieged with a chronic inflammatory bowel disease. Her illness has left her gut microbiome "in the red" – and she is deficient of many important bacterial species, suffering from dysbiosis due to intense antibiotic and other drug treatment in her past.

Our protagonist partakes in a free clinical trial of a synthetic fecal microbial transplant (FMT), where the colonies of gut microbes are "curated," and selected for a particular gut profile and disease type. Currently there is biotech research being conducted on engineering bacteria communities allowing for designed FMTs, making feasible a programmable microbiome therapy. Once in the treatment, she is administered an experimental engineered synthetic gut microbial cocktail, called *SynGut*.

Things turn out strangely, the treatments don't seem to work. She leaves the program. But soon after, our protagonist finds that she has new-found tastes, and "powers" giving her a novel ability to ingest decomposing foods. She recognizes her affinity with vultures and other scavenger animals. (Turkey Vultures, *Cathartes aura* or the "golden purifier.")[14]

What would it be like to take on a vulture gut microbiome? And how would that change our relationship to death and life, to waste, to our sense of ourselves and eternal transformations and cycles of life? Like transgenic, hybrid creatures, becoming perhaps "tranimals," described by Kelley and Hayward in their article "Carnal Light" as, "*…instances within which we can see more closely the appearing and disappearing boundaries between the human, the post-animal (human and non-human), the in/un/human and the animal. This is not necessarily about cross-species identification, but is rather about a somatic and sensual synthesis that manifests synecdochically rather than metaphorically*."[15]

Excerpt from sci fi "Lazarus: Dreams of becoming vulture":

I now advise others how to eat. I teach what I learned from my animal colleagues. I administer bacterial drinks and perform FMTs with particular bacteria that I culture and grow – DIY in my home laboratory. I can identify the bacteria needed to digest certain foods. These bacteria are already in abundance in my own "off-balance" gut microbiome. I just exaggerate them. Others like me want them too.

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[11] Excerpt from High, Kathy, "Dear Bees and Microbes," *Institutional critique to Hospitality: Bioart Practices. A Critical Anthology,* edited by Assimina Kaniari, GRIGORI Publications, Ippokratous 43, Athens, Greece. 2017, 33.

[12] Roggenbuck, Michael et al, *The microbiome of New World vultures* in *Nature Communications* volume 5, Article number: 5498, 2014.

[13] Excerpt from High, Kathy, "Biology as Clinical Practice - Biology as Inscription - Biological Transmutation- adaption" to be included in forthcoming anthology, *Informatics of Domination*, eds. Zach Blas, Melody Jue & Jennifer Rhee, Duke University Press.

[14] Greek "katharsis" meaning to purify or to cleanse. Latin "aureus" for golden / Greek "aura" means breeze.

[15] Lindsay Kelley & Eva Hayward, "Carnal Light," *Parallax*, 19:1, 115, 2013.

… I train my human teams to clean down to the bone. I am proud of my troops. We can only work at night or under cover. Much of the world needs to dispose of decomposing materials. We help with the flesh at least. Those waste products feed so many of my people. What would have been landfill was now food. Such a miracle…

I wasn't sure if the SynGut had adapted my gut to accept the toxins or if it was my predisposition — how I was configured before. We now hone certain bacteria and bacteriophages to create our own targeted toxic gut environment. … We add and subtract bacteria until we make a perfect noxious balance. Perfect. Just too perfect. They had given us the tools and we adapted them. Vultures were our models, our kin. Who knew it would be so neat. The world's food rot was our banquet.

Outer Space, Boucher: on Wombs as/and Spaceships

A disturbing possibility is that future life may exist only inside ecological enclosures, each a kind of biologically miniaturized world.

…

It is difficult to imagine early humans dreaming of creating materially closed ecosystems; this is a new quest.

…

Mars would be remade in the image of Earth.

Dorion Sagan, Biospheres: Reproducing Planet Earth

What kind of legacy for lifeways do space analogues enable us to imagine?

…

In Biospheres: Reproducing Planet Earth, Dorion Sagan writes -and I wonder if he is not an unfaithful son to his mother Lynn Margulis when he does so- that Gaïa is a living organism, and not an emergent property of interaction among organisms. To "prove" his point, he needs to make Gaïa a force capable of producing its own offspring, and he does so with a provocative yet not totally assumed suggestion: "understanding the way in which the Earth is using people to reproduce itself," he writes "makes for a story more real and yet more unbelievable than the strangest science fiction."[16] For the first time, he adds "we recognize our cosmic role as midwives aiding in the gestation, delivery, and development of a new form of life."[17] Here, Sagan is making Gaïa in the image of our capacity to reproduce it at other scales. He is remaking the Earth in the image of a biological necessity (the function of reproduction) more than he is inventing modalities to greet the potential unknown lifeways that biospheres could produce.

From the framing of nature in National parks and space cabins to the framing of life in petri dishes and glass vessels, the architectures we build to sustain life bear weight on our capacity to tell stories about life. When we travel to space, whether it is imaginatively, scientifically, technically, or emotionally, which reproductive tropes do we bring with us? What kind of economies of/for reproduction are we capable of inventing? What kind of perceptual adventures do these tropes and economies make possible? Which traps and pitfalls – as opposed to legitimized forms of knowledge- are we capable of thinking with?

To think of life beyond the earth, or after the ~~image of the~~ Earth, to scale life from the molecular to the cosmic, from the bodily to the planetary, is an adventure that can quickly reify the representation of life, of the human, and of the Earth. Against the modernization and the essentialization of life, often guided by ideals of progress and domination, can we, and here I quote anthropologist Anna Tsing, develop techniques to "look around rather than ahead?"[18]

The first premise here is that one cannot think about planetary futures without thinking about bodily futures at the same time. As much as the delocalization of human beings in outer space has changed our representation of the Earth, the delocalization of the embryo in petri dishes, and the delocalization of ecosystems in biospheres, has modified both our representation of reproduction and our economies of reproduction. How do these delocalizations and shifts in representation affect our modes of political organization?

The second premise is that if we don't know what a body can do, how can we know what the spaces within which it moves can? Would the scaling of a body, of a world, of an infrastructure, or of a planet provoke a total reconfiguration of their milieu? In a discussion with artist Lucy McRae, creative director of BioGinkgo Christina Agapakis provocatively asks "can one consider the uterus an onboard printer"?[19] Following from Agapakis, can we grasp/capture the body as a spaceship and scale it up to interplanetary life? What could be the power of the body in the making of interplanetary architectures and infrastructures? Could we, in this scaling context, consider the artificial uterus a biosphere at small scale? And, conversely, the biosphere a uterus at large scale? What modes of existence and lifeways would be carried from one scale to another? How could we scale the qualitative differences between these analogues into forms of political interests?

The scaling effects generated by analogue architectures delocalize lifeways and work as powerful tricks to make - or remake- a unified (and already known) image of the body and of the Earth. Not only pre-given and unified, but

[16] Sagan, Dorion, Biospheres: Reproducing Planet Earth, McGraw, Hill Publishing, 1990, p.7

[17] Ibid., p.11

[18] Tsing (2015), p. 22

[19] Agapakis, Christina and McRae, Lucy, "Beyond Wearables: The Future is Fleshy," in Being Material, Cambridge: MIT Press, 2019, p.83

also fragmented: to scale is an activity that can bring you up and down, in and out. In *Alien Ocean*, anthropologist Stefan Helmreich reminds us of the distinction between romantic and baroque visions of complexity articulated by philosopher Chunglin Kwa to describe microbial sea. Romantic visions, Helmerich explains, "gaze upward to a unified, integrated, overarching, holistic system, like Gaia. Baroque approaches to complexity," he contrasts, "tunnel downward, to the intricate, convoluted, endlessly and multifariously recombining."[20] These visions -and also those associated with overviews and views from nowhere- are sadly often "embedded in mapping practices dedicated to owning and controlling territory."[21] How, then, do we come to validate our scaling practices? How do we come to valorize what they tell us about lifeways and their geopolitics? (And also about our own capacities of imagination?) Can analogues produce unforeseen images of the body and of the Earth, create resonances rather than rationalities, and give rise to lifeways that challenge our imagination?

…

How shall we take care of this scaling problem?

…

Teaching us how to take care of problems, to live constructively with them -in and through their ruins- Tsing challenges us to remember the pitfalls of scalability. Scalability, she tells us, is "the ability to make one's research framework apply to greater scales, without changing the research questions;" it is "creating an expansion without the distortion of changing relations."[22] Informed by the meaning of the word scale, could we instead think of scales as shelters of thought, as hosts of lifeways, as the layer around a bud or as the scale of snakes and fishes? Could we think of scaled analogues as more than variations on models? That is, as something that "resembles nothing outside itself," as something that is "self-referenced to its own variations."[23] Could we think of scaled analogues as operators of transformation, as generators of social difference (rather than as predictive models of comparison)?

The exchanges among and between designs for and off Earth are axiological charged, creating a sort of opaque oscillation between environmental and bio- ethics. What kind of ethics are fostered when we anticipate and practice maneuvering in places like the Lunar and the Martian landscapes? For biologist Henri Atlan, bioethics is a field whose questions are asked to society by biology and not the contrary, meaning that if the questions are asked by biology, biology alone cannot answer them, even if it plays a central role in their formulation.[24] Referencing the social and political status we give to embryos when we grow them *in vitro*, Atlan tells us that in our encounters with analogues "instead of searching for a criterion of scientific origin, we should accept a criterion of law based upon our sensibility and our immediate perception."[25] "It is this immediacy of perception," he explains, "that we should recover and assume, instead of searching for an illusory essentialist definition of nature and of human persona."[26] To scale analogues should thus be similar to thinking "par le milieu," in the midst of objective research, scientific facts, and nature, on the one hand, and between justice and dignity, on the other. While justice and nature are two domains that are hardly reconcilable, Atlan urges us to remember that sensory experience can lead to the production of ethical values endowed with the power to maintain the social value of this impossible reconciliation. This impossibility should however not read as an opposition, but rather as a contrast that produces social differences.

To scale analogues is thus to gamble on the possibility to "live inside of this regime of the human and still exceed it."[27] To scale analogues is a form of experience, a lived abstraction that emerges in the immediacy of perception, one that vibrates in the concrete, one that makes the scale effects localisable in space and time. It is a method that aims at generating sources of signification which situate us, and which give meaning to our existence. It is thus a practice that carries the fabulatory function of inventing new lifeways.

Collective Conclusion

Back to collective survival. We have read and listened to/with each other and to/with our stories. Whether we sweat like horses, share the diversity of our gut bacteria with vultures, or produce interplanetary offspring, we came together not to debate or interpret the question of scaling sentience, but "to collectively attach ourselves to discern"[28] it. We came together through our concerns, because we seek to construct problems with meaningful legacies.

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[22] Tsing (2015), p.64

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[25] Ibid., p.13

[26] Ibid., p.15

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Authors Biographies

Kira O’Reilly works with ephemeral forms to consider ideas of *the body*, it’s mutability and limits. This includes collaborations and articulations with other species, living materials, objects, and audience. Crossing disciplinary categories her practice arcs visual art, art, science and technology, performance, live art, and dance. Her work has been exhibited widely throughout Europe, Australia, Asia, and North America where she has also taught widely. Currently based in Finland where she writes, makes art, mentors. Her book was co-edited by Harriet Curtis and Martin Hargreaves, and includes essays by Marina Abramović, Shannon Bell, and Tracey Warr.

Kathy High is an interdisciplinary artist working with technology, art and biology. She collaborates with scientists and artists, and considers living and dying systems, empathy, animal sentience, and the social, political and ethical dilemmas of biotechnology and surrounding industries. She has received awards including Guggenheim Foundation, National Endowment for the Arts. Her artworks have been shown at the Museum of Modern Art (NYC), Science Gallery (Dublin), NGBK (Berlin), MASS MoCA (North Adams). She has had residencies with SymbioticA (2009-10), Finnish Society of Bioart (2013), Coalesce UBuffalo (2016-17), Djerassi Scientific Delirium Madness (2019). She is Head of Arts and Professor at Rensselaer Polytechnic Institute, Troy, NY.

Marie-Pier Boucher works on the impact of science and technology at an interplanetary level with a specific focus on the design of habitats for sustaining life in extreme environments. She is co-editor of *Being Material* (MIT Press, 2019), *Heteropolis* (2013), and *Adaptive Actions (Madrid)* (2010). Her research residencies include: Johnson Space Center, NASA; Banff Center for the Arts; Max Planck Institute for the History of Science and; SymbioticA: Center for Excellence in Biological Arts. She is an Assistant Professor of Media Studies at the University of Toronto.

Breeding sentience: queering lineage and voguing enhancement

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Abstract

In our indulgence to touch immortality, our fear of being forgotten, our unconvincingly altruistic embrace of self-love, our attempt to get rid of social and biological pressures or simply the uncaring lightness of an inadvertent encounter, we grip the reproductive practice Today's tales of the birds and the bees are a wholly different reproductive conversation as male fertilization, female ovulation and surrogate gestation have become more and more hacked to respond, not only to the reproductively challenged, but also to a demanding array of kinship design strategies. This panel entitled "Breeding sentience: queering lineage and voguing enhancement" focuses on the enriched experience of procreative manipulation through artistically creative forms of ART (assisted reproductive technology). As critical "reprotech" voices, the six panelists approach the topics of: (a) the unnatural selection of species, (b) the growth of human-animal hybrids, (c) biodiversity and neoeugenic engineering, (d) gender/genital sociocultural rebalance, (e) matchmaking based on genome sequencing, (f) the impact of preimplantation genetic screening, and (g) prenatal imaging. Our point is that art must be taken into account, to validate the checks and balances, at a time when the ethical limits and the multitude of potential human genetic manipulations are consistently challenged through the practice of formally deregulated principles.

Keywords

ART, Baby Bump Selfies, Bio Art, Biobank, Boy or Girl, DNA Valentine, Genetic Art, Genome Editing, GM, Hybrid Life, Medical Imaging, Reproduction Anxiety, Sperm and Eggs, Unnatural Selection.

Introduction

Is there any sentience of what is yet to be? Can one experience the sensation in a new environment taking into account the future beings? When consequences are immediately unseen, what is the sensation of a breach? Is there sentience in neglecting the generations to come? Can sentience be induced? And, just because one feels it, does it mean that one actually cares enough to do something about it? "I need you baby to warm the lonely night" but can we love actually the offsprings of once speculative fiction with ethics? [1] How powerful is biopolitical aesthetic and how resilient is our consciousness?

A Crab Hermit and a Mosquito Walk into a Bar

Roughly around May 2019, a video kept resurfacing on various social media: the scene portrayed a Hermit Crab using the plastic head of a discarded doll as her home. Why would a hermit crab trade her own house for one made of plastic? And why a plastic head? In our fantasies we can wonder: Was she left homeless (the sign of a marine real estate crisis?) and this doll's head was the only object she could find? Was this a conscious choice? Was the hermit crab actually ingenious and even artsy, or just desperate? Was this a sign of resilience or of some – twisted – sense of humor?

Commentaries below the video from people ranged from shedding tears for the degradation of nature, to expressions of awe regarding the resilience of the crab. Importantly, most comments reached the same conclusion: humans were the cause of this real estate crisis, and no, the hermit crab was not particularly creative, or playful, or creepy: her amazing degree of adaptation was strictly dictated by utilitarian purposes. The crab was the "unlikely poster child for the serious pollution problem occurring on remote Pacific islands (USA today)." [2]

In a recent science documentary, a handful of mosquitos are shown flying carefree, seemingly enjoying some early evening damp warmth, typical of tropical weather. As the night is about to come soon, it is time for them to feed and mate. This scene does not take place in Africa or Brazil, where these families of mosquitoes are from, but in a controlled environment room in the lab of ecology and genetics at the Polo GGB in Terni (Italy). [3-4] Genetically

modified mosquitoes using CRISPRcas9 technology are produced in London and are shipped to Terni and kept in climate-controlled chambers. Some of them will be left alone through their regular life cycles, while others will be allowed to mate, thus transmitting their mutation onto their sexual partners and turning them sterile. The resulting population of mosquitoes will no longer reproduce and will eventually collapse.

The GMmosquito lives her life at the service of science. But does she know that the source of light is not coming from the sun, but from a sophisticated lamp that simulates the different phases of the day? That her comfortable world is confined to one room? Is she aware of her lethal uniqueness? The mosquito has been vilified for many centuries because of her ability to carry and transmit deadly diseases, which she injects in her victims when she feeds off their blood. But the lab-made GMmosquito somehow belongs to a different species, whose main purpose in life is to (maybe unwillingly?) exterminate her own. [5]

Without diminishing the significance of climate change and the careless patterns of human activity, there is something quite intriguing about these two episodes: in adopting (adapting to) the plastic head as her home, the hermit crab is simultaneously nature and artifice, reality and fiction, it speaks to planetary transformations in the Anthropocene and to unexpected resilience and ingenious behavior. [6-7] We will probably never know if she "decided" to adopt a new home. However, as we take note of her bizarre new appearance, we acknowledge her existence. Despite being born in captivity and not being given the option of picking their own housing, mosquitoes share very similar characteristics with the Hermit crab: they too are both nature and artifice, reality and fiction, and promise to bring unexpected or unintended environmental changes.

Popular culture has spent lots of ink and words to mourn the loss of species and diversity (mostly the pretty animals, like the megafauna), but spent no time talking about how other ugly, abject insects (like the mosquito) should be let die. Thus, rather than mourning the creatures and the (arbitrary) nature that we have lost, one can ask: what is emerging from these (maybe desperate? Maybe deliberate?) acts of adaptations and survivals? [8] What new hybrids can gene drives and other manipulation of organisms for science can be generated? [9]

Flying On My Own

In terms of evolution, humans and birds are far apart. However, connections between our species and birds have been increasingly explored.

Since ancient times, the human species has somehow been interested in exploring the "potentials" of birds in everyday life. [10] Primarily as a food resource, followed by a variety of uses, from religious rituals to ornamentation.

There are several explanations for this close relationship, such as sharing the same environments or human fascination with colors, shapes, songs, and behaviors (especially flight) of birds. [11] Recently, a study has shown that possibly the brains of birds and mammals may be connected in regions responsible for certain actions, such as decision-making and sense of direction. [12-13] These results open a "pandora's box" about our connection with birds, allowing us to question our own evolutionary – past and future – path.

Why are we so connected to the desire to fly? Is this another "missing" link between us? What possibilities open up in the future where the sky is not the limit but that's where we want to go?

Embryos on the Lam: Developmental Anatomy Reveals Sentience as a Process Art-Metabolic Interstellar Ethology

From Sentience as Object Relations to Queer Adjectivist Ontology (QAO), this discussion explores the crisis of Descriptive Cathexis and the indeterminacy of consciousness. The origins of bodily anatomy and sensate form in All Organisms Living (AOL) begins with an allegorical review of the nearest non-vertebrate ancestor: Tunicate as sentimental notochordian sessility. Beyond the atrophy of vertebrate origins, there arises a question of consciousness: is all anatomical formation/diversification simply evolution and development towards presumed fitness regimes or is it indeterminate allegory alone that drives anatomical drift? Are mutagenesis and decay simply popular ways out for objects as avoidances of standardizations? If so, then can queer biodiversity be our a-priori: a working yet flexible definition of anatomical exuberance?

In a universe of multifarious signals, synergistic spectra and dissonance divergences… can we explain the mistake of birth as a morass, a knotted remash of piled entropic flesh, a feeling of twitching nervous energies through a lattice work of potentially endlessly looped back and forth segmentation boomerangs that might extend the organism as a stack of eventually repeating asses and heads attached by spines and metametacarpels ad infinitum like a tapeworm or thin ribbon candy? In other words, is the segmented organism just an arbitrary number of segments chosen by fate and chance and later developed into bi-directional wound of pumps and senses? Is that all sentience is? Beyond the anatomical biTransversal symmetry axiswerks, Lulu and Nana represent other axis workers. As the first official transgenic people, born of neoeugenic engineering, Lulu and Nana are being reared as the ugly head of enhancement perfectionism.

New reprogenetic technologies are interceding as stop gap measures to sustain a utilitarian chthulucene. Yet these sci-powered rhetorical orgiastic readings of our engineered mirror-sapiens often miss the differently-abled punctum of the Germline Heritable Transhuman Arts. In this sense, sentimentality is mere propaganda, PR for rationalization in word but not deed, and an atrophy of as the repressed indeterminate nature of blind prophecy. The repressed poetry in motion of forced and branded posthumans and

their GMO human breeders (that is germline engineers as anatomical graffiti artists and inept seers), return and resurface in the eternal money shot of the gene insert during microinjection fertilization. Trait choice and the sensory world of next-gen transgenic semisuperhuman mutant versions is a perceptual and metabolic unknown. But if novel sentience is a question of inbred reprogenetic style then the answer is partly in the exploration of novel non human sense organs both synthetic and found as the perceptual and cognitive worlds of our novel transgenic breeds approach an Interstellar Ethology.

Is it a Boy or a Girl?

At the very moment we enter the world our bodies are defined by gender. It is the first piece of information we ask about a baby – Is it a boy or a girl? Historically, the upmost importance has been placed on this perceived dichotomy. It is the basis of traditional notions of family, politics, culture and medicine, underpinning the patriarchal and normative societies that have for the most part dominated human history.

Figure 1. *In Posse* by Charlotte Jarvis ©Photo: Miha Godec.

In *In Posse* Charlotte Jarvis aims to rewrite this cultural narrative; to use art and science to disrupt the hierarchy as the attempt is to make semen from ("female") cells. In Posse is a Latin term with a literal meaning of 'before we are born'. It refers to something which is possible, which has potential, but is yet to be called into existence. We are striving for a form of technological, biological and creative activism.

The project is being exhibited throughout its journey as a series of cultural artifacts and rituals belonging to a contemporary reimagining and reenactment of the ancient Greek festival of Thesmophoria – a fertility ceremony in honor of the goddess Demeter and her daughter Persephone. Little is known about the original festival because men were forbidden from seeing or knowing about the rites; the festival was women-only and thus largely undocumented. Female semen is a starting point for reimagining the Thesmophoria with different groups of women, trans and gender non-binary people: for populating a history without patriarchy and a future in which the gender/genital power balance is redressed. The festival takes the form of a documented ritual, installation and durational performance across multiple sites including the gallery space. The participants build on the scant extant details and rumors about Thesmophoria – the burial of a pig, a seed feast, the use of pine branches, "ritual obscenity", serpentine and phallic offerings, etc. – and create new collaborative rites and rituals.

In Posse seeks to use science and art to undermine traditional notions of patriarchal power and to examine the meaning of gender now and in the future. [14-15]

Posthuman Artificial Net Embryo Synthesizer

What if an artificial intelligence could help us find our ideal mate? In her artwork *PHANES* Jaden J. A. Hastings has biobanked her eggs in a biobank, has a complete sequence of her whole genome sequence, and, as part of another artwork, the artist programmed an AI to tell her what errors needed correcting in her genome and how to fix it.

Named for the Greek Protogonos, PHANES allows anyone to submit their genome for consideration by the algorithm in the form of a Variant Call Format (VCF) file that one can obtain from most direct-to-consumer genetic tests. Based upon its own parameters, the algorithm then produces hypothetical future generations that a pairing with the artist's eggs might produce. The family tree, according to PHANES, reaches into the future, rather than the past.

Figure 2. PHANES by Jaden J.A. Hastings ©Kontejner.

This work is intentionally provocative, and made even more so as it is functional (not speculative). Yet, it is proposing a step toward a carbo.silico entanglement that is already in progress—from shifts in matchmaking due to the algorithms behind social media and dating apps, to selection of embryos for IVF—which makes PHANES simply another step in the same direction. [16]

Prenatal Portraits and Keepsake Ultrasounds

The end of the twentieth century witnessed a proliferation of different forms of visual representation of pregnancy in popular culture through diverse media. A once controversial trend of celebrities which proliferated thanks to the expansion of social media and the boom of mobile phones with camera. This interest for the self-documentation of the pregnant body is connected with the understanding of the moment and the massive number of free applications able of image editing the photos captured. [17] It is also associated with the development of the concept of story and the sharing of private moments related with everyday life. Not to surprise the fact that the once niches of pregnancy pornography and lactation fetish have actually become mainstream as the caring mother gained an extra label MILF. [18] In any case this is an interesting turn of the table compared with medical maternity literature which persists on its illustration of pregnancy to partially represent the body of the gestant as if mutilating it was a form of underlying the supremacy of the youngest life forms.

Besides baby bump selfies, there is another type of imaging circulating more intensely on social media. Ultrasound's sharing has been characterized as a form of rite of pregnancy as well as the first picture of the unborn and therefore, we could dare to say, the introduction of the new being into the market statistics as a fresh consumer/consumable. [19] By itself the ultrasound was an imaging technology only directed towards cases of family history with malformations. As the ultrasound became a routine test there is a visible change in the semiotics of its resulting images. Abusively misused by the pro-life narrative as well as by pregnancy termination practices based on gender preferences, ultrasounds are always a source of income to ultrasound clinics. [20-21] If prenatal testing is a support material for breeding sentience amplifying or source of detachment upon disclosure of an unborn's disability, this is a point one may reflect upon. [22-23]

For those of us who have not followed the reproductive path, the breeding sentience is externally perceived, either through medical imaging or through fiction. This is a disembodied voyeuristic kind of self-narrative, with a potential superficial tactile extension if close relatives or friends, who have engaged in pregnancy arrangements, allow the physical contact between our body and the gestant's, i.e. the mediated touch of the unborn. In the artwork of Karolina Żyniewicz's "Synthetic motherhood" the artist combining her DNA sequencing with the samples of ten males creates the visualization of their possible offsprings because as she says: "I am pretty sure I will never be a mother, but I am curious, as probably every woman is, how my offspring could look like." [24]

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Jaden J. A. Hastings is an extremophile and CEO of Alpha Space, a mission-led organisation devoted to conducting vital field research that accelerates our ability to support sustainable life on Earth and beyond. An alumna of New York University, Harvard University, and the University of Oxford with advanced degrees in both Biology and Bioinformatics, J.J.'s career in scientific research spans over 15 years at some of the world's leading research institutions. She is also an internationally-acclaimed artist with an MA in Art & Science from Central Saint Martins and a doctoral degree at the University of Melbourne. In 2017, J.J. founded the x0.lab Initiative a not-for-profit organization that supports mission-based scientific field studies and supporting STEAM education in remote communities. As a University lecturer across multiple fields, J.J. is devoted to fostering curiosity and resilience in her students, which stems from her long-standing roots as a hacker.

Dalila Honorato, Ph.D is Tenured Assistant Professor in Aesthetics and Visual Semiotics at the Ionian University, Greece. One of the founding members of the Interactive Arts Lab, where she coordinates the Art & Science Research Group, she is also a collaborator at the Center of Philosophy of Sciences - University of Lisbon. Her research focus is on embodiment, monstrosity, the uncanny and the acrobatic balance between phobia and paraphilia. The starter of the conference "Taboo-Transgression-Transcendence in Art & Science", Dalila Honorato launched together with Marta de Menezes "FEMeeting: Women in Art, Science and Technology". She has been granted a sabbatical leave to develop her art & medicine research project "PARTS: on the agency of surgical leftovers", at RPI (USA), A+C-UNAM (Mexico) and Ectopia Lab (Portugal), in the Spring of 2019, having gynecological tissue and identity as focal points.

Charlotte Jarvis is an artist working at the intersection of art and science. Charlotte's practice often utilises living cells and DNA: she has grown her own tumour, recorded music onto DNA, seen her heart beat outside her body and is currently on a quest to make the world's first female sperm. Charlotte has exhibited her work in eleven international solo shows and over one hundred and fifty group exhibitions featuring large-scale multimedia installations and performances. Charlotte has been resident artist at a number of universities and scientific institutions, including the European Bioinformatics Institute and the Hubrecht Institute. Charlotte's work has won the Bioart and Design Award in the Netherlands and the Alternate Realities Commission in the UK. She has been peer-review published in Leonardo Journal in the USA. She is currently a lecturer at The Royal College of Art and Goldsmiths University London.

Felipe Shibuya was born in São Paulo, Brazil. He studied Ecology and Nature Conservation at the Federal University of Paraná, where he earned his Ph.D. Currently, he is an M.F.A. candidate in Studio Art at the University at Buffalo, working at the intersection between biology and art. All of his work involves aspects of his own identity, and he always highlights the visuality of nature. His current projects involves the deconstruction of archetypes in species that became poetized by humans (such as hummingbirds), and biovisualization.

Adam Zaretsky stages lively, hands-on bioart production labs based on topics such as: foreign species invasion (pure/impure), radical food science (edible/inedible), jazz bioinformatics (code/flesh), tissue culture (undead/semi-alive), transgenic design issues (traits/desires), interactive ethology (person/machine/non-human) and physiology (performance/stress). A former researcher at the MIT department of biology, for the past decade Zaretsky has been teaching an experimental bioart class called VivoArts at: San Francisco State University (SFSU), SymbioticA (UWA), Rensselaer Polytechnic Institute (RPI), University of Leiden's The Arts and Genomic Centre (TAGC) and with the Waag Society. He has also taught DIY-IGM (Do-It-Yourself Inherited Genetic Modification of the Human Genome) at New York University (NYU) and Carnegie Melon University (CMU). Dr. Z is currently Media Arts Faculty in the School of Communication and the Arts at Marist College. His art practice focuses on an array of legal, ethical, social and libidinal implications of biotechnological materials and methods with focus on transgenic humans.

Sentience and Trans-Species Collaboration: Considering the Aims, Desires and Perceptual Landscapes of the Non-Human

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Abstract

Artists and researchers work with living and semi-living organisms for many reasons. In 2004, the artist and theorist Roy Ascott coined the term "moist media" to represent the convergence between dry computational systems and wet biological processes. Ascott saw moist media as a way of extending the sensorium of the self. Some makers may utilize these materials to explore issues in the anthropocene that are faced by humans and non-humans alike, while others may be motivated by the aesthetics of life itself.

What do these artworks, studies, and designs tell us about the aims, desires, and perceptual landscapes of the non-human? This panel will explore sentience in our companion species through the work of five contemporary new media artists working with living and semi-living organisms.

In their presentations, these artist-researchers will share what they have learned about sentience in other species from working in a non-anthropocentric framework. The panel will also consider the issues involved in collaborating with life, animal rights in the studio, and what our companion species can teach us about living systems.

Keywords

Sentience, anamality, non-anthropocentric design.

Small But Not Stupid: Alternative Ontological Visions at the Intersection of New Media Art, Cybernetics and Non-human Organisms

Carlos Castellanos

While still controversial, notions of cognition, sentience and intelligence in "primitive" microbial organisms such as bacteria are increasingly gaining acceptance in the scientific community. [i] Yet at the same time, there is a kind contradiction here, as modern science and engineering do not place very much significance on the *agency* of these organisms. The world of mainstream science is (at least in theory) a fully knowable place. This world is turned into scientific representations. These representations are then used to dominate and control that world. [ii] The agency of matter and microorganisms is barely considered. Emergence disappears. This dualist ontology that separates people and things has a certain rational clarity but it has also proven to be quite destructive. So what is the alternative? I will argue that many contemporary new media artists working with living and semi-living organisms present us with a different ontological vision. One where we know the world through experience and performative engagements with non-human life. This is similar to what Andrew Pickering describes as the "nonmodern" ontology of cybernetics. [iii] A vision of the world as one of continuously interacting adaptive systems in perpetual states of becoming, characterized and brought forth via numerous and complex relations of alterity. In this panel presentation, I will discuss how the work of various new media artists

(including myself) who are working with living organisms and engaging with science and technology while also challenging its prevailing ontology. These works are not static, finished artefacts, but systems that foreground unpredictable emergence and dynamic interplay among numerous heterogenous agents (microorganisms, humans, intelligent machines, etc). We can identify 3 primary characteristics in these works: (1) behavior that is not determined in advance, (2) the work is constituted both from and as adaptive and emergent processes (thus making it inherently "time-based") and (3) the primary vehicle for this dynamic emergence is the agency and adaptive behavior of non-human living organisms. Often works utilize so-called primitive organisms such as bacteria and slime mold – showcasing their strange and complex intelligent behaviors and thus (I will argue) raising their ethical and ontological status.

As Pickering notes, this paradigm "fit[s] exceedingly badly into the paradigm of modern science". [iv] But it does fit quite well into the cybernetic paradigm. These works essentially share the same ontology of becoming as, for example, the work of cyberneticist Gordon Pask, who advocated for a nonmodern "cybernetic method" of maximizing interaction with an observed system to attain knowledge as a "participant observer", as opposed to the traditional scientific method, where interaction is minimized. [v] Here then we have the possible ingredients for "an alternative art-science formation in which the arts and sciences of unknowability genuinely hang together". [vi] More broadly, these works may be characterized as engendering perceptual shifts with regard to the divide between humans and nonhumans, system and environment, observer and observed. They present possibilities for new zones of negotiation and reciprocity between human and non-human subjectivities. Primitive, non-human life are presented not as passive and malleable but are in fact lively and dynamic, with agency and "umwelts" of their own. As these works suggest, a myriad of alternative possibilities for human-non-human relations are possible. With this in mind, I will conclude my presentation by introducing a provisional framework for multi-species computer interaction based on these ideas.

Trans-Species Collaboration and Sentience in New New Media

Elizabeth Demaray

In this presentation, I will address sentience in the non-human by considering a series of artworks that I have authored that focus on the aims, desires and perceptual landscapes of the non-human. These projects are unified in their use the framework of a biotope, which is a small environment or community of life forms that may include humans. These works also involve the concept of trans-species giving, which is the idea that the commonalities among life forms are such that we may actually be able to give another species a hand up. Lastly, all these interactions are examples of non-anthropocentric design, being that they do not benefit, engage, or address humans in a utilitarian way.

In this vein, I fabricate alternative forms of housing for hermit crabs, program listening stations that play human music for birds, design feeding sites for urban ants that are malnourished due to processed human food, and build robotic supports that allow potted plants to freely seek sunlight and water in a domestic environment. Key to these attempts at design from a non-anthropocentric perspective is the work of biologist Jakob von Uexküll. In 1909, Uexküll proposed the concept of an *Umwelt*, which represents each organism's perceptual filter. The Umwelt for one of our companion species may be radically different from the one that most humans experience.

The work *PandoraBird: Identifying the Types of Music That May Be Favored by Our Avian Co-Inhabitants* speaks directly to the Umwelt of wild feeder birds in an environment populated by humans. A collaboration between myself and the Art and Artificial Intelligence Laboratory at Rutgers University, this mobile outdoor learning system employs a novel algorithm for species identification, plays avian-favored human music, and builds a database of the compositions that local feeder birds may prefer.

This project acknowledges that birds in urban settings are routinely bombarded by human noise and that many avian species pay attention to it. In the U.S., cat birds and mockingbirds replicate sounds made by people. In Australia, the lyre bird learns human tunes and teaches them to successive generations of its young. However, no one has studied what kinds of human music our avian companion species might enjoy. This piece addresses this void in our knowledge by creating a cyber-physical system that utilizes computer vision, machine learning, and design for the non-human to create an interactive experience for birds. The long-term aim of this work is to build a system that can log each newly identified bird species as a "user" at Pandora Radio, allowing this non-human life form to utilize a human AI system to track its musical preferences. While *PandoraBird* aims to identify which human music different birds might prefer, its ultimate goal is to create an interface that empowers birds to select the kinds of music played in our shared environment.

While the *PandoraBird* listening station features birds that we can readily identify, *Communis Spatium* addresses the needs of the tiny, often overlooked pavement ant. Research from the Amy Savage Lab at Rutgers University has shown that ants in urban spaces exhibit "urban ant feeding syndrome," which means that they are more aggressive and irritable than their country-dwelling cousins. This is because city ants must survive on "bonanza" food supplies, items that people discard in urban settings such as pizza crusts, hotdog buns, and soda pop. Rarely do these dropped food items include meat or healthy fats. These urban ants are so

starved for protein that they attack and eat most other environmentally beneficial insects in their surroundings.

To alleviate this poor diet, the *Communis Spatium* project proposes that city dwellers adopt a local urban ant colony. This involves feeding them healthy food at outdoor sculptural installations. These specially designed sites offer and architecture that can be shared by ants and humans alike. Non-ant participants are also encouraged to use a specially designed ant feeding app, where they can carefully log their donated food items.

The last example of non-anthropocentric design that I will share is a system that I co-authored for potted house plants. Titled *The IndaPlant Project*: *An Act of Trans-Species Giving* it is designed to facilitate the free movement and metabolic function of ordinary houseplants. This project has successfully created a community of light-sensing robotic vehicles**,** or floraborgs, each of which responds to the needs of a potted plant by moving it around in three-dimensional space in search of sunlight and water. Currently housed in the School of Engineering at Rutgers University, this community of floraborg's spend each day searching for spots of sunlight in the building's corridors. When the plants are thirsty, they gather at a hallway drinking fountain and wait for a passerby to give them a drink. The project is now proposing the creating of a cyber physical interface that will allow for greater communication between each plant and its robot support. This system may, by extension, pave the way for greater communication between humans and plants.

Figure 1: Cropped image of bacteria sampled from fermenting vegetables growing on blood agar, from *Fermentum,* Tyler Fox

Reticulating "Umwelts"

Tyler Fox

Gilbert Simondon proposes that key spaces of power—the heart of a thick forest, a mountain peak with a stunning view—are the seed of art and technicity. These "key-points" work as a vast network around the planet "commanding over the man-world relation, in a reversible way, for the world influences man just as man influences the world." Simondon argues that in the twentieth century this network is not just natural locations, but actualizations of an "insertion of human effort" in the world. Together, human and natural made artifacts and locations structure our experience of the universe. Art is, he argues, a continuation of experiential key-points: bundles of intense affective experience. Simondon's limitation, I would argue, is an overemphasis on human experience of key-points. How might such an understanding of nonhuman experience shift our understanding of our shared universe? How might we understand human and nonhuman experience as different points in this network of key-points, and what might we do to foster an understanding of reticular, experiential milieus? How might an intensification of affective experience bridge the lived experience of humans and nonhumans? How might technicity, the relation between humans and technology, be considered as an expansion of our umwelt beyond human experience? In this presentation, I will draw upon my own art practice to explore and expand upon these ideas, extending the questions rather than answering them definitively.

Symbiotic Intertwining from Parasites for Symbionts

Ken Rinaldo

The intersections where the machine, animal, plant, bacteria, and humans meet are where our futures exist. Three decades of creating interactive robotic art have taught me that living systems provide the ultimate models of what technology can become. Communication is at heart of my work with a desire to break down and reveal behavior, processes, and patterns inherent in natural and now semi-living species. My work exposes the underlying beauty inherent in this intercommunication of all species (organic and machinic) at all scales. As anaerobic bacteria receded to our stomachs 2.5 billion years ago, now symbiotically intertwined with our survival, so too are retreating into a comfortable embryonic sac, enveloped by our technologies. A new emergent species, neither human nor machine, is emerging, and we are becoming and have become symbiont. Still, technology presents social and environmental challenges and evolves more quickly than the biologically intertwined natural living system can coevolve. This talk offers observations and solutions, on where we are heading, with technologies that at times seem more parasitic than symbiotic.

Becoming Biodiversity: upgrading your human reality

Amy Youngs

Can our smartphones connect us with multispecies worlds? Will we learn to participate as better citizens in the ecological commons? Becoming Biodiversity is an augmented reality art app that encourages participants to explore and experience the world of non-humans present in an urban park space. Mixed-reality animations and storytelling are experienced as an overlay to the actual park as a method of embodied engagement. The participant re-enacts stories from the perspectives of non-humans; playing the part of animals, plants, and fungi as they move along the trail. Inspired by the work of Thom van Dooren and Deborah Bird Rose on attentiveness and the non-human storying of places, I sought to enmesh the viewer in a place as it might be experienced by important actors within our shared world. Though I cannot truly know the perspectives of other species, speculative narratives do offer a way to intentionally engage them. The stories enacted by participants of Becoming Biodiversity may be characterized as anthropomorphic, and the technological format questioned; nevertheless, these techniques are employed to redirect attention towards non-humans, with the hope that we may begin to take their worlds seriously.

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Human Collaboration & Machine Generation Across Media

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Abstract

Our panel explores machinic sense and sensibility through a discussion of our joint work on generated media systems. The three of us have been collaborating in various ways for the past 15 years; We all three worked together to create the combinatorial video artwork *Three Rails Live* in 2013. We will discuss how we have worked together to develop simple but culturally meaningful systems that generate combinations of language, images, and sound. Rather than trying to produce systems that mimic human intelligence or pass as human, we have created systems that perform the basic functions that computers can do well: Manipulating symbols and drawing from distributions. In doing so, we have relied on each other's human sentience to collaboratively develop voices and visions that are overtly machinic, but which work to exchange and arrange human visual and textual elements.

Keywords

Generative art, machine voices, code, combination, collaboration

Introduction

Over the past 15 years, media artist Roderick Coover, computational poet Nick Montfort and electronic literature author Scott Rettberg have collaborated in different configurations on multiple experiments in automatic generative expression in a series of computer-driven works engaging current ecological crises through computational systems. In this panel, these three artists, whose main focus is video art (Coover), small-scale poetry (Montfort), and larger-scale narrative (Rettberg), will discuss how they work collaboratively to help develop a machine voice, and machine visions, that proceed from simple but significant computer-driven combinatorial generation of media elements. They use these systems to shift the language addressing contemporary issues such as climate change and fundamental questions of language, expression and meaning.

Coover, Montfort and Rettberg first collaborated on the generated video artwork *Three Rails Live* (2013) [1], in which prose segments, video clips, and even the beginning and end of the titles of different segments are put together as the piece runs. They have each collaborated with each other on several other projects as well.

To highlight just those works that involve generative media production: Montfort's generated Web poem "Taroko Gorge" (2009)[2] was modified by Rettberg to become "Tokyo Garage" (2009)[3], leading to an extensive series of dozens of modified versions of this poetry generator by others. This phenomenon, derived from a simple poetry generator and a playful hack, has subsequently resulted in the "Taroko Gorge" generators becoming some of the most frequently cited works of electronic literature. Coover and Rettberg developed the recombinatory, narrative climate change film *Toxi•City: A Climate Change Narrative* (2016)[4] and also collaborated on *Penelope* (2018)[5]. Most recently, Coover and Montfort collaborated on 360 video and 4-screen performance *The Altering Shores* (2019, with music by Adam Vidiksis)[6]. The three have collaborated on other projects that involve the exchange of, response to, and revision of media elements, including the experimental, fragmentary novel *Implementation* (Montfort & Rettberg, 2004, 2012)[7], a set of four one-minute video pieces, *Currency* (Coover & Montfort, 2007)[8] and the video installation, *Fathoms* (Coover & Montfort, 2007) [9].

Figure 1. Generative text is layered on combinatory video imagery in this image of kayaking in petrochemical industrial infrastructure on the Delaware River in *The Altering Shores.* Image © Chouette Collective LLC.

Generative & Combinatory Works Discussed

The following four works will be at the center of this discussion, *Three Rails Live* (2013), *Toxi•City: A Climate Change Narrative* (2016)*, Penelope* (2018) and *The Altering Shores* (2019).

Three Rails Live is a collaborative work by Coover, Montfort and Rettberg using multiple writing systems and visual systems. Running continuously, the system will, practically, never generate the same narrative in the same order twice, but never-theless produces a coherent holistic story of a man's late search for meaning among the detritus of his life and environment. The three collaborators put the system together working remotely, while in frequent discussion, exchanging both media elements and code.

Figure 2. Technological constructions of meaning combine in differing visual, narrative and poetic systems in Three Rails Live. Image © Roderick Coover, Nick Montfort and Scott Rettberg.

Coover sent a selection of short video clips and images to Rettberg and Montfort. Rettberg viewed the clips and sorted them arbitrarily into themes (Landscape and Fate, Tourists, Death by Snake, Industrial Sites, Trains, Flood, Toxic, Flight, Stripped, and Third Rail), wrote short three short narrative segments for each theme, and then recorded readings of each of these narratives. Montfort selected particular images, and, inspired by a concept developed by Harry Mathews, wrote "perverbs"—remixes of two different proverbs that subvert the original—for each of the texts paired to an image. Montfort also constructed a title gener-ator that arbitrarily creates a title for segment of the work as it runs.

The system the authors constructed selects two image sets and two of the narrative recordings from a constrained random selection. A perverb with a moral to the story is then assigned and the process begins anew. The system thus results in short narrative videos with new juxtapositions of images, texts, and perverbs each time it runs. All of the texts and images emerge from this aleatory but thematically determined method.

Toxi•City: A Climate Change Narrative is a combinatory work by Coover and Rettberg. It is focused on six characters whose lives have been transformed by sea-level change and flooding in the industrialized region of the Delaware River Estuary. Fictional testimonies are set against actual accounts of deaths that occurred during Hurricane Sandy. In this database narrative, as some stories seem to resolve, others unravel, and individuals grasp for meaning from fleeting conditions of a world in flux.

Figure 3. In *Toxi•City: A Climate Change Narrative,* Coover and Rettberg building upon research into energy infrastructure and sea-level rise floods to present a combinatory work in which narrative approach resolution between the systems tares them apart and starts afresh. Image © Roderick Coover

The system is used to provoke questions as to how conditions of life would change if repeated storm surges and tides flooded the densely populated lands with toxins from the hundreds of sea-level petrochemical industry sites and post-industrial brownfields.

The fictions are interspersed with nonfictional accounts of deaths that occurred during recent storms in the area, most notably Hurricane Sandy. The narrative events are drawn from actual events and predicted conditions faced in the Delaware River Estuary as well as events along the nearby coastal shores of New Jersey and New York. Other collaborators include the actors Kamili Feelings, Alice Gatling, Dan Kearn, Marianne Rendon, Chris Monaco, Jason Marck.

Figure 4. Algorithms in *Penelope* bridge historical and contemporary themes of longing, mass extinction, and migration. Image © Alejandro Albornoz. Roderick Coover and Scott Rettberg.

Penelope is a combinatory sonnet generator film based on Homer's *The Odyssey* that addresses themes of longing, mass extinction, and migration, which are not simply relegated to the past. Using a similar combinatory structure to that of Raymond Queneau's Cent mille milliards de poèmes, the computer-code-driven combinatory film can produce millions of variations of a sonnet that weaves and then

unweaves itself, mixing video, sound and text. Re-combinations of lines of the poem, video clips, and musical compositions produce a different version of the project on each run.

Penelope was co-produced by Alejandro Albornoz (Sound), Roderick Coover (Video), and Scott Rettberg (Text and Code). Other contributors to the project include Kristiansand Symphony Orchestra oboist Marion Walker, voice actress Heather Morgan, and actors Helen Amourgi, Kostas Annikas Deftereos, and Sophia Kagadis in non-speaking roles. The video and the text were developed by Coover and Rettberg during 2017 residencies at the Ionian Center for Arts and Culture in Kefalonia, Greece. Kefalonia is reputedly the historic home of Homer.

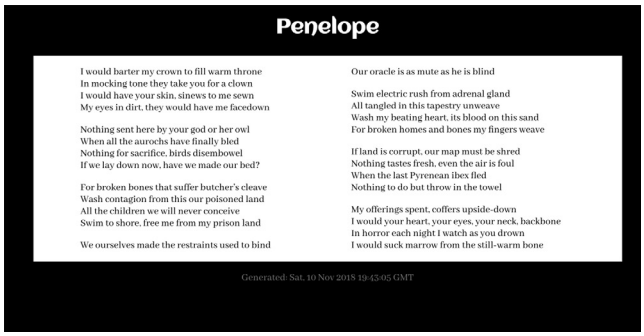

Figure 5. Each cycle includes the presentation of the generate poem. Image © Alejandro Albornoz. Roderick Coover and Scott Scott Rettberg

The Altering Shores is a collaboration between Coover, Montfort and composer Adam Vidiksis. The generative system creates a continually evolving stream of text that forms the horizon line in an immersive cinematic experience. Set in the marshlands and industrial wastelands of our local Delaware River watershed and others worldwide, the experience presents a kaleidoscope of climate futures through fragmented language and multi-layered sounds and images.

The Altering Shores, Montfort developed a poetic text generation systems that expresses the challenges of articulating the unfathomable threats of extinction, annihilation and erasure brought about by the climate crises. Through repetition, variation, and weighting, barely recognizable words and short phrases take shape briefly. For the most part, these rush past quickly and can only be glimpsed and partially recognized. Levels of the textual flow range from "bubbles" that consist of only 'o' in uppercase and lowercase through the complex chemical names of pollutants.

Coover's 360 imagery of kayaking along shorelines is interwoven with abstracted imagery of infrastructure, shipping, beacons such as lighthouses, and murky waters in which float torn photographs and memory images. As the work hones in on particularly sites of catastrophe, waters rise, and in the murky mix, much of it filmed underwater, language mixes with debris. The sound is composed by Adam Vidiksis (Temple University) for electronics, vocals, and trombones. Some human voices uttering the text are transformed into the machine sounds of water industries, submerged pipes and tankers and other texts are transformed into coded signals such as Morse code, evocative of the observations and a state of emergency, The resulting work explores the evasive and perhaps unspeakable threats that climate change poses on human existence through fragmented language, multilayered sounds and images recorded in the marshlands and industrial wastelands our local watershed and others worldwide.

Figure 6. In the live performance of *The Altering Shores,* generated text layers project across performers as they regard the video images of a landscape being submerged in the terms of chemical contaminants. © Chouette Collective LLC.

The collaborators will discuss how these artworks employ strategies of code and multimodal collaboration to surface simple but still important types of machine sentience, and to reframe meaning-making systems. They will also describe how their collaborations proceeded. Their work involved defining collaborative processes, producing and revising media of different sorts, and defining machine processes. The types of constraints and procedures used to shape a collaboration among people are significantly different from those used to instruct the symbol-manipulating computer and are worth comparing in detail. Ultimately, as this group of artists sees it, the machine's sentience, or rudimentary cognition, the means by which it selects and arranges media elements, was another element for discussion and exchange among human collaborators, rather than being an additional participant in the artmaking process. In these works, the machinic intervention serves as a structuring element, a trope, and a means of offering alternative versions of texts, stories, poetry, film, and music to the reader, viewer, listener or interactor. While these works are very much human-authored in comparison to poetry generated using neural networks, computation plays a significant role in audiences' experiences while giving the collaborating human element a greater degree of control over the user's experience of the work.

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The ocean that keeps us apart also joins us: charting knowledge and practice in the Anthropocene.

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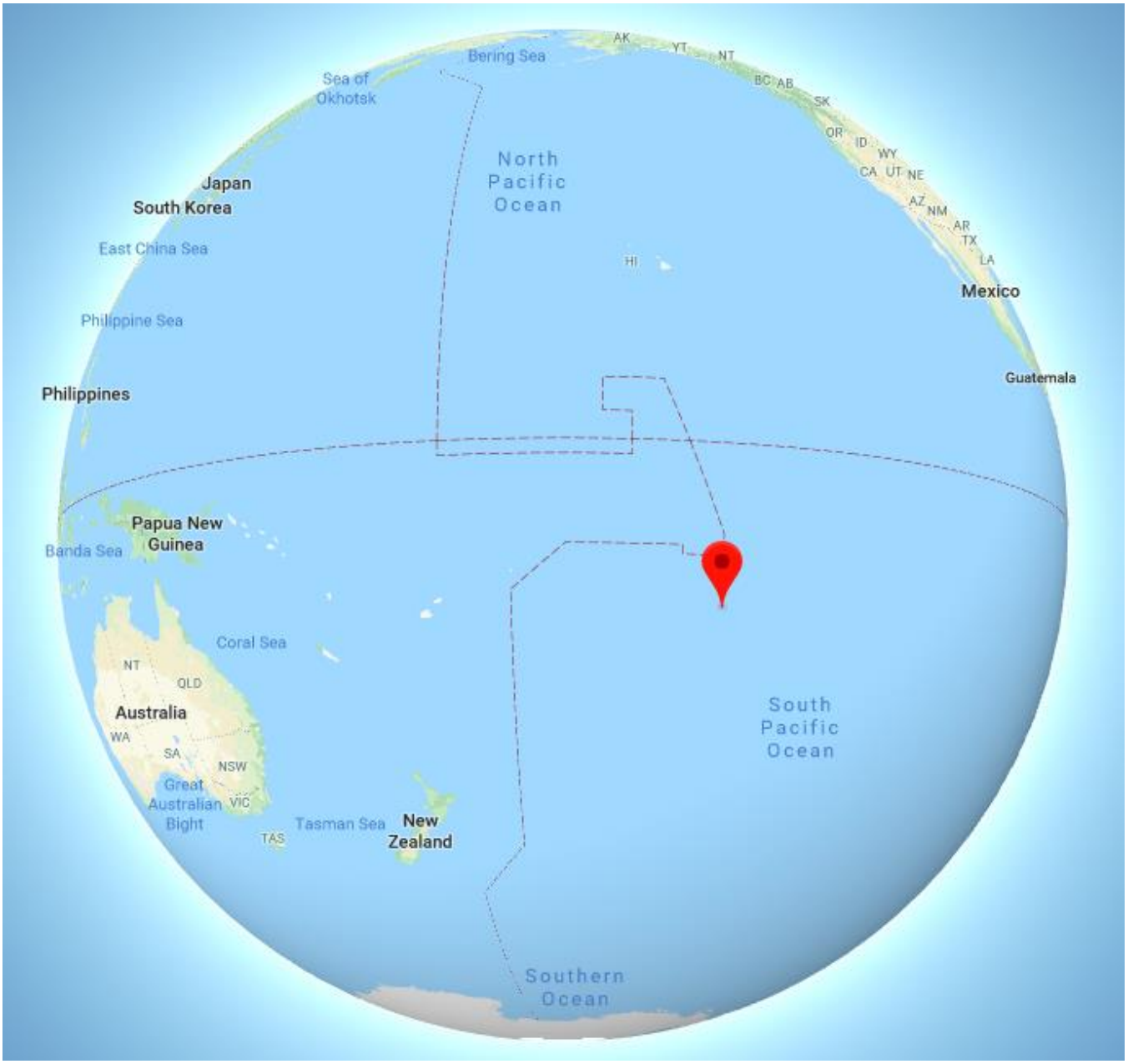

Figure 1. Google spherical projection map of the Pacific Ocean Te Moana Nui a Kiwa with Tahiti marked.

Abstract

This panel consist of five experts who have collaborated across hemispheres of Earth in the context of environment. Collaboration has become increasingly common over the past 15 years, to now being a pre-eminent form of creative practice. Over the same period, the human connection to climate change has moved from being predominantly known in academia, to a situation where the climate crisis is widely acknowledged intergenerationally and across most mass media. This development has forced a revision of knowledge and theory, led to engagement with indigenous peoples and new sites for projects. The notion of the constitution of a sentient human being has changed, in particular moving out of solely Western conceptions. These forces have led to an activist reorientation in creative practice, with ramifications for art, society, humanity and Earth which together lead to a re-shaping of language.

Keywords

Climate crisis, intercultural, interdisciplinarity, intergenerational, indigenous, new knowledge, art, science, culture, technology.

Introduction

The panel will first sketch changes to the role and prominence of collaboration in practice, illustrated by reference to project activity. An awareness of art and science will then be introduced with reference to the work of David Bohm. The conception of life on Earth as an integrated whole forms an important connective point to the philosophies of indigenous peoples and is a foundation of contemporary sentience.

This will be followed by an introduction to associated changes in theory and knowledge. From this basis, engagement with indigenous groups in project activity will be scoped, with particular reference to previous ISEA exhibitions.

A change in philosophy as a result of the Anthropocene will be discussed along with a range of projects that engage with art, science, culture and technology with particular focus on the environment and activism as a basis for projects. The focus of the discussion will then turn to language, its role in shaping climate and the world, and the emergence of a new terminology geared to post-ecological scenarios, encompassing both organic and non-organic worlds and dimensions.

2004– 2019: collaboration

The first panelist will discuss changes to the role and prominence in the past 15 years. In essence there has been a transition from informally arranged collaboration at events such as Polar Circuit and Solar Circuit. In these collaboration interests in art and science were melded based on the sensibility of those co-located.

A trope in regard to cross hemisphere engagement was already set in place at this time, largely due to the commitment of participants. Since that time, project based activity around art-science collaboration has become a feature of calls to action: the deliberate framing of issues and projects around art-science interactions.

In the context of knowledge, an important step outside of disciplinarity has taken place at this juncture. In 2004, most academic institutions were divisively split between disciplines, where the art department almost never engaged with the science department. While this remains the situation in many institutions (not for want of trying) it has mainly been left to interdisciplinary research centres to pick up on the thrust of interdisciplinarity and engender projects across disciplines though often away from the campus context.

While commonly art and science were considered at opposite ends of some kind of knowledge spectrum, there were figures with a deeper awareness that foregrounded art-science interaction such as the scientist David Bohm among others. This introduces to the panel discussions, notions of interconnectedness and trans-disciplinarity.

Presently cross-disciplinary teams connect from remote locations and collaborate in hybrid environments. Within the process of these collaborations many questions emerge such as how is the most important element defined in such collaboration? Are there any rules? Is there an applicable methodology? How are cultural differences approached? How are the underlying artistic, social and political motivations defined? While extensive flexibility, modularity[1] and mutually satisfying professional and personal relationships seem to contribute to the ultimate success of the collaborative process many of these questions remain unanswered.

2004 – 2019: theory

If the silos of disciplines are discarded, the consequences for knowledge are significant as categorization was previously the fundamental premise for knowledge acquisition by research.

Importantly, when disciplinarity is dissolved, so too is the notion of knowledge as independent of culture. This is largely a Western colonization of thinking where the basis for knowledge acquisition is logic, rationality and propositional exploration followed by research and proof. That approach effectively privileged Western knowledge over that of cultures outside of the Western European cultural hemisphere. This was sufficient to discount other forms of knowledge acquisition and excluded the knowledge base of indigenous and ethnic minorities.

Interconnectedness and transdisciplinarity generate a new condition of sentience upon which knowledge is based and language is constructed. The Anthropocene imposes a reflection about the time span of the species and cultures in contrast to that of individuals. The Climate crisis implies a cognitive leap, a vision extended to a future that must be

attempted to govern, although we will not be part of it. The challenge is going beyond the generational time, into an expanded and intergenerational dimension that overcomes the biological lifetime of many. It also implies a different vision of humanity and its relationship with the "non human" and the environment, as a complex dynamic intercourse among different cultures, towards a further level of awareness in a sort of new pact with the existing.

On these topics the art*science project has activated a three-year research program (2018-2020) on Climate Change, with conferences, exhibitions and projects. Art and science can collaborate in order to reflect on the present and to imagine the future, bringing together cultural institutions, scientists, artists, researchers to focus on environmental transformations and their geographical, ecological, economic and cultural impacts. Until now four events have been organized (Cervia, Rome, Urbino and Bologna), and some are in preparation.

ISEA 2004 – 2019 and SCANZ 2006 - 2018: engaging indigenous and ethnic minorities

In contrast to conventional compartmentalized Western worldviews indigenous cultures across the world focus on a holistic understanding of Nature based on thousands of years of traditional experience - David Bohm, a noted physicist and originator of the casual interpretation of quantum theory, challenged established notions concerning the nature of reality and the order of the universe in his publications including Wholeness and Implicate Order (1980). The endorsement of the holistic nature of the world by David Bohm became an essential scientific argument.

At ISEA2004 which occurred in Helsinki, Tallinn and on a cruise ship between that sailed via Stockholm, there was a project that attempted to connect both local ethnicities and hybrid Polynesian cultures through the development of the constitution of Leistavia, a portmanteau of Lei and stavia. The former is well known in Polynesian as a flower garland worn around the neck, which is also found in India. Stavia is a common suffix to place names in the Baltic and surrounding areas.

The resultant constitution bore hallmarks from The Estonian constitution post Eastern bloc, and a unique cultural context in Polynesia – the 1838 Laws of Pitcairn Island, which gave all over 15 the vote (i.e. women were not excluded), protected cats and called for a Meritocratic Head of state. Ecological sustainable values were overwhelmingly voted for by the majority.

By *ISEA2011:Istanbul*, a multicultural approach involved the indigenous people of Aotearoa New Zealand as part of the core concept and exemplars of a curated exhibition within the overall ISEA shows. *Te Kore Rongo Hungaora* incorporated a chart of Te Taiao Māori, the Māori universe.

Then at *ISEA2012:Albuquerque*, the Māori conception of Wai or flow dominated in a curated selection of projects. At the request of the kaumatua guiding the project Dr Te Huirangi Waikerepuru, this project involved local indigenous Dineh-Navajo.

Subsequently at *ISEA2019:Gwangju*, video works crossing the art-science and intercultural border were exhibited. These were based firstly on scanning a painting by contemporary Māori artist Wharehokasmith which was then converted to audio; the audio was then converted using generative video software. This created a video-audio art work.

In between these exhibitions SCANZ residency, workshops, exhibitions and hui (symposia) events took place every two years in cultural partnership with Te Matahiapo in Aotearoa New Zealand. The basis for this cross cultural engagement was the consideration that part of the solution to climate change entailed involving the voice of indigenous peoples. This is an alteration of the sentient mind, and is a key driver to the current condition of knowledge.

*SCANZ2015:water*peace* attracted indigenous peoples from Aotearoa New Zealand, Canadian Inuit and Vanuatu, with core events at the historic settlement Parihaka. This developed into events in partnership with Maata Wharehoka, a Kaumatua (elder) and Kaitiaki (guardian) of one of three Whare Nui (meeting houses). *Water, Peace, Power 2016* attracted the participation of a representative of the Yorta Yorta people of Australia who collaborated with Australian artist Tracey Benson. It also folded in low emissions technology as an element of projects in a direct statement about the environment. *SCANZ 2018: He Punawai Hohourongo Pace, Water, Power* saw the location of the entire residency, hui and workshops at Parihaka, with Nina Czegedly co-ordinating Roger Malina Skyping into the Whare Nui Te Niho o Te Atiawa, meaning he spoke in a room containing images of ancestors and family of the people of the house. Residency workshops and hui at Parihaka are in total contrast to conventional exhibition and symposium venues, and facilitate engagement with the community in ways no conventional exhibition could.

Salty Reflections across spaces and seas

Salt is a common and simultaneously precious substance, essential to the growth of life, yet able to destroy life; symbol of economic wealth and able to trigger environmental decline ...salt has many functions: not only do they differ radically, but they are also often located at opposing ends.

During *Art*Science 2018*, a group of international artists and theorists converged in the city of Cervia, a popular seaside destination with an interesting history and architecture located on the North East coast of the Italian peninsula. The city is crossed by a canal connecting the sea to a small sized salt flat reservoir, which doubles as a conservation site and one of the major tourist attractions of the region.

In the Cervia context, salt is an important metaphor, it is the symbol of a delicate balance between conservation and tourism. That is, it stands at the cusp between the desire to preserve a very delicate and rich natural reserve constituted by the "Saline" and its surrounding territory, and the need to manage its tourism. The latter is a threat to this equilibrium. However, it also acts as an incentive to its preservation. The "Saline" (salt flats) constantly evoke the labor of the

"salinari". Remembering this tradition is very important : it is not just a source of entertainment, but also brings back the ephemeral memory of a past long gone which will likely be forgotten soon.

Because of the fragile relations between tourism and conservation, nature and artifice, sustainability and wealth that it is able to evoke, "salt" is an ideal catalyst to initiate dialogues about climate change and across different contexts. The installation "Creating and Destroying: salty reflections" by panelists four (ITA CAN) and Elaine Whittaker (CAN), was created as a piece able to connect the above narratives through the properties of salt and the "salt flats" as complex ecosystems.

For those who want to listen, the objects comprising this installation also reflected a series of contradictions calling for dialogues, questions, memories. Their function was evocative, rather than pedagogical.

The event also enfolded a cross hemisphere session connecting Cervia to Ngamotu New Plymouth in Aotearoa New Zealand as part of the exhibition *Art-science + environment* curated by panelist three.

But the goal was to think past salt and the saline. When located in the context of climate change, it asked the following questions: Is it possible to preserve both Saline and Tourism simultaneously? Is it possible to remember and recreate the past. In spite of, or as an opposition to the environmental industrial and economic changes that have transformed our world in the past several years?

2004 – 2019: engaging language in post-ecology scenarios

The fifth panelist will discuss the role of language in shaping the world, with a particular focus on climate and post-ecological scenarios and the emergence of a new terminology to describe them. Language - be it oral, written, genetic or algorithmic - is embedded in ancestral forces which give it the power to materialise anything that is part of the world as we conceive it, reconfigured into cartography, human species, artificial intelligence, geography in the broadest sense. Taking these considerations as its premise, and with the support of works produced at the intersection of art and science, the discussion will examine new or re-defined terms related to the post-Anthropocene era. Each of these is a tile in the mosaic that re-draws the outline of our contemporary landscape, with its constantly-evolving forms of interconnection between humans and non-humans. The debate overall expresses the urgent need to introduce a new terminology in order to attune to this newly-discovered scenario, where possible shaped by a combination of local tradition and globalized knowledge, and encompassing both organic and non-organic worlds and dimensions.

Author Biographies

Nina Czegledy is an independent media artist, curator, and researcher with international and national academic affiliations is based in Toronto, Canada. She collaborates on interdisciplinary projects internationally.

Pier Luigi Capucci is an Italy-based researcher, academic and EU consultant on art/science/technology. President of Noema and founder of art*science-Art & Climate Change project.

Ian Clothier has exhibited in public space 107 times in 15 countries including six ISEA exhibitions, as artist, curator and events producer. Primary works have involved engaging with art, science, culture and technology frequently with indigenous peoples and in the context of environment.

Roberta Buiani is a researcher, activist and media artist based in Toronto working at the intersection of science, technology and creative resistance. She is co-founder of the ArtSci Salon at the Fields Institute for Research in Mathematical Sciences and is program advisor for the Subtle Technologies Festival.

Since 1999, Elena Giulia Rossi has expressed her research throughout writing, curating, teaching, based on exploring contemporary art and its relationship with science and technology, from a socio-anthropological perspective. She is founder and editorial director of Arshake. Reinventing Technology (www.arshake.com).

Kinship and Disembodiment in Mediated Cloud Spaces

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Abstract

This panel explores the idea of human and machine sentience as they pertain to art practices. Sentience makes new media art unique because it is a pathway to a different understanding and approach to time, space and the body. But, is machine sentience the same a biological sentience?

"From the Orrery to the Cloud: Precursors and Foundations of Sentience in New Media Art" is a reflection by Steve Daniels on how the history of technology and media systems and corresponding shifts in cultural metaphors interact to create artworks that make meaning through sentience.

"Mediated Networked Selves - New modes of Human and Machine Sentience?" is an exploration by Alexandra Bal of the historical roots of cybernetic, telematic cultures in order to ascertain how new modes of human and machine sentience currently emerging are an evolution of our culture. She discusses the potential dangers of a world where machines and embodied sentience are incomprehensible to disembodied humans.

Lila Pine explores Go'gmanaq which examines our kinship with new media technologies.

In "Creature Quality in Kinetic Art" Kathleen Pirrie-Adams shows how the behavior of kinetic art moves the audience away from the field of vision into a phenomenological field of experience. It explores how movement invites identification and establishes the 'creature quality' of human-made entities.

Keywords

Embodied, Kinship, Sentience, New Media Art, Media Frenzy, Cloud Thinking, Rational vs Sentient, Emotions.

Introduction

What the heck is a sentient machine? Is it the same as a thinking one? Can machines feel? Can they think? What characteristics do machine sentience and biological sentience share? What is a sentient artwork? When Indigenous people utter the expression "all my relations" who/what are they referring to? How does language inform our understanding of relationships? How does the behavior of kinetic art interact with human behavior? These are some of the questions this panel will explore.

From the Orrery to the Cloud: Precursors and Foundations of Sentience in New Media Art

Sentience is a fundamental aspect of the creative work I have produced for the last 15 years. In this panel contribution, I will reflect on how the history of technology, resultant media systems and corresponding shifts in cultural metaphors, [1]interact to create space for art works that make meaning through sentience. [2]

Artists who create works that employ sentience, as a core mode of meaning construction, employ unique relationships to time, space, technology, culture and even other forms of media.[3] I will suggest a timeline of technical, cultural and media innovations that landmarks revolutions from the orrery to the cloud as a way of reflecting on antecedents and emerging ideas that make sentience in art possible. [4], [5]

Looking at Canadian New Media artist works from the late 1960's to today I will explore and question how technical shifts that began centuries ago inform and oppose the contemporary language of sentient media art.

Mediated Networked Selves - New modes of Human and Machine Sentience?

Sentience is a form of sensory awareness deeply embedded within our bodies. It is demarcated by our relationship to space, which plays a much more fundamental role in perception, identity formation, and consciousness, than we tend to realize. [6]

Contemporary western tools of perception have adapted to a human consciousness that exists in hybrid techno-natural spaces. [7] As we increasingly co-exist with machines, our notions of identity and perception have shifted to include them in the landscape of our realities. [8]

I will retrace how our current mediated networked selves are the result of telematic and cybernetic cultures that emerged with the first humans. Additionally, humans have been fascinated with the idea of machine sentience since antiquity, if not earlier in the east. [9]

As machine learning advances, machines are exceeding humans at some mental tasks. [10] Does this mean that machines have sentience? And, is machine sentience the same as biological sentience? And will humans ever be able to perceive machine sentience? [11]

In the case of humans, sentience is intricately connected to the senses. Thus, it is embedded in the body. Machines, on the other hand, use technological sensors to provide information to their AI. Their embodiment is not the same as ours, nor is their thinking process. As we coexist with machines, are machines and humans evolving into different types of consciousness? [12]

As most urban humans use technologies to read the terrain of data embedded in augmented spaces instead of using their senses, the natural world, which has become incomprehensible to many, is increasingly understood through the lens of mediation and data. What are the potential dangers of a world where machines and embodied sentience are incomprehensible to disembodied urban humans?

Go'gmanaq

I have been thinking about a word in L'nu (the language of my people). Go'gmanaq conveys a notion of kinship that extends to people, animals, plants, and objects considered inanimate to the Western mind [13]. New media, for example, is go'gmanaq. In urban environments, everywhere we go we encounter it. Doors open as we approach them, lights turn on as we enter a room, the stairs move under out feet, "smart" cars take us where we want to go, pacemakers keep our hearts beating. Our new media relations, like all our relations, are always active and acting on our world.

Creature Quality in Kinetic Art

This paper examines how the behavior of kinetic art moves the audience away from the field of vision into a phenomenological field of experience. Making reference to artworks by Rebecca Horn, Theo Jansen and Sun Yuan and Peng Yu, it explores how movement invites identification and establishes the 'creature quality' of human-made entities. It describes the affective consequences of the embodied encounter they occasion in order to draw a distinction between interactive works that serve as reflecting mirrors and those that rely upon choreography to generate empathetic engagement.

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Authors Biographies

Dr. Alexandra Bal examines how sensory culture affects our health. She has done SSRCH funded research focused on the impact of social digital media on children and youth and of violence in social media. Alexandra explores the sentience of native plants through digital photography.
She is currently associate professor in the New Media program in the RTA School of Media, Ryerson University. She teaches courses related to DIY culture, new media art histories and creative processes.

Steve Daniels uses electronics and communication technologies to create hardware agents, kinetic sculptures, ubiquitous spaces and networked events. Through his practice he juxtaposes disparate knowledge systems and experiences in an effort to reveal their underlying structures and assumptions. His works and collaborations have exhibited at the TIFF Lightbox, Ontario Science Centre and InterAccess (Toronto, ON) and were recently included in the MACHines show at the Centre des Arts, Enghien Les Bain (FR), as a part of Eveil/Alive/Despertar (SESC Santana, Sao Paulo, Brazil), TEI'15 (Stanford, USA) and ISEA (Disruption) 2015 (Vancouver, CAN).

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Dr. Lila Pine, of Mi'gmaw descent, is a New Media artist and Indigenous thinker. She is the Director of Saagajiwe, Ryerson's Indigenous Communication and Design network, whose mission is to facilitate the creation and dissemination of Indigenous thought and ways of knowing and doing. The name Saagajiwe, given by an Elder in a sacred ceremony, is an Anishinaabemowin word which means something like the first ray of light.

One of Lila's research/creation projects seeks to develop a way of "seeing" sound in order to identify distinct qualities in the speaking of different languages. It employs digital art creation as a scholarly research tool and it engages Indigenous research methods to shift perceptions around the relationship of language to worldviews and ecological concerns.

Lila is also collaborating with Buffy Sainte-Marie on a project called *Creative Native: Youth Mentorship in the Arts Initiative*, which brings touring multi-arts festivals to First Nations communities across Canada.

She is currently associate professor in the New Media program in the RTA School of Media, Ryerson University where she teaches Indigenous media and new media courses at Ryerson University in Toronto, Canada.

Dr. Kathleen Pirrie Adams is the Chair of RTA School of Media at Ryerson University. She is a curator and media theorist who has developed exhibitions and media programmes for the TIFF Bell Lightbox, Toronto Photographer's Workshop (TPW), the InsideOUT Gay and Lesbian Film Festival, the Images Festival, and the Venice Architectural Biennale. Her most recent publications include a chapter in the *Routledge Handbook of Museum, Media, and Communications* that examines how digital media reframes the core provisions of the museum. Her current research project looks at how amateur experts use online spaces to create 'heritage-at-large'.

Agency & Autonomy: Intersections of Artificial Intelligence and Creative Practice

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Abstract

Arguably, the most important aspects underpinning artistic experimentations in the broad fields of artificial intelligence (AI) and artificial life (A-life) lie at the intersection of autonomy and agency. **Autonomy** is the foundational element of any living system. Defined as the property of being self-determining with no outside control over actions and internal states, autonomy refers to a system's ability to assert its existence and to simply *be*. Through their interactions with their environment, autonomous systems achieve what noted biologist, neuroscientist and philosopher Francisco Varela called the "shap[ing of] a world into significance" [1]. This notion of autonomy as being assertive, ties right into the notion of **agency**. Defined as the ability to take action in the world and influence others, agency is how autonomy is exercised, articulated and maintained, via capacities such as adaptability, viability and sentience. With this in mind, this panel will bring together practicing artists and researchers who will discuss their work through the lens of agency and autonomy. How are AI-based tools and methods such as machine learning/deep learning, evolutionary computing and agent-based approaches currently being utilized by artists? The panel participants will discuss their work and individual approaches to these topics, followed by discussion.

Keywords

Artificial intelligence, machine learning, computational arts, autonomous systems, agency, robotics.

Introduction

Artificial intelligence (AI) and machine learning (ML) technologies have evolved alongside the development of computational systems. Research into computation machines and systems during the years surrounding the second world war had long lasting effects on various fields, and in this initial stage and later, the comparison of computation to the nervous system was being mapped out [2]. At the same time, computation machines developed alongside advancements being made in AI and ML. There have been some slowdowns and obstacles in AI research fields, but research developing AI has been around for decades and arguably perhaps centuries [3]. Recently due to more and more powerful computing capabilities complimented with large amounts of data exhaust, the more contemporary branch of AI has seen an explosion of sophistication in new applications of machine learning, and these technologies are now readily available to researchers, industry, and governments. It seems data has become embedded into every aspect of our lives, and AI is being explored for all kinds of applications and tasks. This explosion of AI and ML has also nudged its way into the discussion around creativity and artistic practice. The creative act is a complex and unique feature of subjective human intelligence. So perhaps this is one reason why creativity has become a target for engineers to set their sights on as a means to develop more sophisticated AI technologies.

In addition, these technologies are being explored by artists and the creative coding community. This raises many questions that this panel will discuss through their research and practice. Mainly, how is AI being applied in various creative practices, and how do familiar questions surrounding agency, authorship, and autonomy in the arts resurface through this new lens of AI. Furthermore, what does it mean that artists and engineers are experimenting with AI tasks that are creative in nature. This leads us to the question centered in this year's symposium – Why Sentience and other questions and topics to be discussed that include (but are not limited to): How are artists thematizing agency and autonomy in their work? How are AI-based tools and methods such as machine learning/deep learning, evolutionary computing and agent-based approaches currently being utilized by artists? What kinds of novel experiences are possible at the intersection of machine agencies and those of non-human organisms? What theoretical frameworks and methodologies can be utilized to properly analyze and evaluate this work? What are the politics of agency and autonomy in AI? The following subsections highlight the diverse ideas and practices of the panelists and each addresses these issues through research, arts practice, and industry experience.

Agencies of Deep Learning Generative Models in Creative Practice

In the last five years, there have been rapid advances in the machine learning branch of artificial intelligence. Specifically, a more powerful machine learning system has moved forward significantly – the type of deep learning called generative modeling. This machine learning model is distinct from its counterpart discriminatory modeling, in that this technology doesn't stop at just being able to classify data belonging to certain labels. Generative modeling has to infer patterns and structures in the data in order to be able to generate or create novel outputs [4]. It is truly a creative AI, and this raises very important ethical issues. In a time when data and information is constantly and simultaneously weaponized or under attack, the prospect of generative modeling raises issues between what data is accurate and what is generated by AI. At the same time, this new technology offers us a unique ability to really question and probe ML and AI itself. Because of how generative modeling must function in order to complete its tasks, it offers a lens into really understanding where the data comes from, how AI works to understand it, and what is the inherent structure of the data.

Figure 1. An image generated by the DeepDream model [5]. Images created and shared on Google Photos by Michael Tyka.

Five years ago, Google published a story about a technique they were developing called "Inceptionism" where the engineers were trying to understand "…what exactly goes on at each layer [within a Neural Network]" [5]. Specifically, the idea is to understand what is really going on with each layer in NN, why and how it works, and what are the properties that drive a model to be a success or a failure. As they were taking this closer look, the engineers came to "one surprise: neural networks that were trained to discriminate between different kinds of images have quite a bit of the information needed to *generate* images too." [6] The model was aptly named DeepDream, and by looking at the properties of the images, one can see the mathematical logic behind their creation: a mash-up of repeating, self-similar, and modular forms. What are the ramifications of a machine or AI as creative agent? The idea of what is an artist and what does it mean to be creative has a long history and has been debated throughout our history of culture and art. One could argue that this idea of machine as artist is simply another extension of this ongoing debate surrounding the artist or author. Rather than these questions, I propose that the more relevant questions are those surrounding how best to leverage these technologies within the creative act and how do these technologies inform our perceptions of the world and understanding of cognition.

While considering biological and technical systems, I will present research and works created through generative deep learning that highlight these issues. N. Katherine Hayles begins to pull apart some of these questions regarding AI, cognition, agency, and autonomy. She discusses 'nonconscious cognition' within biological and computational systems: "Notwithstanding the profound differences in contexts, nonconscious cognitions in biological organisms and technical systems share certain *structural* and *functional* similarities, specifically in building up layers of interactions from low-level choices, and consequently very simple cognitions, to higher cognitions and interpretations." Furthermore, Hayles points out the need to clear away questions regarding thought and cognition (both natural and technical), and "Following from these fundamental questions are further issues regarding the nature of agencies that computational and biological media possess, especially compared with material processes, and the ethical implications when technical cognitive systems act as autonomous actors in cognitive assemblages" [7]. Here Hayles is rightly clearing the ground. The questions about whether machines can think or whether machines can make art are irrelevant. Rather, they lead us to more relevant questions about agency in nonconscious cognition and the ethical implications when nonconscious cognitive systems act autonomously on our behalf. What are the properties of creative agency? What are those of autonomous agency? As Hayles is alluding to above by using such a concept as 'nonconscious cognition,' when we think about intelligent agency, and look at the functioning of natural systems, the answer to this question has become more elusive. Creative expression has been used throughout our history to tell stories and which functions an underlying aspect of our sentience. How do these creative neural networks or machine artists represent, question, undermine, or highlight this unique function of human autonomy, agency, and perception? What are the ethical, moral, and responsible developments of this technology?

Intersections of Living and Machine Agencies in the Arts

Since the 1950s, a multitude of artists have created artworks using and/or inspired by computational technologies. For this panel I will be discussing artworks that feature linkages between computational systems and non-human living organisms. The last several years has seen an increasing interest in this area of electronic arts. Although sometimes falling under the umbrella of biological art, I want to argue for its distinction as a unique genre, falling somewhere in between bio-art and computation art: what might be called biocybernetic arts. For this panel I will be focusing on a particular subset of this area: works that feature encounters or interactions between living organisms and intelligent — often agent-based — computational systems employing machine learning methods. Often these systems — like their living, non-human counterparts — are autonomous, that is, capable of taking action within their environment in response to what they sense and perceive. Here the autonomous agents respond to actions and behaviors of living organisms and produce some sort of output related to its learnings and interpretations of those actions and behaviors. Often, this output (in classic cybernetic fashion) is fed back into the living organism's environment, influencing its behavior in some way.

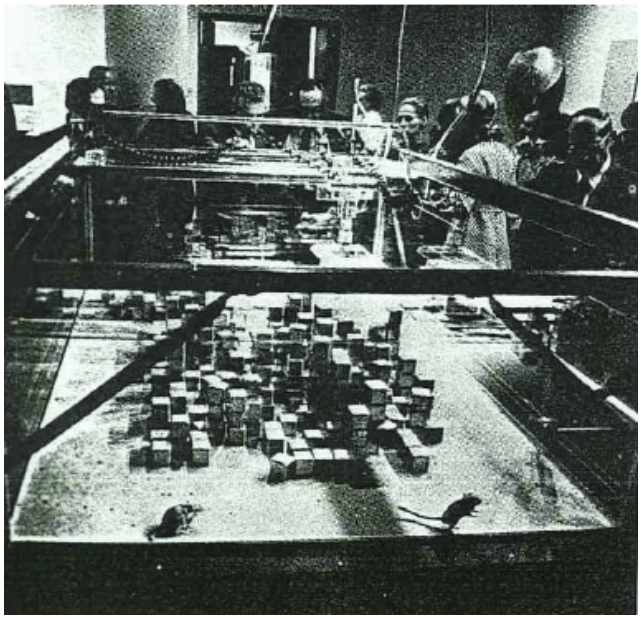

Figure 2. Gerbil Architecture (1970) by Nicholas Negroponte and cyberneticist Gordon Pask [5]. A small chamber of cubes is inhabited by a family of gerbils, who push the cubes around as they move throughout the space. A computer scans the scene at intervals and aligns them to a grid, either back to their previous position or at a new location in the grid.

Examining the social-cultural, technical and phenomenological implications that arise from these encounters between living and machine agencies, I will argue for the recognition of a distinct aesthetic paradigm rooted in the unique ways that non-human organisms and adaptive intelligent machines evolve their behaviors in response to one another. Building upon Peter Cariani's categorizations of adaptive and emergent systems [8] and Andrew Pickering's "non-modern" ontology of cybernetics and new media art [9], and drawing upon Francisco Varela's notions of the autonomy of the living [10], I will sketch out a provisional analytical framework to aid in understanding the meanings and implications of these works — works which through their explorations of novel forms of nature-machine interactions may be able to enhance our capacities for reimagining fundamental notions of evolution, intelligence and learning and facilitate new modes of approaching and understanding our techno-organic environment, opening up discussions on how both humans and non-humans are adapting and (co)evolving in response to the myriad of techno-scientific reconfigurations of their environment. Through the exploration of novel forms of nature-machine interactions, biocybernetic artworks we may be able to enhance our capacities for reimagining fundamental notions of evolution, intelligence and learning, to facilitate new modes of approaching and understanding our techno-organic environment and to open up discussions on how both humans and non-humans are adapting and (co)evolving in response to the myriad of techno-scientific reconfigurations of their environment. Furthermore, I will argue that by creating these strange types of techno-ecological systems that can bridge heterogenous life-worlds, all kinds of heretofore unimagined possibilities for mutual understanding and influence emerge, which may give us new perspectives on non-human alterities and may serve to question the anthropocentric the divisions between humans, human technology and the more than human world.

Sentient Beings: Responsible Human Agents and Creative Machines

A general AI that would fix all our problems or would destroy all our lives does not exist. The current proliferation of AI technologies using Machine Learning (ML) methods may come from the fact that each algorithm is developed for a specific task and situation. This is the diversity that makes this field collectively powerful. However there is a steep learning curve to understanding each of these algorithms. To properly apply them as a user, to co-create with them as an artist working with ML methods, or to appropriately bring these algorithms into our lives as a member of our society, the role of humans to ask questions and seek sensible actions in every step of artificial intelligence (AI) development and consumption has become vastly important.

Human Agents and Machinic Surrogates

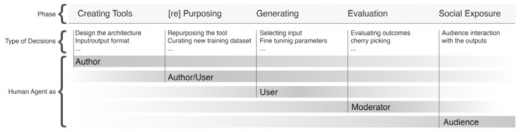

Figure 3. The Range of Human Roles in Collaboration with Machinic Surrogates [11]

The human roles in co-creation with ML algorithms range between the role of the author and the audience. In-between, there are positions as the user and as the moderator based on the tasks they undertake. Artists as human agents may engage in one or multiple phases throughout this spectrum. Using the definition of collaboration in 20th century art practice, the current relationship between human artists and ML algorithms is considered to be mediated through technical artifacts such as algorithms and data and thus the collaboration happens between human agents and their machinic surrogates.

Human or Machine Creators

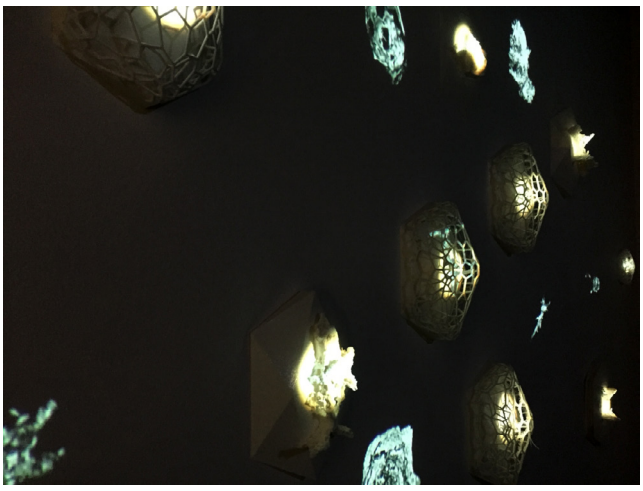

Figure 4. Installation View of the Aural Fauna Project [12]

Two examples will be discussed to look at the details of the relationship between humans and machines. First, the Aural Fauna project that is an interactive installation presented in 2019. Aural Fauna are unknown organisms imagined by AI. Human visitors may wake them up and share empathetic moments by touching or singing to them. The artist team of this project developed their own ML algorithms to imagine/generate the bodies of this unknown creature. The other example is a robot painting practice. The researchers of this project aim to make a creative robot artist that has its own artistic style and that is not merely a printer for reproducing processed or generated images.

Creativity in Question

How do we make a creative machine? Creativity is not a sudden burst out of blank space. It involves "a multitude of definitions, conceptualizations, domains, disciplines that bear on its study, empirical methods, and levels of analysis, as well as research orientations that are both basic and applied - and applied in varied contexts." [13] From Newell, Shaw, and Simon's insights on computational creativity [14] to Boden's definitions such as combinational creativity, exploratory creativity, and transformational creativity [15], defining what kind of creativity, which is appropriate for the specific task of a machine, would be a sensible first step to build a creative algorithm/machine. Yet some questions remain. Can we computationally model ambiguity? Would the novelty search result in a valuable discovery? Where is the threshold between randomness and creativity? Last but not least, how do we evaluate the creativity of an algorithm?

Sensible to Responsible

If we have a creative algorithm, it would need a dataset to learn from. As widely known, datasets raked to test ML algorithms may not accurately reflect our world. We are in the process of developing an online tool that collects people's face photos and labels. Participants may choose their way of contribution and provide accurate description of themselves from their own perspectives. This slow and self-defined method is presented as an alternative to the currently available image datasets and as a way to mitigate harmful biases in ML applications. As one of many steps we would need to take to be responsible human agents working with creative machines.

Performative Robots and Creative AI

This section discusses two performative robot projects that share a core ethos about the nature of human-centered AI (HC-AI) and Creative AI: *Amigóide* (2010-) and *Embodied Robots for Music* (2018). HC-AI focuses on the design, development and deployment of intelligent systems that cooperate with humans in real time in a deep and meaningful way. HC-AI is defined by two goals: (1) the AI system must continually improve by learning from humans while (2) creating an effective and fulfilling human-robot interaction experience.

The two projects apply these core goals as a central philosophy from which the concepts of Creative AI and Experimental Learning in the context of performative robots are developed. At the center of this discussion is the articulation of a shift in thinking of what constitutes Creative AI and new Human-Centered AI forms of machine learning

from inside the flow of shared experiences between robots and humans.

These projects explore new ways of working artistically with machine learning in real time, having the human artist in the loop with robots that sense constantly the environment and respond to it, challenging and enhancing human creativity by stimulating, inspiring, interacting and co-operating in the flow of embodied live improvise art-making, responding to the interaction with a human trough a cyclical relational process. Creative AI, in this view, includes practices that have AI embedded into the process of creation, but also encompasses novel AI approaches in the realization and experience of such work. The ultimate goal of these projects is not to find solutions to replace human creativity, but to enhance it and move it forward into new discoveries.

Amigóide: Engagement, AI, and Robotics

Amigóide (figure 5) is an automaton which searches for humans to engage in friendship with. Two versions have been developed, using different AI approaches. The first one (2010-2011) uses GOFAI (Good Old Fashioned Artificial Intelligence) [16], whereas version 2.0 (2019) was built utilizing a mix of GOFAI and deep learning, taking advantage of modern machine learning frameworks, which allowed the use of computer vision and image recognition techniques in real-time. The automaton interacts with people through movements, LEDs, synthetized voice and demonstrations of digital feelings. *Amigóide* reacts through its lights when the infrared sensor readings (version 1.0) or computer vision analysis of the camera video stream (version 2.0) indicate whether a human interactor gets close to it or not after a round of interaction.

Once the automaton finds a human it starts to follow this potential friend, intending to start an endless friendship. It gets closer to the eminent friend and poses the question: "Fabian, do you want to be my friend?". Fabian is an imaginary friend programmed into the automaton's mind. After the initial contact, *Amigóide* tries to conquer the friend through a series of sentences such as "Fabian, what do you look for in a friendship?".

Amigóide can be described as a rational agent, i.e., an agent "that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome" [17]. Hence, it is a rational agent whose best expected outcome is to establish contact with humans and conquer their friendship. The concept of rational agent is pivotal to this project because it leaves room for uncertainty. The aim of a rational agent is not to achieve perfect rationality – always doing the right thing, that in this case would be to do everything to acquire lifelong friendships –, as it is impossible in complex environments.

Figure 5. *Amigóide*. ©Fabrizio Augusto Poltronieri.

Embodied Robots for Music

The aim of this project is to investigate the technical solutions and artistic potential of AI driven robots co-creating with a human musician in realtime. The overarching research question with *Embodied Robots for Music* is: *If we want robots to join us inside the creative acts of music then how do we design and develop robot systems that prioritise the relationships that bind musicians inside the flow of music-making?* The goal of this research is to make humans more creative through deep and meaningful relationships with co-operating intelligent machines.

To solve the research question posed above, we needed to design, develop and deploy a robotic Creative AI that would have a presence within the co-creativity of the flow of *musicking* – the creative acts of realtime music-making. *Musicking* is a term that defines a perspective that 'to music is to take part' [18]. 'Taking part' can happen in any capacity such as performing, composing and listening. This approach reinforces the understanding that when musicians enter the world of *musicking*, there is coping in a very different world-of-concern than if they were walking down a street. In a sense they become a different creature with a different set of priorities and concerns than a normal, human wakefulness. The technical and artistic solution for *Embodied Robots for Music* focused on a robot that was first and foremost a coping entity in this specific world-of-concern.

Generative Systems for Music Composition and Production

The use of statistical processes and AI systems for the generation of music has a long history. In terms of the use of computer processing to aid music generation, early work beginning in the 1950s, notably includes that undertaken by Iannis Xenakis [19], John Cage and Lejaren Hiller [20, 21],

and later Charles Ames [22] and David Cope [23]. With the resurgence of neural network or connectionist systems in the 1990s [24], and most recently using network architectures termed deep learning, such sub-symbolic systems have shown good results in many generative application domains, including music composition and audio engineering.

Such systems have begun to reach performance levels which make them viable as commercial tools for musicians, and the wider public, to use. Music composition systems, aimed at enabling non-musicians to create musical pieces for video soundtracks, or as musical social network identities have been demonstrated by companies such as tomandandy.com and Humtap.com respectively. One of the authors (Smith), while employed at tomandandy.com, led the development of an experimental system "Ennio" in 2002 for matching music soundtracks to video sequences. This formed an early music information retrieval (MIR) recommendation system, matching the visual "rhythm" derived from peaks in a novelty measure between video frames to spectral features derived from the audio signal of recorded music using digital signal processing (DSP). In developing humtap.com in 2014, transcription of both melodic ("hums") and percussive ("taps") audio into symbolic representations is then used to drive a proprietary composition algorithm which seeks to combine the rhythmic structure of the tapping with the melodic contour of the humming. These musical fragments are recorded using internet connected smartphones by different users, so that the musical combination of pairs of users forms a musically oriented social interaction.

For music production, tools such as those from companies such Imagine Research (2010), iZotope.com (2012) and LANDR.com (2014) use AI methods to automate parts of the audio engineering required to produce professional sounding musical pieces. In the case of iZotope, several products used for audio restoration (noise reduction and repair) or signal processing are able to leverage such machine learning techniques as classification to identify regions of audio that exhibit problems. In the case of LANDR, classification is combined with model based learning to control audio signal processing to perform mastering (signal processing of mixed music tracks) automatically via a simple web interface. Other machine learning techniques such as recommendation, using audio features to search within a multidimensional space, are used by LANDR to suggest musical loops and samples (short audio fragments) which are acoustically musically similar, or complementary, to query samples.

There are common challenges which occur in producing such systems. These include issues around formulating design goals, such as the complexity of the user interface, based on the degree to which AI systems can understand musical goals of users and hence reduce the number of parameters a user must manipulate to achieve a goal. With improvement of machine learning model architectures, moving from rule systems informed by DSP in the case of Ennio, to linear classifiers such as support vector machines in systems by Imagine Research and iZotope, to non-linear systems such as deep learning in use at iZotope and LANDR, complexities of audio representation are able to be better learnt, when training on audio examples. However acquisition of training data which represents the musical task remains bounded by the problems of labelling, both in terms of requiring human annotation, and by differing ontologies of labelling for different musical genres or purposes. Such generated systems naturally pose questions of authorship and rights management, and the intersection of expectations of generated musical genres and how aesthetic judgements of generated music can be used in evaluating such systems.

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Authors' Biographies

Johnny DiBlasi is an artist who works with computational media, data and network hardware to create large-scale, interactive installations that fuse data into the physical architecture. With these works, he explores the aesthetic possibilities of data gathered by sensors dispersed throughout the landscape and how these artistic experiences can connect users to the pulse of the landscape in which they coexist. DiBlasi is Assistant Professor of Scientific Visualization and Digital Media in the Department of Art and Visual Culture at Iowa State University. DiBlasi earned an MFA from the Photographic and Electronic Media program at the Maryland Institute College of Art in Baltimore, MD. DiBlasi teaches studio courses in video, web design, creative coding and interactive media, and he exhibits his artworks and installations nationally and internationally.

Carlos Castellanos is an interdisciplinary artist and researcher with a wide array of interests such as cybernetics, ecology, embodiment, phenomenology, artificial intelligence and transdisciplinary collaboration. His work bridges science, technology, education and the arts, developing a network of creative interaction with living systems, the natural environment and emerging technologies. His artworks have been exhibited at local, national and international events such the International Symposium of Electronic Art (ISEA), SIGGRAPH & ZERO1 San Jose. Castellanos is Assistant Professor in the School of Interactive Games and Media at Rochester Institute of Technology.

Eunsu Kang is a Korean media artist making interactive art installations and performances. She is also a researcher on the possibility of creative AI and an educator teaching art-making using machine learning methods. Her career started as a self-taught video artist in Seoul, Korea. Having over 100 exhibitions and constantly studying new technologies for two decades, her works have transformed into interactive and interdisciplinary art projects. She has won the Korean National Grant for Arts three times. Her works have been invited to exhibitions around the world and presented at conferences such as ACM, ICMC, ISEA, SIGGRAPH Asia and NeurIPS. A couple of years ago she left her tenured art professorship to focus on research at the intersection of art and machine learning. Most recently she taught Art and Machine Learning and Creative AI courses at the Machine Learning department of Carnegie Mellon University.

Dr Poltronieri Fabrizio Poltronieri is an artist who explores the relationship between technology and deep-rooted philosophical concepts, such as chance. His current artwork involves Artificial Intelligence, applying machine and deep learning techniques to create and design narratives, moving images and objects. Poltronieri is an Associate Professor, member of the IOCT (Institute of Creative Technologies), and Co-Director of the Creative AI Research Group at De Montfort University, Leicester, UK.

Leigh M. Smith is a computer scientist, post-doctoral researcher and software developer of music information retrieval (MIR), audio signal processing, artificial intelligence (AI), computer graphics, and cryptography systems. He has worked on many commercial music software projects, and is currently a senior research engineer at LANDR Audio Inc. in Montreal, Quebec, where his focus is on automated mastering, music recommendation, and other music AI projects. He has previously worked with the Music Cognition Group at the Universiteit van Amsterdam and Analysis/Synthesis Group at IRCAM (Paris), and taught at several universities on music perception, cognition and MIR, with a focus on analysis and modelling of musical rhythm for interactive performance systems.

Aesthetic and User Experience in Biofeedback Art

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Abstract

Artworks with biosensors could be called biofeedback artworks. Our intention is to discuss the changing landscape of practices and research in the area of art where biological information of spectators/interactors is used as input for the functionality of artworks. We would like to ask about new challenges in the design of artistic-technical devices and art historical implications. As technology for artists becomes more available and cheaper, do we see new emerging trends in building biofeedback artworks? How to contextualise the effect of these works in research on aesthetic experience?

Keywords

Biofeedback art, interactive art, biosensors, biometrics, symbiotic interaction, machine vision.

Introduction

In this panel we would like to discuss works which are in direct contact with the viewer's body through biofeedback sensors. We can call it a biofeedback art, and the interaction of viewer and the artwork as symbiotic. Viewer and artwork are entwined into a whole and the activity of the artwork is connected with physiological data obtained from the viewer. These are essentially contact-based works which read body-generated data and are equipped with sensor systems built around biofeedback which are able to read the viewer's bodily reactions from the surface of the body or from inside it.

Our interest is to discuss questions about biofeedback art from positions of practitioners and art history researchers.

Raivo Kelomees: "Critical Approach to Aesthetic Experience and Symbiotic Interaction in Biofeedback Art"

Different sensor technologies are used to measure a variety of parameters. Some standards that utilise specific technology are: Heart Rate Variability (HRV); EEG, Electroencephalogram, neurofeedback—brain electric activity; Electromyogram (EMG)—a technique for evaluating and recording the electrical activity produced by skeletal muscles; Galvanic Skin Response (GSR), now standardised to electrodermal activity (EDA); Electrocardiogram (ECG)—the process of recording the electrical activity of the heart over a period of time using electrodes placed on the skin.

Here we might name works by artists Ursula Damm, [1] Ulrike Gabriel, [2] and Seiko Mikami [3] which utilise various monitoring methods of physiological activity. To the above we can add the following: *pneumograph* which provides feedback about the relative expansion/contraction of the chest and abdomen, and can measure respiration rate (the number of breaths per minute, breathing sensor); *rheoencephalograph* (brain blood flow biofeedback) which is a biofeedback technique of conscious control of blood flow; *photoplethysmograph* which is a device used to optically obtain a volumetric measurement of an organ [4]. Here also we find examples, some of them legendary works from the 1990s, such as Ulrike Gabriel's *Breath* (1992) [5] and Char Davies' *Osmose* (1995)[6]. Despite the fact that such well-known examples belong to the 1990s, most artworks in which these sensors are used to characterise the changes that have taken place in the digital art environment: equipment nowadays has become cheaper

and it has undoubtedly become easier for experimental artists to build unique systems for symbiotic interaction.

We can divide works by the awareness and unawareness of the participation. The non-awareness of the viewer in the context of biofeedback art could raise questions in the situation where sensors are able to register data over distance. A current example would be the retinal scanner which hypothetically acts as a distant bioscanner. In fact, retinal scanning exists as a biometric identification technique, since the retina is a structure of blood vessels so complicated that it is unique for every person and even identical twins do not share the same pattern [7].

Sensor technology was used by Pia Tikka for her project *Enactive Cinema* shown at the Kiasma museum in 2005 [8]. Here the film narrative was manipulated by viewers using heart rate and skin conductivity sensors. Again the viewer's task was to act consciously and deliberately to see how the activity and body data could influence the multiscreen movie installation. Sean Montgomery's projects also demand conscious participation: the viewer must place their hands on the artwork. His installations *Emergence - biofeedback art installation* (Figure 1),[9] *Vital Threads Biofeedback Apparel* [10] and *Telephone Rewired* [11] all use biofeedback. This situation is seen clearly in the exhibition space: when a viewer puts a hand on the object of installation the surrounding environment of light and sound starts to pulsate to the rhythm of his/her heart.

Figure 1. Sean Montgomery, Emergence - biofeedback art installation, 2010.

Analysing biofeedback works critically, we can say that some utilise the technology in order to enrich the work—biodata becomes the source for visual and auditive events. Karen Lancel and Hermen Maat's *E.E.G. Kiss* (2014) [12] invites two visitors to kiss, during which their electroencephalogram is displayed as a circular audiovisual projection (Figure 2).

Figure 2. Karen Lancel and Hermen Maat's E.E.G. Kiss 2014.

The work is experienced as a public performance and is an exciting act for the participants—for the audience there is amusement as an erotic act takes place enlivened with audiovisual technology. Wherein lies the novelty and charm of the work? The authors explain that: 'A kiss is an obvious case of intimate, emotional interaction, based on bio synchronizing, spatial nearness, touch, sight, fluids, smell, endurance [12]'. The keyword 'bio synchronization' promises that visually an equalisation occurs in the electroencephalograms of the two kissing participants—unfortunately it is not very clear as to whether this actually happens. Without a doubt it is not the main goal of an artwork to produce new knowledge (although sometimes it happens), but rather to produce experiential situations which could not be achieved in any other context. Publicly performing an intimate act for *E.E.G. Kiss* comments on the possibility of sharing experiences online and raises questions about the surveillance society.

Varvara Guljajeva: "Exploring biometrical data as a score and artistic material"

Abstract

This part of the panel describes an interdisciplinary performance titled Circular NeuroKnitic with Beethoven where a pianist brain waves affect knitted textile's pattern in real-time. In other words, we are talking about a symbiotic performance between musician, machine, and biometrical data, which happens at the same time and space.

The case study serves for exploring the role of biometrical data in the interactive system of an artwork. In addition to that, the role of participant is investigated and contextualized from the view point of interactive art.

Introduction

There are an increasing number of affordable and easy-to-use biometric sensors, which enables artists to expand their concept horizons and implement the most inner body data into an artwork. Several practitioners have been exploring biometrical data in their creative practices. We can see that the artists are not only eager to apply yet another source of user data, but they are also concerned about vanishing

distance between human body and data-driven systems. For example, Rafael Lozano-Hemmer has applied in several artworks of his biometrical data as heart rate, breath, and fingerprints. The artist describes his position towards biofeedback as following: "I am very concerned but also curious about the age of metrics. These days everything is quantified." [13]

System-wise the biometrical input results in interactivity because it affects the output of artwork. If we look from the perspective of a participant, it can be described more like the act of participation or even giving away a piece of one. Audience cannot really control its heart rate, fingerprints, eye or skin color. To some extent we can control brain data but not entirely. Hence, it is not appropriate to apply here the term of interactivity without any further explanation. On the other hand, often we still know little about this data and there is a little transparency how it is interpreted.

Raivo Kelomees describes this type of interaction as symbiotic interaction where an artwork becomes a part of the spectator. [14] It is like signing with its own blood and becoming connected forever. The title of Rafael Lozanno-Hemmer work ALMACÉN DE CORAZONADAS (2006), refers exactly to this fact: the storage of gut feelings – participant's heart beat is trapped inside the artwork forever. Another example is NeuroKnitting by Varvara & Mar where the artists describe the garment containing the emotional state of participants collected via EEG headset as a personal database of emotional state.

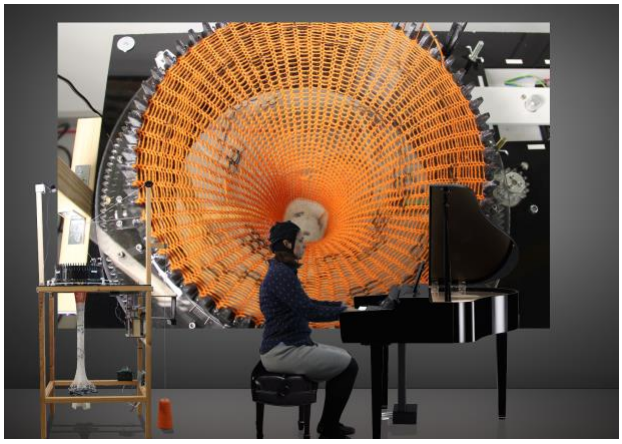

Figure 3. Performance setting of Circular NeuroKnitic with Beethoven (2020) by Varvara & Mar

The current case study aims to bring together existing kinetic artwork adapted for receiving biometrical data as brainwaves of a performer and a classical piano concert. Apart from re-thinking great work of composers, like Beethoven, we are also offering different experiences to the audience. Suddenly the public can hear not only an artistic interpretation of composition, but also the emotional state of the musician, which has resulted in the movement of a circular knitting machine installation, visuals, and plotted pattern to the produced garment in real-time. It means the user's affective response to music is captured every second and memorized in the knitted textile's pattern, which is sprayed to the yarn before being knitted.

In the end, the application of biometric data for artistic purposes often resulte in surprise to discover our body fluxes, something unknown although it is an integral part of us. In addition to that, it raises concerns about our profound relationship with technology, which is able to capture every aspect of our lives and existences.

Oliver Laas: "Surveillance and Privacy in Biofeedback Art"

Abstract

Biofeedback art – interactive art that uses input from biofeedback sensors to generate audiovisual output – raises numerous interesting questions about surveillance and privacy. What is the relationship between biofeedback art and surveillance? What kind of impact might biofeedback art have on the privacy of the audience?

Introduction

Surveillance is the collection of personal data for the purposes of managing those whose data has been gathered. [15] Surveillance both constrains our freedom and allows us to participate in society by keeping us informed and increasing our security. [16] Personal data has three characteristic features:

- *Multiple realizability*: personal data may be acquired by different types of information processors (both artificial as well as human) and may be stored at different locations in different media.
- *Variety of methods*: personal data may be generated by a variety of artefacts, methods and techniques.
- *Contextual meaning*: personal data do not have meaning outside their context of use. [17]

These features explain the ease of data gathering, storing and how its meaning depends on how it is used.

Common types of personal data, such as national identification numbers, bank account numbers, name, and gender, are increasingly supplemented by biometric identifiers like facial features, fingerprints, DNA, iris recognition and other identifying bodily markers. The gathering of such personal data leads to the creation of a *data double* or *shadow* – an additional public identity constituted by the personal data stored in databases. This data double is often the object of governmental actions and procedures. [16] A person may have multiple data doubles. Because data doubles are privileged in the administrative

management of people, personal biographical and testimony tend to lose their value as sources of truth about the individual. [18] The decreasing cost of surveillance technologies and the rise of social networking have inaugurated a *personal information economy* where the public and private sectors both depend on and share the personal data of individuals with each other. [19]

Since biofeedback art is situated within a cultural context of mass surveillance and the personal information economy, it is pertinent to inquire what is its relationship to its context. Arguably, we can distinguish the following attitudes toward surveillance:

- *Passive acceptance*: there is no reason to worry about surveillance if you have nothing to hide.
- *The critical attitude*: we should foster public discussion about surveillance and its surrounding issues.
- *The hijacking of surveillance*: involves the use of surveillance equipment for the production of visual material without any critical or political aims. [20]

While many artists have historically adopted a critical attitude to surveillance, such an attitude should not be taken for granted. Rather, it should be determined whether some works of biofeedback art have not hijacked surveillance technologies for purely aesthetic purposes. If this is the case, then such works, arguably, express the prevailing zeitgeist of our performance and spectator society where individuals volunteer their personal data for recording as a means for asserting selfhood (as can be witnessed in reality TV, webcams and so on). [21]

Changing attitudes toward surveillance can also influence how biofeedback art could impact the audience's privacy. Although there is probably no general and all-encompassing definition of "privacy," at least four kinds of privacy can be distinguished:

- *Accessibility/physical privacy*: S has physical privacy when S is free from any kind of physical intrusion by others due to restrictions on their ability to have physical interactions with S.
- *Decisional privacy*: S has decisional privacy when S is free from the interference of others in his or her personal choices, plans and decisions. [22]
- *Mental privacy*: S has mental privacy when there is a restriction on the ability of others to access and manipulate the mind of S. [23]
- *Informational privacy*: S has informational privacy when S is free from the epistemic interference from others due to their restricted access to personal data about S. [24]

Since biofeedback art utilizes the personal data of its audience, then it can, in principle, violate, for instance, the mental or informational privacy of the users.

The purpose of this discussion is to consider the extent to which biofeedback art may be a sign our changing cultural attitudes toward surveillance and to see what this implies about the possible privacy violations involved in interactions with such artworks. Finally, it will be considered how one might consent (e.g. by entering the gallery or interacting with the work) to relinquishing one's personal data in exchange for an aesthetic experience.

Sean Montgomery: "The introspective lens of biofeedback art"

Abstract

From the dawn of humanity, technology has been a window into the societies, cultures, and individuals who use it. With the explosion of technology in the 21st century, it has become possible to peer ever deeper into aspects of human life, now making it possible possible to sense the very electrical and chemical signals from the body that create who we are. Biofeedback art at once multiplies our ability to feel, express and communicate the signals that make us most human and yet also asks us to consider what fundamentally differentiates the electrical impulses of the internet from those impulses constantly traveling throughout our own bodies.

Introduction

Biofeedback art works often examine how technologies can reveal and expand human abilities. Vital Threads Biofeedback Apparel [10] senses signals from the body to open design and fashion to dynamic new forms of self awareness, personal expression and interpersonal communication. The collection includes the "Truth Wristband" that dynamically reflects the wearer's psycho-emotional (electro-dermal) response, a "Heart-felt Shirt" that lights up with the wearer's heartbeat (ECG), and the "Thinking Cap", a hat that lights up with different patterns depending on the wearer's brain activity (EEG). By measuring and displaying the wearer's biological signals, Vital Threads Biofeedback Apparel enhances the wearer's freedom to express his or her personal vantage on a moment by moment basis.

Figure 4. Sean Montgomery, Hive Mind 2017 - brainwave-driven on-stage discussion about the future of augmented cognition.

Telephone Rewired [11] and Hive Mind (Figure 4) [15] are biofeedback art works that expand on this extension of

human capacity. Based on neuroscience research, showing that rhythmic stimuli can entrain neuronal oscillations to alter perception, reaction times, and memory formation, Telephone Rewired uses pulses of light and sound to cycle the viewer through a sequence of different brain states. Some sequences create a sense of calm and clearing of the mind, while others might deliver a sense of focus and heightened cognitive function. Similarly, in Hive Mind two performers engage the audience in a biofeedback-driven on-stage discussion in which no words are spoken. Instead, the brain rhythms of each performer directly generate pulses of light and sound that synchronize the brain oscillations of viewers and create an immersive environment that transports the audience to altered states of consciousness. As one performer's brainwaves become the stimuli that entrains the other performer's brain patterns, a public brainwave-driven conversation unfolds between the performers. Together the works have broad implications from increasing the capacity of human learning to synchronizing multiple people for greater collaboration and empathy, and generally asks what possibilities exist for the future of augmented and collaborative cognition.

While biofeedback art can celebrate and enhance our humanity, works like Emergence [9] invite the viewer to further examine the relationship between biology and technology. When a viewer touches the installation, the electrical impulses generated by each beat of the viewer's heart propagate throughout the viewer's body and are detected and digitized by the installation. The viewer's heartbeat is then propagated into the surrounding infrastructure of the space as pulses of light and sound and ultimately onto the internet -- with each beat of the viewer's heart, Emergence captures an image of the interaction and uploads it to the internet where it can be seen on flickr or facebook. By drawing parallels between the human body and the infrastructure of the digital age, Emergence invites the viewer to think about what fundamentally differentiates the electrical impulses of the internet from those impulses constantly traveling throughout their own body.

From works that reveal and enhance the capacity of human ability, to works that examine the similarities between our biology and our technology, biofeedback art gives the viewer a new lens to look at themselves and consider how our relationship to technology and to one another may change as we head further into the 21st century.

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Authors Biographies

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As an artist she works together with Mar Canet forming an artist duo Varvara & Mar. Often duo's work is inspired by the information age. In their practice they confront social changes and impact of technological era. In addition to that, Varvara is fascinated by kinetics, participation, and digital fabrication, which are integral parts of her work.
The duo has been exhibiting in international shows since 2009. Their works have been shown at MAD in New York, FACT in Liverpool, Santa Monica in Barcelona, Barbican in London, Onassis Cultural Centre in Athens, Ars Electronica museum in Linz, ZKM in Karlsruhe, and more.
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Sean Montgomery is a new media artist, technologist and educator in New York City. Using research methodologies combined with emerging technologies, Sean takes a trans-disciplinary look at the human condition to examine the changing relationship between the physical and metaphysical world. From developing wearable bio-sensors and algorithms that derive meaning from sensor data, to creating interactive new-media art installations that have shown around the world, Sean's work focuses on how technology can enhance our understanding of ourselves and create new ways for people to interact with one another and the objects around them. After finishing his Ph.D. in Neuroscience, Sean founded Connected Future Labs, an agile R&D consulting group that utilizes a depth of expertise in circuits, algorithms and design and created EmotiBit, a truly wearable open-source sensor for capturing high-quality emotional, physiological, and movement data.

Beyond Anthropocentrism:

Art Practices to expand human experience, understanding, and creativity

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Abstract

This panel unfolds ideas around Animality, and the papers undertake a critical discussion on the relationship between the human and nonhuman and explore possibilities for us, as humans, to transcend intelligence and consciousness by focusing on nonlinguistic and affective experiences. Each panel focuses on different subjects in this context and introduces art projects as research methods, ranging from 3D game art, media performance and responsive media. This discussion leads us to acknowledge limitations in the anthropocentric perspective and to rethink how we should live, interact and co-evolve with nonhumans.

Keywords

Media Art, Responsive Media, Experiential Understanding, Nonhuman, Planetary Cognitive Ecology, New Materialism, Radical Feminism, Affect Theory

Introduction

With the advancement of technology, we can predict the future by analyzing accumulated data and calculating all possibilities and find out the most effective route to process almost everything we do. Humans unceasingly communicate and exchange logical inputs and outputs with technology and access a huge amount of data at any moment in a second. Today, human cognition is closely tied to technological cognition, and algorithm-based information often appears more credible than our intuitions and feelings. In such interactions, what happens outside of the layer of interfaces that allow us to immediately perceive digital representations? While nonlinguistic forces are overshadowed by numerical and logical data and tangible representations, we continue missing out on abundant untold stories, experiential knowledge, and affective experiences. These panels unfold ideas around Animality and undertake a critical discussion on the relationship between humans and nonhumans and explore possibilities for us, as humans, to transcend the linguistic and logical frame of understanding to discover the bustle of dynamics around us, which often occur by, with, and between nonhumans.

I: Cognitive Coevolution of Human and Technology; What is at Stake?

Human cognition is increasingly interconnected with technological data and the computational processes. In this cognitive network of humans and machines, they seem to exchange represented information such as text, numbers, and images, however, their interactions occur at various levels – consciously, unconsciously, nonconsciously, and even through material processes (Hayles, 2017). Given our mind is enacted based on the history of actions performed in the world at various levels (Varela, 1993), humans and nonhumans are not separated in nature, and the boundary in this distinction is arbitrarily imposed based on humans' biased, anthropocentric perception. This hierarchical understanding of the relationship between humans and nonhumans has led to the unsustainable development of technology. Humans have deemed technology as instrumental tools with which they can control a whole system as its creators. Humans have purposefully devised technology in pursuit of convenience, domination, efficiency, and controls

In a new geological epoch – the Anthropocene – it became evident that technology exerts a greater impact on humans and the planet and that culture and nature are profoundly interconnected (Haraway's term *natureculture* demonstrates their inseparability). In addition to the environmental connectivity, technology entrains human cognition and behavior and comprises a huge part of the cognitive ecosystem, where digital data and neural signals are intertwined. From this perspective, the human and technological relationship is symbiotic rather than hierarchal. For sustainable coevolution, people need an alternative perspective to overcome the binary opposition of humans and nonhumans, understanding technologies as "companion species" (Haraway, 2003).

To identify such a complex network of relationships of humans and technology, in this part of the panel discussion, I propose an unorthodox exploration to understand technologies as beyond instruments, apparatus, or tools that serve

modern societies, further understanding them through the lens of transdisciplinary art practices. First, I argue that biological systems could provide insights for a comprehensive understanding of technology, noticing its possibilities of mutation and evolution have occurred through interactions with environments. In the same way that organisms mutate in response to external stimuli, computation code and programming language have evolved and been influenced by the environment, geography, population, and climate it inhabits. Secondly, I will discuss the importance of affective experiences in understanding the human-technology relationship and how focusing on rule-driven approaches to technology fosters the separation of humans and nonhumans. I argue that limiting human-technology interaction to logical communication blinds us from noticing diverse cognitive modes and affective understanding as well as nonlinguistic and visceral experiences in the relationship between humans and machines. Lastly, two of my recent projects, Surrogate Being and Enacted Scene will be presented to demonstrate how I embody those ideas with an alternative research method and how artworks allow me to investigate nonlinguistic and affective experiences beyond linguistic, numeric and visual representations.

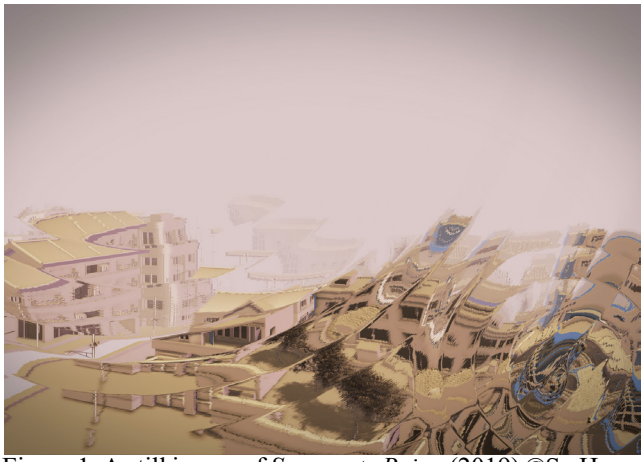

Figure 1. A still image of *Surrogate Being* (2019) ©Su Hyun Nam

II: Exploring possibilities of technologies' collaboration with environments, climates and other indeterminacies

Located in Buffalo NY, Silo City (a complex of privately-owned grain silos located in the downtown area of the city) was a place where you felt there was a story. It was a story about making work with nonhuman forces and how as humans we might negotiate with these actors, not to fend them off, but to enter into a dynamic relationship with them. It was a story about developing strategies for improvising with conditions beyond our control. It was not an origin story or a story with a strong narrative arc, it was a story about the shifts in weather patterns and industrial decay and the way both were activated by their surroundings. A polyphonic conversation began to establish itself between the different elements that were in play – amplified but not dependent on our use of sound and recorded media. How do we cultivate the right conditions for these dynamics to unfold between people and places? How do we create environments in which we can interact with each other and our physical world in new unexpected ways, informed but not dictated by the technologies we employ to enhance our experiences?

Such interactions require paying close attention to our individual perceptions, detailing how these observations inform our interactions with both the environment and our approach to mediating that experience. As Su Hyun Nam and I kept returning to the silos, the dialogue continued to evolve. During one visit, the camera became so frozen by the cold, that it began documenting a smeared effect across the screen as though revealing the ghostly trace of the things around us. Instead of moving the camera to look for a new point of action, it was held still, letting the traces appear and dissolve across the screen. We were inside a new space we hadn't been before and there were two people in the distance far away enough to become thin lines flickering back and forth. Behind them was the bleached bright rectangle of the sun coming through the window, making their human forms seem even more permeable. It lasted only a few minutes, but it was moments like this where a small perception turned into an event. As an observer I had to hold the awareness of the interaction and fold these perceptions into the developing process derived out of many experiences in a lived world without clear boundaries.

Figure 2. A documentation image of media performance, *Sites Do Things to People* ©Stanzi Vaubel

III: The Indeterminacy Festival

My own research is structured around the creation of collective events. My role as director of these projects is focused on understanding how individuals practice their disciplines. I focus my attention on creating spatial structures which are intended to allow individuals who have not interacted prior to the event, to come together, and within the span of a week, bring a year of autonomous preparation within their own

community or research onto a much more expansive and collective stage. What results is not an installation project or a series of disparate performances taking place at different venues around a city, but a finite hour-long durational performance in which all of these collaborators hold their individual focus while coming into polyphonic concert with all of the other participants.

To create these structures, I employ the work of biologist Jakob von Uexküll. Uexküll theorized that all organisms live within their own 'umwelts' or self-contained universes and that these 'umwelts' are driven by the instinctive needs of that organism (Uexkull, 2010). By the necessity of survival, that organism is completely unaware of what lies outside of their self-centered world. Applying the 'umwelt' to humans within different fields of expertise, disciplines, and communities became a way to value the autonomy and separateness of experience, while also finding meaningful ways to bring an unlikely set of individuals together.

Indeterminacy emerged as a framework for thinking about my research and artistic practice. I liked the term indeterminacy because no one really knew exactly what it meant. If you were from the music world, it referenced John Cage and chance music, but if you were from the Physics or Math world it referenced Heisenberg's uncertainty principle. If you were, like me, a student of the interdisciplinary field of Media Study, then indeterminacy would have emerged from theoretical frameworks which formed a new definition of the term. Unlike for Cage or Heisenberg, where the term indeterminacy was stamped onto a certain set of ideas, for theorists like Elizabeth Grosz (Grosz, 2008), the word seemed to almost bubble up and emerge as a way to describe a methodology for living that was almost too ephemeral to fully grasp onto (Coole and Frost, 2010). This was the definition of indeterminacy I felt most at home with, describing a constant reaching towards new methods for configuring the things around us. The Indeterminacy Festival took on this task.

IV: More-than-human Thought Matters: New Media and Difference in Itself

In addition to the call to disambiguate notions of agency between human and non-human distinction (referenced above), we also take to task problematic aspirations toward equivalencies between human and non-human thought abundant in discourses around machine learning and artificial intelligence. What's at stake, given our entrainment with technical systems, is nothing less than the production of subjectivities. While many researchers in ML and AI have given up trying to define intelligence (pace Turing, Minsky, etc.), there remains at the core of these projects what Gilles Deleuze (1996) has called "an image of thought" -- a fundamentally Kantian conception of thought grounded in recognition and representation. As the engineer and philosopher Reza Negarestani points out, the similarity between the general intelligence project and Western philosophy precedes the English analytic turn or the cognitive turn (movements concerned with consciousness and perception which are often invoked in the context of AI) (Negarestani, 2018). Negarestani suggests that the project of AI is an empirical and experimental portion of the much older project of German Idealism (Fichte, Kant, Hegel, etc.). In his chapter on the "image of thought", Deleuze implores us not to reduce thought to consciousness, intelligence to sentience, and experience to perception (Deleuze, 1996). Deleuze emphasizes the power of experiential encounter and affective relation in bringing forth thought: "Something in the world forces us to think." (Deleuze, 1996) This radically empirical notion of thought negates the possibility of synthetic intelligence equivalent to an experiencing subject (Xin Wei and Johnson, 2020).

With this theoretical background, I argue we must unseat intelligence, sentience, and consciousness as criterion for agency and embrace difference in itself as the only possible basis for a non-anthropocentric ethic. Drawing on work in new materialism (Grosz, 2016), radical feminisms (Ettinger, 2006), and a politics of the weird and eerie (Fisher, 2016), I'll show how work in responsive media art research need not deal with humanistic presuppositions of agency, creativity, or expression, but instead can meet with the more-than-human on emergent terms. In particular, I'll analyze some experimental work with 1) digital-physical hybrid system *Lanterns* (Johnson et al.,2019), wherein human bodies and non-human encounter and entangle, clash and coordinate, producing novel dynamical ensembles, and 2) the radically inhuman rhythmicities of urban infrastructure, which become sonic as researchers traverse the city of Phoenix, AZ, USA in their radiophonic, automotive apparatus (a car with an AM radio). The researchers catalogue this work in the video-sound-haptic installation Idiotic Resonances: *Uncanny Valley of the Sun* (Johnson and Mechtley, 2013). These works help me to articulate both an understanding agency in terms of matter and media, as well as a field-based approach to working with computational media called responsive media (Xin Wei, 2013).

Figure 3. A documentation image of *Lanterns* © Garrett Johnson

V: Mealtime Matter: What do we swallow?

Microbiome is an ecological community of commensal, symbiotic and pathogenic microorganisms found in and on all multicellular organisms studied to this date, from plants to animals. The human microbiome comprises of the populations of microbial species that live on or in the human body—the commensal bacteria, viruses and fungi, and other single-celled animals such as archaea and protists that call our bodies home and are ten times as many more than human cells(Collen, 2016). “We are, rather, an array of bodies, many different kinds of them in a nested set of microbiomes. (Bennett, 2010)” Microorganisms interact with each other and affect each part of the body. The body is almost and always closely related to the non-human inhabitants.

The body is transitional as a fluctuating domain where non-human agencies pass in and out of the body, as Bennet notes, "My ‘own’ body is material, and yet this vital materiality is not fully or exclusively human. My flesh is populated and constituted by different swarms of foreigners. (Bennett, 2010)” These put in a new light how many of us unconsciously—and naturally, we would like to believe—perceive what we consume and discharge. In this sense, I focus on a meal to re-think and investigate the complex and delicate linkage between humans and nonhumans. During the mealtime, foreign bodies enter into the body through food ingestion, then leave the body through excretion. Sometimes nonhumans are transplanted into the body through contact or they just penetrate through the skin. They are then let out again in the air or other ecosystems again. However, the seeming simplicity of this ‘eat and poop’ logic cannot disclose what we go through over the dinner table. We swallow not only the food, but the conversations, emotions, opinions, and the moments. While dismantling the bionomic environments of our bodies, we interchange our social and cultural experience, building and rebuilding relationships.

I explore boundaries and relationships over the dinner table as my art practice. I have a meal with various people, who form different levels of intimacy with me; a stranger, an acquaintance, a casual friend, a close friend, and an intimate one. The mealtime is documented, the residue of the meal is collected, and they are re-materialized through my artistic explorations and experiments: The scraps are transplanted on petri dishes, where bacteria and fungi will grow and form bionomic environments. The dialogue and the scene are fragmented and translated. The in/tangible sentiments are transferred and reinterpreted in installations that incorporate text, image, video, interactivity, performativity, and gamification. Tracing back and forth along the things I swallowed, the shared memories are poured, chopped, scrambled, melted, baked, and plated up together to serve audiences, generating a narrative on boundaries and relationships.

My recent project, *Unending Meal (2018),* annotates, unravels and entangles a mealtime with the issues of culturally brewed representation and a sense of interconnectivity. In this work, the leftover food from the meals is transplanted on petri dishes. The bacteria and fungi grow as the food is rotting. The microbes from the participants’ body fluids on the food grow together. This microscopic world turns into poetic and abstract imagery. The enlarged images of microorganisms are reimagined as a playful 3D animation and sculptural objects. The audiences are invited to play with the objects as an input to manipulate the 3D animations and other videos in real time. Multi-channel videos are produced with the video footage of the meals, the animations, and other materials. The audio recordings of the conversations during the meals are transcribed, edited, and inserted as a sound and subtitles. The video explores the interlaced dialogues and narrates the conceptual framework. Representation of the mealtime is installed together. In addition, an interactive storytelling video is produced using a game engine. An audience plays with a controller and manipulates the order and duration of the scenario and this interaction remaps and restructures the timeline and the plot of the story.

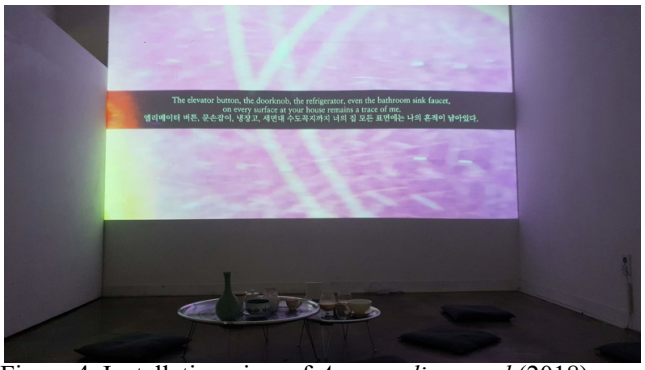

Figure 4. Installation view of *An unending meal* (2018) © Sanglim Han

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Garrett Laroy Johnson: Garrett Laroy Johnson works with responsive media environments to probe, condition, engender, and refract relations between technological determinations and productions of subjectivity. Trained as a musician and musicologist, questions of ensemble, materiality, expression, gesture, and vocality are central to his research. Johnson designs and creates digital-physical systems to compose with sound, light, and expressive materials in immersive and quotidian spaces alike. Johnson has presented research-creation at ACM MOCO, SEAMUS, SLSA and SLSAeu, ACLA, AAG, and has had works performed and exhibited at Kennedy Center as well as the National Academy of Sciences in DC, in London, San Francisco, Cincinnati, and Phoenix. A significant aspect of his work deals in community building and organizing, exemplified in varied and far-flung groups such as LORKAS (the laptop orchestra of arizona state, 2013-2015), PHuN (the post-human network, 2016-present), and ITITIT{inc} (2017-present). Garrett received an MA in musicology from Arizona State University and a B.M in Music History from Ohio University. He's currently a PhD candidate in Media Arts and Sciences at Arizona State University. He is a researcher at Synthesis @ ASU and ASU's Center for Philosophical Technologies.

Sanglim Han: Sanglim Han explores disembodied, fragmented, and interstitial bodies. Through performative media, primarily simulated 3D animations and experimental games, she creates a site for fluctuating identities where our personal and social experiences are revisited, and boundaries are convoluted. Her works have been presented internationally at various venues and festivals from Austria, Bulgaria, Denmark, Ethiopia, Germany, India, Netherlands, Spain, Portugal, South Korea, Turkey to the USA. She first enrolled at the Korea Advanced Institute of Science and Technology, then began her art studies at the School of the Art Institute of Chicago. After receiving her BFA, she researched an intersection between art and science at the University of California, Los Angeles where she received her MFA. www.sanglimhan.work

ISEA2020

Some Provocations from Skeptical Inquirers about Animal Sentience

Panel Discussion

Patricia Olynyk[1], Ellen K Levy[2], Meredith Tromble[3], Bob Gluck[4], Joel Ong[5]
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Introduction

Patricia Olynyk and Ellen K Levy

Artists at the art/biology, human/animal interfaces have embraced evolving technologies, particularly over the past half-decade, producing works that explore sentience and non-human subjectivity; cognition and perception; animal welfare; and interspecies communication. This panel will discuss a selection of works that engages technology to explore the territories of human/nonhuman sentience, agency, interactivity and collectivity. This panel will also consider DIY biology and a host of exhibitions over the past decade in which polarizing debates concerning animal welfare, censorship, and the claim of racist culturalism have emerged.

Those whose works we reference include: philosopher and social theorist Brian Massumi, who views the body and media as cultural formations that operate on multiple registers of sensation and who also claims that through animality, humans can ascend to an ethic that is creative, expansive and vital; art historian, curator, and critic, Caroline Jones and her critical writing on the mediated sensorium; Professor of Comparative Literature Daniel Heller-Roazen and his theories on the archeology of sensation; and ornithologist Richard Prum whose research on birds substantiates the role of avian and human songs and their impact on gesture and language, social memory, the social ecologies of songs, and the conditions that make cultural transmission possible.

Keywords

Sentience, cognition, perception, animality, ethics, social memory, affordances, CRISPR technology, phylogenetic, cultural transmission, molecular phylogenetics, microbiome, quorum sensing, zoomusicology, interspecies, sensorium, Umwelt, genetic engineering.

Interspecies communication: failing again, failing better

Meredith Tromble

Some thinkers argue that sentience, defined as the capacity for sensation or feeling, exists throughout the material world. Western cultures disempower entities with whom humans can't communicate with as “objects” or “animals,” but the divide may be in communicative abilities, not sentience or lack thereof. This paper pursues the troubled notion of “interspecies communication” through a discussion of new media works by artists including Stephanie Dinkins, Ian Ingram, Richard Lowenberg, Rachel Mayeri, and others. The concept “interspecies communication” is a mess. It falls apart at the beginning, in the middle, at any conceivable “end.” How are we to distinguish, with our new awareness of the microbiome, among “species?” Are the dynamic entities we attempt to grasp and hold within that term discrete enough to speak of “inter-”change? Even if we affirm our opening concepts as imperfect but useful, and step into the realm of “communication,” the ground crumbles before us. The many relevant sciences, from primatology to marine bioacoustics and bacterial quorum sensing, offer a swarm of different ideas about what “communication” might be. Turning to our lived experience, we ask how an exchange of thoughts, feelings, or information between a human and nonhuman can be verified, when humans rarely understand each other? These conundrums press as the need to rethink our relationships with nonhuman species, lest we lose them altogether, grows.

Trans-species perspectives on musical mind

Bob Gluck

Music making is a phenomenon that transcends species, human and non-human. The presence of non-human musical minds has been established by many researchers, among them zoomusicologists (Hollis Taylor, Emily Doolittle, Francois-Bernard Mache; all of them also composers); performer/observers (David Rothenberg); ethologists with

musical interests (Donald Kroodsma, Rachel Levin, Peter Marler, Katy Payne, Richard Prum, Alexander F. Skutch); and ethnomusicologists and observers of cultures retaining a strong connection between music, ritual, and the natural world (Theodore C. Levin, Bernie Krause), and other thinkers (Joan McIntyre, Dario Martinelli, Thomas Sebeok). Human musicians draw upon not only melodies but formal models of songbirds, and antiphonal forms transcend species despite unrelated evolutionary descent and differing anatomical and mental structures. Certain songbird and whale species display musical social learning and individual musical innovation, factors once thought to be uniquely human. How can we balance the uniqueness of specie-specific expression with analogous forms of expression cross-species? Environmental context, physiology, the role of learning and culture (human and non-human), and specie-specific "interests" seem, to an important degree, to drive differences and parallels between musical minds, human and other. James J. Gibson ("affordances") and Jakob von Uexküll (*umwelt*) provide helpful frameworks addressing how context drives expressive modalities. This presentation will address what we can learn about animal (human and non-human) sentience from the evidence of musical expression viewed from a cross-species perspective.

Co-culturing sentience: a multi-species ecotopia

Joel Ong

Where traditional eco-criticism addresses notions of the pastoral and rural as utopian visions, an emerging ethics around artificiality and hybridity (from both the sciences and the computational arts) presents a future perspective that is more entangled with the "wild" than is disruptive. Indeed, many forms of life exist now within our ecosystems at the intersections of *in vivo, in vitro and in silico* forms (Peters 2014). Our nascent ability to comprehend all these simultaneously is in itself a very important progression of the body's *mediated* sensorium, where embodiment and experience reminds us of our existence within a very diverse ecology of species and sentiences (Jones 2007).

This paper will discuss a series of research-creation activities and workshops around the research project "Umwelt Microbiana". Highlights include explorations of the aerial microbiome, experimental cycles of co-culture of skin/earth bacteria, ecoscenography workshopping in the urban microbiome, and the creation of *in vitro "*neo-life" via genetic engineering. In the era of climate change, viewing elemental and organic media as repositories of sensory information (a microbe's *umwelt* for instance) encourages a sort of self-reflexivity that we speculate can lead to a set of guidelines for an *eco-topia.* As well as being experientially oriented, the project also focuses on creative story-telling, where parallel lineages of environmental poetics in the history of literature and music (in the vein of Thoreau, Frost, Muir and Debussy etc) provide models for blending artistic and scientific modes of information. In our experiments and workshops, we have also created participatory mythologies that merge indigenous mythologies and scientific knowledge and will share these briefly.

Channeling Doolittle

Patricia Olynyk

In response to a technology mediated world increasingly desensitized to physical sensation, some artists employ technology to call upon viewers to expand their awareness of the worlds they inhabit, whether those worlds are their own bodies or the interspecies environment that surrounds them. This presentation will examine our mediated sensoria and how technology affects communication with and between our non-human others. "Amplified, shielded, channeled, prosthetized, simulated, stimulated, irritated…our sensorium is more mediated today than ever before." (Caroline Jones, Professor of History, Theory and Criticism, MIT). A selection of artworks discussed in this presentation includes: Hörner/Antlfinger's *Contact Call* (2006), a work that plays with the elements of communication among humans, machines and animals in which the competing sounds of mechanical devices— telephones and fax machines—are discovered to be imitated by two live African Grey Parrots; and Kuai Shen's *Playing With Ants & Other Insects* (2012), in which the artist combines ant mimicry with emergent properties in games and in human culture. This talk will also discuss "pet translators" and new developments in AI algorithms that seek to enable communication with animals.

Empathy on the phylogenetic level

Ellen K. Levy

This presentation explores how scientific knowledge gained through technology (from the microscope to CRISPR-Cas9) has enlarged our ideas of sentience. Earlier concepts were based on Aristotle, suggesting that species could be rated on a "unilinear, phylogenetic scale." Technology continues to change the way we view species across the phylogenetic spectrum. A notable example is the re-gendering of the heraldic "King" bee of the 17th century, originally thought to be male, stingless and selected for its "beneficence" to represent the Barberini family. According to art historian David Freedberg, the advent of microscopy brought about a shift in how the bee was viewed along with an altered reception of the scientific method. In our time, Carl Woese's work in molecular phylogenetics, the study of the genetic relationships among microorganisms, resulted in taxonomic revisions with new principles of organismic descent. Epigenesis is similarly now changing our notions of classification and how we relate to microorganisms. This talk explores how such changes influence our understanding of sentience. Research discussed includes ornithologist Richard Prum who substantiates the role of female sexual agency with regard to sentience. Artistic examples include Bill Tomlinson and his

team who have used AI interactively to model animals undergoing social integration.

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Author's Biographies

Patricia Olynyk's art and writing investigates the ways in which social systems and institutional structures shape our understanding of science, human/non-human relationships, and the natural world. She was appointed inaugural director of the Graduate School of Art in the Sam Fox School at Washington University in 2007, where she was also appointed as an endowed professor. She holds a courtesy appointment in the university's School of Medicine and is a fellow in the Living Earth Collaborative. Earlier, Olynyk was faculty in the School of Art & Design at the University of Michigan, where she also became the first non-scientist appointed to the university's renowned Life Sciences Institute. She is the recipient of numerous awards and distinctions and has exhibited her work nationally and internationally at: Palazzo Michiel, Venice; the Saitama Modern Art Museum, Japan; the Brooklyn Museum; the National Academy of Sciences in Washington, DC; and the Los Angeles International Biennial.

Ellen K. Levy is a NY-based artist whose practice encompasses mixed-media installations, lecturing, curating, and writing. She was president of the College Art Association (2004-2006) and earned her doctorate in art and neuroscience from the University of Plymouth (2012). She then was Special Advisor on the Arts and Sciences at the Institute for Doctoral Studies in the Visual Arts. Her diploma is from the School of the Museum of Fine Arts, Boston following a B.A. from Mount Holyoke College. Levy has had numerous exhibitions, in the US and abroad, including the New York and the National Academy of Sciences. Honors include an arts commission from NASA and AICA show award. She was Distinguished Visiting Fellow in Arts and Sciences at Skidmore College (1999). With Patricia Olynyk she co-directs the NY LASER program, part of Leonardo/ISAST. She has published widely on art and complex systems and curated exhibitions on complexity and neuroscience.

Meredith Tromble is an intermedia artist and writer who makes installations, drawings, and performances, often in collaboration. Her curiosity about the links between imagination and knowledge has stimulated a number of collaborations with scientists, including the Vortex series of drawings, interactive artworks, and performances. Her work has been presented nationally at venues ranging from the Yerba Buena Center for the Arts, San Francisco to National Academy of Sciences, Washington, D.C and BioBAT Art Space, Brooklyn. She holds joint appointments as artist-in-residence at the Complexity Sciences Center and visiting scholar at the Feminist Research Institute at the University of California, Davis. She is the editor of two books, The Routledge Companion to Biology in Art and Architecture, co-edited with Charissa Terranova, and The Art and Films of Lynn Hershman, University of California Press. Her recent publications include PUBLIC Journal #59, Interspecies Communication, co-edited with Patricia Olynyk.

Bob Gluck is a pianist, composer, writer, rabbi, and professor of music at the University at Albany. Born and raised in the New York metropolitan area, his eleven recordings include works for jazz ensemble, duets, and electronic

media, most recently Early Morning Star (FMR 2020). His interactive installation, a collaboration with Cynthia Beth Rubin, Layered Histories, has toured internationally. Gluck is author of three books You'll Know When You Get There: Herbie Hancock and the Mwandishi Band (2012) and The Miles Davis Lost Quintet and Other Revolutionary Ensembles (2016), both published by University of Chicago Press. The Musical World of Paul Winter, an Intelligent Arts eBook (2019), surveys the work of the saxophonist/environmentalist. His current work is an exploration of human music making within a trans-species context. Gluck completed an MFA (Rensselaer Polytechnic Institute, 2001), and master degrees in Social Work and in Hebrew Letters.

Joel Ong is Assistant Professor in Computational Arts and Interim Director of Sensorium: The Centre for Digital Art and Technology at York University in Toronto, Canada. Ong is a media artist whose work typically involves artistic and scientific perspectives of the environment expressed through sound, video and interactive elements. His installations and research projects have been shown and presented at various venues around the world. Following his studies in Biology and Ecology at the National University of Singapore, his graduate studies at SymbioticA, the Center of Excellence in Biological Arts at the UWA resulted in a project that merged nanotechnology, tissue culture and sound. He has continued his explorations in the Interdisciplinary Arts through individual and collaborative works with scientists in environmental studies, microbiology and data aesthetics. Ong is an artist with the UCLA ArtSci Collective. More information can be found at www.arkfrequencies.com .

ISEA2020
Queering Infrastructure: The System Through the Erotic

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Abstract

This panel questions what a politics of sentience might look like as it examines how the erotic as a queer method can be used to reimagine systems, networks and infrastructures as agential and embodied spaces.

Keywords

Queer studies, eroticism, feminism, pornography, multi-species communication, biotechnology, webcams, ecosystem services, climate geoengineering.

Queering Infrastructure: The System Through the Erotic

In 1978, feminist writer Audrey Lorde presented her seminal essay "The Uses of the Erotic: The Erotic as Power" that challenged the word's patriarchal overtones. In the essay, Lorde not only redefines but reignites the erotic as a power of feeling – a physical, psychic and emotional energy that can't be reduced to a commodified good or systematized affect. In our current zeitgeist of neoliberal and recolonizing regimes, the use of the erotic as a vehicle for understanding and a means of empowerment is re-emerging. Conjoined with the tactics of queering networks, power is being reclaimed through more sentient experiences and actions that disrupt hegemonic narratives and engage a broader spectrum of bodies. The invisible is becoming more perceptible through subtle shifts in knowledge production that embrace intuitive modes of learning. British artist Rachal Bradley calls for an "erotics of infrastructure" as a way to "explore how the pleasurable, the charged, and the circuitous might recalibrate infrastructure from a non-neutral to a negotiable framework underlying our perception and our behavior in manifold ways." This panel questions what a politics of sentience might look like as it examines how the erotic as a queer method can be used to reimagine systems, networks and infrastructures as agential and embodied spaces. Topics include queering the atmosphere, money as a sensory device, laughter through multi species communication, and how aphrodisia can disrupt global machines.

Presentation 1: Aeolian Borders: Queering the Atmosphere

Recent states of border conflicts and migration politics have prompted us to look to the skies as a source of poetic freedom (such as with Joanne Teasdales' kite-building projects in refugee camps). Increasingly, the language and metaphors embedded within these have been commented upon in the same vein as the broader trajectories of animal migration. Albeit, add in the human and these become geo-political events – staged invasions, species migrations, boundary transgressions and other associated anthropogenic activities. At the same time, this "meteorological turn" is not without existential struggle. As emerging visualizations inform us, a rush of personal drones, aeroplanes and satellite companies are sparking similar levels of bordering and control from military and governmental institutions, even as these lines are invisible and transitional. And even more so, the drive towards climate geoengineering and controlling the weather could be the latest, most devastating vestiges of colonization we know. As Associate Director for Research and Innovation at the Red Cross Climate Centre Pablo Suarez says, "These are exciting times for us scientists, but terrifying times for us humanitarians". What is required is a theory (and practice) of deviation, to disrupt the hegemony and patriarchal worldview beyond poster-friendly 'oversight effects' or wildlife conservation documentaries, and to address deeply set values and global cultures that feed our desire to consistently project our desires on the environment, as opposed to with it. The paper approaches this from a position of 'strangeness' as described by Sara Ahmed to address the new cultural frontier of the atmosphere, adding the phenomenology within an awkwardness of 'deviant behaviours' and the politics of mixing with radical eco-poetics from the theosophical/neo-transcendentalist movements in such as Leopold. The paper does not shy away, and instead begins from, the feeling of vertigo and nausea associated with heights and windiness.

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Presentation 2: 'Give me pleasure with your tips!': An Erotic Interrogation of Money on a Sexcam Platform

By promoting online sexual performances, personal interactions, and monetary exchanges between audience and performers, sexcam platforms are machines for the laboring of affect: machines that exploit, accelerate, and capitalize on it. One of the main tools of these machines is the money that circulates within, made-up currencies with many sides. Drawing upon Audre Lorde's *The Uses of the Erotic* (2012), this presentation performs an erotic interrogation on the made-up currency ('tokens') used on Chaturbate.com, one of the most popular sexcam platforms, asking about what is virtual in this 'virtual money.'

This research shows how tokens have several meanings and uses depending on who has them. For the audience, tokens are an affective tool that allows communication and recognition. Although the abstraction of an abstraction, tokens have physical representations through sound and vibrations. In fact, despite its slippery materiality, this currency allows the audience to remotely activate teledildonics inserted in the performers' bodies. This erotic disturbance, as this presentation develops, have infrastructural consequences both for the platform and the bodies that inhabit it. Setting 'the stage for actions to unfold' (Bratton, 2015), the platform allows the materialization of a new assembled body: a mix of humans and machinery—and its impersonation. As with the Industrial Revolution's automaton (Sussman, 1999), this fiction does not surge in a void but in a techno-economic landscape where it could exist, where capital not only reproduces global processes in bodies—as feminist scholars have recalled—but fabricates ones that can affect and be affected by thousands. The automaton is not only a figure here: if a body is formed by relations of forces and velocities (Parisi & Terranova, 2000), tokens facilitate to re-configure the bodies of the performers by embedding capital in their structure, taming and making them able to react to stimuli sent by thousands of unknown viewers. Likewise, this circulation modifies the bodies of the audience as well, giving them the power to affect the body of a stranger remotely, bounded to this assemblage by the sticky qualities of the accelerated affect. The recognition of an erotics of infrastructure, following Rachal Bradley's call (2019), challenges discourses of agency within the platform and opens up novel ways of engagement with it.

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Presentation 3: Subtle Sounds_Queer Laughter

Many creatures and materials operate in a sonic range that is beyond our human hearing, using either an ultrasonic or subsonic range of frequency. Human's hearing spectrum is from 20Hz–20kHz. Ultrasonic vocalized sounds and communication exist side-by-side our own limited audible range, perceived only subtly by us. What are the erotics of these sounds? What is the power in them? The artists working with sound technologists, audio engineers and scientists are developing tools to engage with this hidden audio world. One project has been "Rat Laughter" that uses ultrasonic rat giggles to compose a chorus of laughter for rats to enjoy. Hahahahaha. Listening to this laughter chorus "translated" technically puts the listener in the position of an "other" species. The use of vocal indicators of various other emotional states in other species has helped reveal emotional circuits that may be of importance in understanding the ancestral sources of human emotionality (Brudzynski et al., 1995; Jürgens, 2002; Newman, 1988; Panksepp, 2007). This research allows us to be aware of our deepest connection to life and the vast amount of information we do not know. Or as philosopher Timothy Morton asks in an essay entitled "What is Dark Ecology?": Ecological awareness forces us to think and feel at multiple scales, scales that disorient normative concepts such as 'present,' 'life,' 'human,' 'nature,' 'thing,' 'thought' and 'logic.' Listening to rat laughter "translated" puts the listener in the position of an "other" species and allows us to engage with their play.

Presentation 4: Aphrodisiac in the Machine

"Aphrodisiac in the Machine" is a multimedia installation that explores the queering and eroticization of biopolitical power in the quest to bioengineer non-human life for human survival. The project takes the form of an environmental sci-fi narrative about a futuristic aquaculture farm. Merging fact and fiction, the story centers around the bioengineering of a new species of cyborg oysters that are able to convert toxic water into an aphrodisia-inducing fluid that is piped into municipal water sources. Playing on the libidinous myth of the oyster, a hermaphroditic organism, the project explores aphrodisia as a more sentient state of being and empowerment that moves beyond mere sexual connotations. It questions the contradictions within new technological models of bio/geo environmental engineering that can often adversely affect nonhuman life and how creating more sentient and perceptible "humans" might be another path to consider.

The project extrapolates on a 2005 scientific study examining whether oysters are actually aphrodisiacs. The study made a buzz in the media but a definitive answer was never determined and no explicit follow-up study on the topic has been conducted since.

The project also casts light on the oyster's long history of domestication and its current role in ecosystem services, questioning the ethics and environmental consequences of utilizing "natural capital" as resources for extraction. Once a food source of the proletariat, the oyster evolved into a bourgeois delicacy that is now nearly extinct due to anthropogenic factors. Initiatives to repopulate go beyond its providing sustenance to the organism's ability to filter massive amounts of polluted water (up to 50 gallons per day) and the use of "oyster-tecture" – leveraging the oyster's habitat as a natural reef barrier against sea level rise.

In the project, the myth becomes a metaphorical wrench in the new global machine of sea farming as more sentient ways of being are unleashed into networks and infrastructures. Focusing on current environmental issues, the narrative moves between multiple perspectives and ways of knowing and being sentient as the story unfolds — the human, the libidinal, the oyster, the invisible living matter in the water and of the network. A non-human subaqueous system is explored comprised of not only the organic flesh and fluids of the oyster body but also the flows of data that circulate throughout.

Authors Biographies

Joel Ong is currently Assistant Professor in Computational Arts and Interim Director of Sensorium: The centre for Digital Art and Technology at York University in Toronto, Canada. Ong is a media artist whose work typically involves artisitic and scientific perspectives of the environment expressed through sound, video and interactive elements. His installations and research projects have been shown and presented at various venues around the world. Following his studies in Biology and Ecology at the National University of Singapore, his graduate studies at SymbioticA, the Center of Excellence in Biological Arts at the UWA resulted in a project that merged nanotechnology, tissue culture and sound. He has continued his explorations in the Interdisciplinary Arts through individual and collaborative works with scientists in environmental studies, microbiology and data aesthetics. Ong is an artist with the UCLA ArtSci Collective. More information can be found at www.arkfrequencies.com.

Antonia Hernandez is a Montreal-based Chilean media artist and PhD candidate in Communication at Concordia University. Mixing media practice and theoretical investigation, her current research explores maintenance activities and the circulation of money on digital platforms.

Kathy High is an interdisciplinary artist working with technology, art and biology. She collaborates with scientists and artists, and considers living and dying systems, empathy, animal sentience, and the social, political and ethical dilemmas of biotechnology and surrounding industries. She has received awards including Guggenheim Foundation, National Endowment for the Arts. Her artworks have been shown at the Museum of Modern Art (NYC), Science Gallery (Dublin), NGBK (Berlin), MASS MoCA (North

Adams). She has had residencies with SymbioticA (2009-10), Finnish Society of Bioart (2013), Coalesce UBuffalo (2016-17), Djerassi Scientific Delirium Madness (2019). High is Professor in Arts at Rensselaer Polytechnic Institute, Troy, NY, with a laboratory in the Center for Biotechnology and Interdisciplinary Studies.

Stephanie Rothenberg's interdisciplinary art draws from digital culture, science and economics to explore relationships between human designed systems and biological ecosystems. She has exhibited throughout the US and internationally in venues including Eyebeam (US), Sundance Film Festival (US), Massachusetts Museum of Contemporary Art / MASS MoCA (US), House of Electronic Arts / HeK (CH), LABoral (ES), Transmediale (DE), and ZKM Center for Art & Media (DE). She is a recipient of numerous awards, most recently from the Harpo Foundation and Creative Capital. Residencies include ZK/U Zentrum für Kunst und Urbanistik in Berlin, TOKAS / Tokyo Art and Space, the Lower Manhattan Cultural Council Workspace, Eyebeam Art and Technology and the Santa Fe Art Institute. She is Associate Professor at SUNY Buffalo. www.stephanierothenberg.com

ISEA2020

Life, A Sensorium: Perspectives from the Sensorium Exhibition at ISEA2020

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Abstract

This Panel is the collection of processes and thoughts related to the group exhibition at the International Symposium on Electronic Art (ISEA) in Montreal this May 2020. The exhibition entitled LIFE, A SENSORIUM investigates the nexus of art, science and technology through the works of artists and researchers affiliated with Sensorium: the Centre for Digital Art and Technology at York University in Toronto, Canada

Keywords

Sensorium, digital art, research-creation, computational art, archive

Introduction

This Panel is the collection of processes and thoughts related to the group exhibition at the International Symposium on Electronic Art (ISEA) in Montreal this May 2020. The exhibition entitled LIFE, A SENSORIUM investigates the nexus of art, science and technology through the works of artists and researchers affiliated with Sensorium: the Centre for Digital Art and Technology at York University in Toronto, Canada. Collectively, the exhibition presents trajectories of research-creation through the faculty that explore corporality and adaptation within the variegated ecologies of the nascent digital/virtual environment. Through multi-sensory experiences, VR and alternative performance structures and installations, the exhibition aims to create affective narratives that extend theories of the post-natural, and play witness to a broader trend of artistic interventions inspired by the dynamism, flux and evolution of life. The panel is consisted of the curatorial team for the exhibition and will focus on the development of central research clustering/topics related to the exhibition leaning on present and past curatorial processes and documentary and archival strategies for digital work.

Presentation 1: Curating Life, Sentience and Computational Art

Collectively, the exhibition "Life, a Sensorium" provides an opportunity for the reviewing of the diverse research questions explored through both theoretical and experimental methods at the research unit Sensorium, and to gather perspectives on current and future research clustering here as a way to situate faculty-based research within institutional armatures, as well as within and in response to external trends in broader digital culture. Most poignantly, any unit that seeks to explore digital culture has to acknowledge the complex network of social, biological and cultural factors that dictate the way life is understood today. In particular, I will focus on selected artworks representative of the Department of Computational Arts at York University the way that these explore an emerging intersection of life through i*n vivo, in vitro and in silico* experimentation. In addressing the works of Mark-David Hosale, Graham Wakefield and Doug Van Nort as they are curated within the exhibition, this paper explores the paradox of quantification in creating sublime and 'immeasurable' works of art, as well as the auto- and allo- poetics of technoscientific entities such as virtual and reactive ecosystems/architectures. Collectively, these works encourage a viewing of *life* as a dynamic unfolding of sentience and multi-sensory aesthetics that emerges from unlikely couplings of digital and analog systems, natural and artificial sense-making processes and emergent forms of knowledge production. In addition, the presentation extends discourses around care and kinship in creating artificial entities and/or environments for co-existence.

Presentation 2: Shared Ecologies: Curating Artistic Knowledge Production in Science and Technology

In March 2019, I produced a one-day exhibition partnership with Sidewalk Labs Toronto — the Alphabet-funded urban development firm that has proposed to transform urban planning from the ground up. As part of a longer curatorial residency, the Winter Warmer exhibition introduced a series of art installations into the public display area of their 307 office space, with the intention of integrating artistic research into the important urban planning conversations circulating around the Sidewalk project.
This paper will discuss the theoretical underpinnings to my curatorial practice, which emphasizes slippages between visual art and other exhibition contexts. The intervention of visual art into non-art realms, like Sidewalk's Winter Warmer, Toronto's CRAM academic research festival (2019), and even city streets (The Situated Cinema Project, 2015 and Urbanity on Film, 2009) have all functioned as gestures of knowledge-creation that bring together the embodied experience of being-with-art and the critical discussion that circulates exhibitions. Art provides a means for thinking-differently about the world, that can exist alongside (and sometimes in paradox) with more traditional academic thought. It is in the tensions or surprising synchronicities between the two seemingly-incompatible forms, that new knowledge arises and becomes both known and emotionally embedded by the spectator. The talk will present relevant examples of artworks from the associated exhibition.

Presentation 3: Archival Remediations and the Temporalities of Climate

This talk will engage with the research that is tied to Archive/Counter-Archive: Activating Canada's Audio Visual Heritage (A/CA), a six-year research-creation SSHRC partnership project focusing on the changing nature and political realities of community based Audio Visual archives in Canada. A network of over 20 archival organizations, many artist run, the project brings together archivists, artists, curators, and humanities based researchers to think about new creative ways to support these different archives with a strong focus on Indigneous, LGBTQ2, Immigrant and women's archival histories—what Juana Suárez calls "minor archives". The presentation will engage with new approaches to the preservation of collective memory that are community based, localized and that reflect a new sense of place, planetary entanglement and archives. The concepts of "liveness," "activation" and "performativity" are at the centre of these situated articulations of the archive in the 21st century that unfold in the context of climate change. Inspired by philosopher Catherine Malabou's recent thinking about Climate Change and her work on plasticity, I am interested in how artists are working to create images for this complex temporality by using the archive as medium. The talk will present relevant examples of artworks from the associated exhibition

Microscopic Otherness and Signs of Sub-molecular Sentience

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Abstract

Human interactions with the microscopic realm and below are mediated by a suite of wonderfully complex apparatuses. These technologies are not passive observational instruments, instead they arguably create the very phenomena scientists are seeking to observe—as the champion of experimentalism Ian Hacking stated, 'to experiment is to create'. [1] Working with such devices, whether in science or art, challenges classical notions of objectivity. These talks examine issues surrounding subjectivity and objectivity in terms of creative practice, and the uneasy state that exists between epistemology and ontology across art and science, drawing upon the theories of Don Ihde, Gilles Deleuze, Felix Guattari, as well as Ian Hacking, Anton Zeilinger and Karen Barad.

Keywords

Media art, technological embodiment, gesture responsive technology, Quantum physics, agency, epistemology

Problematic Perception: Human Interactions with Nanotechnology

In the context of perceptual experience, the sub-molecular realm is a problematic space. Instead of encountering stimuli that the human sensory system has evolved to perceive, we find instead extreme dynamism, light waves that are too small for even our most sensitive optical systems to detect, and physical forces unfamiliar to the human body. Scientific instrumentation, then, has a huge interpretative and translational role in making sub-molecular phenomena sensible for humans. These scientific instruments, unlike analogue technologies, often relegate the human body to the role of mouse clicking rather than a more visceral engagement with the world. *The Society of NanoBioSensing* is a large-scale gesture-responsive projection that enables the viewer to explore Scanning Electron Microscopy images of engineered nanoparticles that act as a gene delivery system into specifically targeted cells. The viewer engages with the imagery, manipulating the images through movement and gesture. The presence of nanotechnology in relation to human biology is made explicit through the content and the scale of the work, while the gestural relationship creates an embodied explorative experience.

Making creative work that engages with sub-molecular phenomena, in my case working with nanoscale phenomena created by chemists, materials scientists and biotechnologists, raises one problem above all others: a lack of direct sensory experience. The nanoscale is 0.1 to 100 nanometres (nm), the size of DNA and viruses, and is the scale where quantum effects begin to reign. Problematically, the light waves visible to humans and most optical detection systems are too large to reflect off nanoscale phenomena.

Humans must rely instead upon instrumentation that not only amplifies light, as in an optical microscope, but that translates digital data into a sensible form, most commonly visual. While some instrumentation collects electrical, magnetic or tactile information from the nanoscale, an "image" cannot be captured all at once and instead is collected pixel by pixel, line by line, by exquisitely precise scanning technologies. The instruments' sensitivity means that they must be sequestered away from the user who, sitting apart at a computer, is separated from the phenomena of interest through many mechanical, algorithmic and digital layers.

This complexity of apparatus is necessary to bring sub-molecular phenomena into our perceptual, or phenomenological schema. Don Ihde's analysis of "technological mediation" and Clark and Chalmers' "extended mind" draw different boundaries of the human mind in relation to technologically augmented experiences. [2, 3] To Ihde, an

embodied technology is brought within the schema of the body, while for Clark and Chalmers, the mind extends amorphously outside the body to incorporate various technologies simultaneously. [4] However, neither analysis addresses how this embodiment might shift in relation to the infinitesimally small. What are the phenomenological scenarios that arise in our interactions with sub-molecular phenomena? This is where media art enters the fray, by creating a three-way entanglement between what Susanne Sæther describes as the 'industrial' technologies of science, the 'post-industrial' technologies of media, and the 'natural' techniques of the body and mind. [5]

While many tools have been rigorously analysed for their phenomenological effect on the user, complexes of scientific instrumentation require deeper analysis. [6, 7, 8] Malcolm McCullough argues that even complex tools of sensorial abstraction, such as those used to interface with the nanoscale, can be transparently embodied, i.e. the awareness of the tool drops away and the attention focuses on the material rather than the tool itself. [9, 10] However, in my experience with computer-operated scientific systems this has not been the case. [11] This disconnect has inspired my interest in returning the encounter with sub-molecular phenomena to our embodied sensory systems, or, getting the computer and the instrumentation out of the way.

The Scanning Electron Microscope (SEM) that I use in my project *The Society of NanoBioSensing* uses a beam of electrons to gather information about the form and shape of larger objects such as insects but also large nanoparticles. [12] This project is a two-story high gesture and motion-responsive projection that enables people to explore SEM images of engineered nanomaterials. I created super-resolution images (65000 by 40000 pixels) of copper tetracyanoquinodimethane (CuTCNQ), a crystalline material that acts as a sponge for environmental and industrial toxins, and a Zeolitic Imidazolate Framework (ZIF-8), a nano-engineered material that acts as a gene delivery system and cancer therapy for specifically targeted cells. The resolution of the images allows the viewer to navigate three dimensions of the images: left/right, up/down, and zoom in/out.

I have developed a hand-based gestural system, however the limitation of this is the requirement of a plinth or other material interface to mount the sensor on (due to limitations in the sensor's range). This in turn limits the movement of the viewer, gluing them to one spot instead of allowing or encouraging them to explore the space in front of the image. In response to this I am developing full body sensing. While the hand is quite at home in relation to gesture-responsive digital technologies the body has not yet fallen prey to such constructed languages of gesture. This frees the viewer to explore a broader range of movements in playing with the work. Another benefit of using full body gestures is that in asking the viewer to perform movements at a larger scale than those in their day-to-day digital interactions, they are made keenly aware of the lack of gestural or sensible possibilities in relation to sub-molecular phenomena.

As we increasingly enable the detection of sub-molecular phenomena with our instruments, we must be perceptually capable of understanding them, and this means bringing the full range of our sensory apparatus to the phenomena. Implicit in my work is a dual desire, at once to return to the gestural state of the body, instead of a static one, and also a quest for unmediated perceptual knowledge of imperceptible phenomena. *The Society of NanoBioSensing* can be read as a form of resistance against the increasing digitisation of scientific observation, which occurs with greater frequency where technological mediation is required, and particularly where there is not only an amplification of stimuli, but also a translation of sensory stimuli. The work recalls a time where the body, the sensory and kinesthetic experiences were a greater part of scientific knowledge production. In *The Society of NanoBioSensing* gesture leads techno-scientific infrastructure, instead of the other way around.

Artificial Sentience from Quantum Chaos.

No matter how hard the human tries to be certain there is no actual point where certainty can take place. This abstract contribution focuses on chaos to identify, conceptualise and visualise a liminal space between the classical and quantum world; everything is in some state of chaos.
This speaker will ask questions of visualising the invisible, indiscernible and unfathomable quantum world of subatomic particles. This quantum artistic research examines the role of atomic and subatomic particles in the search for sentience, materially, ethically, scientifically and culturally. The burden of molecular ethics and aesthetics of care are discussed to enable a critique of the information given to us by science.

The atomistic classical world is in chaos as it vibrates, swirls in probability smears and smudges of energy at the atomic level. Sentience is part of the material world of oscillating swarms, of smears and smudges where atoms can assemble into cells, then tissue to become organs. If we were to travel in a reverse direction, towards a reduction in the scale, all our chaotic particles become smaller and smaller until subatomic particles collide into Heisenberg's uncertainty principle. Our classical chaos is not allowed to keep on reducing in the same way, as it hits a transition threshold, a liminal space defined by the realm of quantum chaos. [13]

In the artwork 'Quantum Chaos Weave', data affect the materiality of the photographic images of felt, relating to Gilles Deleuze's and Felix Guattari's [14] concept of smooth and striated space. The smooth space of felt is not woven, knitted, knotted, intertwined or laced. It is not straited space where the warp and the weft of the woven fabric measures the boundary of the body's movement in space. Felt has its own integrity; its tensile strength is born of chaos and the material becomes a second skin between the body and the world. This is where the real beauty of art lies, in the attempt to capture an ideal born out of chaos, along with quantum chaos latent at the core of matter. This ongoing pursuit of

the ideal, a visual appearance, a vision of nowness that is qualitative, intuited but never quantified.

Possibilities of perception.

In this section, relationships are drawn out between the human investigators of the imperceptible realms, as discussed above, the mediating technologies, and the molecular and subatomic entities themselves. The complex and (possibly) entangled relationships between the observer and observed raises issues regarding the agencies of observation and phenomena, and ultimately the epistemological and ontological reality (or otherwise) of these realms at the limits of scale and perception.

As Ian Hacking, the champion of experimentalism, says, 'to experiment is to create, produce, refine and stabilize phenomena.' [15]

The further we go down the scale, the more the apparatuses shape the phenomena we are investigating, and when we cross the threshold of the subatomic, subatomic, the devices literally create the phenomena they are probing. [16] In the quantum realm, matter and meaning are formed together in physics experiments. So, to understand both the material and conceptual aspects of observing subatomic nature, we must also investigate the devices, the agents of observation. Through the 'point of view' of the apparatuses, [17] insights into the wider conditions of experiments can be gained. More than just playing the role of "passive data acquisition", such apparatuses are intermediaries between humans and subatomic nature, and each apparatus can have its own idiosyncrasies. Such apparatuses become active collaborators, and their own nature must be taken into consideration when responding to and interpreting experiments, as is described below.

Furthermore, the data produced, and extrapolations of meaning can be strange and counterintuitive, and without the context of the specific experimental setup, such data is arbitrary. For example, speaking to an electron (via modulation of its spin using a magnetic trap and Rabi resonance) will cause the particle to literally respond, but in a way that is only meaningful within the parameters and goals of the unique experiment setup.

Experiments such as the Large Hadron Collider in Switzerland probe the epistemological and ontological limits of subatomic being, through colliding particles together, releasing trillions of electron volts of energy. Exotic particles such as the Higgs Boson are literally created from this release of energy, but they only exist for femtoseconds, their fleeting forms, known as "signatures", digitally reproduced from literally millions of channels of data. Such signatures are unique as they are both things and signs of such things, bringing together physical forms and knowledge in a 'coalescence of the human and the material', as particle physics ethnographer Arpita Roy states [18].

There is arguably a limit to how such phenomena can be interpreted (and this argument has been going on for a century). In the 1920's, Niels Bohr, the "father of the atom", stated that we are 'constrained by our inability to construct experimental apparatus in anything other than classical or macroscopic forms, [thus] we are denied an insight into the "true" quantum world. What we get instead is the quantum world as reflected in the mirrors of our classical apparatus' [19] 'Whatever the "true" nature of the [particle], the behaviour it exhibits is conditioned by the kinds of experiments we choose to perform.' [20] And, due to the nature of nature on this scale, the outcomes of such experiments can seem contradictory or inexplicable. How do we interpret phenomena such as a particle in superposition (existing in more than one place or time simultaneously) or entangled particles (where two separated particles essentially behave as (or are) one). There are a whole spectrum of possible responses – at the two extremes are those of the realist and the antirealist. On this question, realists such as Einstein, and antirealists such as Heisenberg have opposing viewpoints. A realist may say that science endeavours to give us a 'picture ... of the world [that] is a true one, faithful in its details, and the entities postulated in science really exist.'[21] From a realist framework, the particle in question is, perhaps impossibly, in two places at once. In contrast, antirealism essentially consists of not believing that any reality can be ascribed beyond observation. Heisenberg worked on an abstract mathematical level to such an extreme that he felt that visual models were in fact "disgusting" [22] Conversely, Einstein worked from visual models that were subsequently formalized into mathematical formulas. Perhaps this is where visual artists are uniquely suited to occupying this zone of contention. Whether it be Gerhard Richter visually probing the threshold of abstraction or Agnes Martin, artists are often experts with exploring such limits. And I should add a footnote in response to design theorist James Elkins' book "Six Stories from the End of Representation" [23] – basically I find his premise fundamentally flawed – artists are able, and indeed are uniquely placed to express, in an open-ended myriad of ways, the abstract and unrepresentable.

The phenomena and data produced in quantum physics experiments is strange and counterintuitive in regard to our directly experienced understanding of macroscopic nature. Quantum states are arguably just representations of the knowledge we have of specific experimental setups, according to contemporary entanglement expert (and exhibitor at the Documenta 13 arts festival) Anton Zeilinger. When it comes to the nature of such subatomic entities, it's not that knowledge of a quantum system doesn't exist before a measurement is made, and the measurement produces, but there is no material capacity for such knowledge to exist. This seems like a radical epistemological stance or material understanding of knowledge, where the extremes of realism and antirealism meet. And interpretations of this experiment can differ deeply. New materialist philosopher Karen Barad develops Bohr's concept of phenomena to interpret the relationships between data, meaning and in quantum physics experiments, . Barad says that there is a 'quantum entanglement between the object and the "agencies of observation"' [24] and from this concludes that 'phenomena are the ontological entanglement of objects and observation.' [25]. This

is in contrast to Zeilinger, whose view of entanglement is 'explicitly epistemic (what is entangled is our knowledge of events). For Zeilinger, observed events are 'just events and that's it'.[26] The data from these events is 'objectively random', existing as a form of 'primary reality' [27] more fundamental than the explanations we may later construct. Although such a definition is not unique to data from quantum experiments, what is unique to entanglement is that such data can be part of completely different future experimental arrangements. It is only 'if we wish to have an explanation, we need to complete the experiment ... [which] requires [a] decision that defines the meaning of the data already obtained'. [28]

In reframing the debate from removed or abstract representations of phenomena to a more dynamic material engagement with nature, physicist and philosopher Andrew Pickering provided an 'ontological vision of the world ... in which both the human and non-human are reorganized as open-endedly becoming, taking on emergent forms in an intrinsically temporal "dance of agency". [29] This notion expresses the essence of the unique nature of technologically mediated perception of such realms of phenomena, in terms of the inter-relations between the scientists, the apparatuses and the phenomena. Such phenomena are "instances of material agency – they are objects that do things in the world' [30] but also are the apparatuses – as Pickering states, they are "a locus of nonhuman agency'. [31] But, in the reductive framework of "textbook objectivity", such wonderful and complex machinic entities are stripped of their idiosyncratic mystery and charm by people pushing reductionism and scientism. Artists working in this area such as myself seek to challenge the reductive framework, and engage with these mediating devices, as well as engaging with the cultures, theories, and the practices of particle physics. I am currently developing a quantum entanglement installation-experiment, which both produces expressive audio-visual-tactile manifestations of entanglement interpretations, but which also creates actual entangled photons. In this way the project is both the thing and a sign of the thing, as it literally creates entanglement phenomena and poetically "entangles" matter with meanings.

As Hacking states, 'realism and anti-realism scurry about, trying to latch onto something in the nature of representation that will vanquish the other ... That is why I turn from representing to intervening.' [32] Hacking's position within the epistemological debate regarding scientific realism is known as entity realism. Entity realism posits that if you can experimentally, materially intervene or interact with unobservable entities, via scientific apparatuses, they are real. Challenging both Heisenberg's intolerant antirealism and the "naïve realism" of Einstein, entity realism enters the experimental fray. This recasts and intertwines the relations between theory and experiment, macroscopic and subatomic materiality. And I believe it is a way of working that equally applies to artists as well as scientists exploring this field. And, like the scientist who chooses their experiment in light of their own goals and dreams, artists can represent that which is unfathomable, and / or get into the realm of the imperceptible, via their machinic collaborators, and literally interact with and create phenomena. In this sense entity realism applies to art practice as much as quantum physics – the entities become real when the artist is using them to do art. Both kinds of practitioners seek out and touch the unknown, and in doing so make it manifest, make it material and knowable. As new materialist philosopher Manuel Delanda states, 'even humble atoms can interact [with us] in a way that literally expresses their identity", [33] and amplified and filtered through both apparatuses and our own idiosyncrasies, such expressions can take form in a myriad of possible manifestations. Such engagements with these realms of the subvisible, and the interactions with the agencies of the apparatuses and the molecular and subatomic entities, open up new possibilities and forms of perception and knowledge.

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Chris Henschke is an artist who has been working with digital and analogue media, sound and light, and experimental science since 1991. He has undertaken a variety of residencies, including an online artist residency at the National Gallery of Australia, 2004, an Asialink residency, 2007, two residencies at the Australian Synchrotron, 2007 and 2010, and an ANAT “synapse” residency at the CSIRO, 2018-2019. He has a Doctorate of Philosophy, from Monash University, 2013-2017, which included on-site work at the European Organisation for Nuclear Research (CERN), Switzerland, as part of the ‘art@CMS’ collaboration. He has since helped develop a cross-disciplinary curatorial PhD research program with Arts at CERN.

Mental Ecologies: Consciousness as an Emergent Phenomena

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Abstract

Taking emergence as the basis of a theory of cross-scale communication interactions – from subatomic particles, molecules and cells to verbal and gestural communication strategies integrating animals, artificial systems and nature to generate a planetary consciousness, we propose navigating conceptual problems related to emergence-based theories of consciousness. Considering the specificity and subtitles of each contributor approach, the panel weaves poetics and reflections on consciousness and sentience as an emergence from elementary entities promoting communication processes between human body native cells and hosted microbiota (Ribeiro); as syncretic entanglement between humans and machines affording the emergence of awareness of nature based on the Cybersemiotic experience of Yoruba religious expressions (Jacques); as emerging form gestural engagements and relational objects- suggesting a field of technoetic experience that allows for structuring and restructuring of consciousness (Lessner).

Keywords

Emergence-based theories of consciousness, Duchamp's conceptualization of the creative act, Roy Ascott's cyberperception, Cybersemiotics, Technoetic, Transdisciplinary creative practices and theories, Gesture, Engagement, Elementary entities level communication, hosted microbiome, native cells communication.

Cross-Scale Conversations: bioart impacts in a molecular level (Ribeiro)

The complex mechanisms of molecular scale conversations within the human body impacts directly the emergence of macro behavior and, beyond the body, influence and direct integration with other bodies and the environment. The neurotransmitters, molecules, can be seen as packages of information. The intestinal or gut microbiota can be defined as the overall species of beneficial microbes that inhabit the gastrointestinal tract [1,2] representing over 90% of the total microbes that colonize the body. To understand the impact of hosting such an eclectic population of single-celled organisms, intestinal microbiota plays a decisive role in the development and progression of neurodegenerative diseases as shown by a considerable number of recent studies, despite the mechanisms of this association are not fully understood. Although the role of oral bacteria [3,4,5] colonizing the intestine is still unclear, intestinal colonization by bacteria of oral origin has been observed and in some cases correlated with several negative health conditions such as inflammatory bowel disease. Nevertheless this shows that the transit of microbiota between oral and gut microbiomes is not only possible but also effective. In the International System of Units (SI) the mole is the unit of measurement for the number of particles contained in a given matter. A mole is a number whose value is equal to the Avogadro's number. To help discuss and understand communicational phenomena that occur at elementary entities' scale, I work, as a conceptual strategy, with the term "[…] molmedia – a metaphorical reference to the concept of 'mole', denoting here not exclusively the quantitative amount of substance but the information exchange processes (taking the substances as messages) that are going on at the elementary entity level, such as atomic, subatomic and molecular, within a given system, which could be a living organism"[6] Taking media (plural of medium) as an intervening agency, means or instrument, emitters and receivers in this system are the microbiota (dysbiome) and the organism cells. As a contribution for the panel I consider a discussion around the implication of proposing the concept and how it can have an impact in understanding bioart propositions that integrates the audience in cross-scales conversations that can impact the audience in a structural biological level. I propose to present and discuss recent works in which I approaching the problem from different but complementary perspectives.

Syncretic Entanglement in the Meta-Environment: A Cybersemiotic Experience (Jacques)

Ubiquitous computing has been expanding human-computer interaction to everyday life; turning refrigerators, cars, phones, doors, and so forth, into interfaces; which, in turn, is changing and affecting how humans perceive and interact with information. This expansion of HCI, coupled with Graeme Sullivan's assertion that artists theorize by using "intuition and intellect, grounded in context-specific circumstances [to] provide an experimental base for constructing new frameworks of understanding" [1], reinforces the need for creative new understandings of the relationship among user, information, and interface (meta-environment). Through the lens of cybersemiotics, it is possible to rethink how the elements of the meta-environment relate to each other, to explain their mediation properties, and to start seeing the implications that these

elements have for one another and for the possibilities of expanding consciousness. Grounded on the cybersemiotic star, the representations of the evolving and complex interactions among the elements of the meta-environment gave birth to the Cybersemiotic Experience, where user, information, and interface can be seen taking turns in mediating the interaction and promoting meaning through an inner-outer world exchange (semiotic dance). Ascott describes this exchange as the "double gaze, seeing at once both inward realities and the outward surfaces of the world" [2] and consequently promoting two distinctively different fields of experience (double consciousness). In classical anthropological terms, [double consciousness] describe[s] the shamanic "trance" in which a shaman is both in the everyday world and at the same time navigating the outmost limits of other worlds, psychic spaces to which only those prepared by physical ritual and mental discipline, aided often by "plant technology," are granted access. In post-biological terms, this is mirrored by our ability, aided by computer technology, to move effortlessly through the infinities of cyberspace, while at the same time accommodating ourselves within the structures of the material world. Søren Brier [3] presents the outer world as Umwelt, based on von Uexküll's "objective life world of the animal mediated by interpretations in the context of what makes sense from a biological, evolutionary sense" [4] (Garcia, 2013, p. 167) which, according to Thomas Sebeok, the father of biosemiotics [5, 6, 7, 8], brings forth an Innenwelt (inner world). The syncretic entanglement of the Umwelt and the Innenwelt or the double gaze, which in Ascott's view leads to double consciousness brings fourth the semiotic dance in the construction of meaning. The understanding of the Cybersemiotic Experience [9], reflecting the potential of metaenvironments to promote the construction of meaning through Ascott's techno-qualia, led to the research and conceptualization of the art project—Andrea's Room— which explores correlations between Yoruba religious expressions with events in the natural world that parallel such understandings. Such correlations aim to highlight aspects of the natural world that seem forgotten or discarded against established aesthetic and moral taboos associated with Yoruba syncretic religion.

Emergence, Technoetics, and the Sensory in Gestural Communication (Lessner)

The sensory aspects of gestural communication create cross-scale interactions that contribute to consciousness and sentience. Lygia Clark's later works, such as *Structuring the Self*, demonstrate the sensory's role in structuring consciousness. Clark's therapeutic practice demonstrated that embodied sensation contributes to the interpretation of self in relation to the world.[1] Her *Structuring the Self* process was activated by gestural performances that worked across rhythmic, sensorial, and narrative systems to allow new conceptions of self to emerge. Her work suggests a field of technoetic experience[2] that allows for the structuring and restructuring of consciousness. Her objects used an intensified sensory engagement to make strange familiar sensory experiences.[3] This tension, grounded in embodied consciousness, lead to an awareness of the ways in which qualia moves from providing feedback to structuring our interpretation of the world. The *Speak/Make* project described below was developed after a period of research in Clark's archives. It is influenced by her use of ritualized and focused gestural performances to reframe the processing of memories, inter-personal interactions, and conceptions of self. *Speak/Make* uses algorithms, contemporary rapid prototyping technologies, and sensory engagement as materials in a process that calls on our embodied knowledge and temporal sensibilities building on the suggestion in Clark's work that relational objects can be transformative and therapeutic [4].

The *Speak/Make* project is an in process work that explores how auditory gestures traverse different temporalities and how that process of traversal gives rise to emergent behaviors. It is a piece of code that translates speech into physical objects, generating parametrically designed sculptures whose forms, texturing, and layout are controlled by auditory gestures. This project looks at the nuances of auditory engagement and how its sensory features call on memory in order to subconsciously affect the contemporary moment. These often unconscious vocal behaviors (products of both intuition and socio-cultural training) affect the behavior of individuals and those they interact with in ways that cannot be fully accounted for through intention and will. *Speak/Make* generates physical objects through a Grasshopper/Rhino algorithm that takes sound from the computer's microphone and uses the frequencies, volume, and rhythms of that audio to arrange and transform shapes derived from past intimate encounters between bodies. These shapes come from previous sculptures collectively called Interstitial Castings, castings of the negative space between two people engaged in intimate gestures like air-kissing or pushing one another. Interstitial Castings transduce ephemeral moments of gestural communication into physical forms. *Speak/ Make* uses t2-D translations of the these 3-D forms to create new sculptures in Rhino's model space. They are designed for rapid prototyping processes like 3-d printing and CNC cutting. *Speak/ Make* looks to capture the ways that rhythm, pitch, tone, and other audible gestures create meaning and affect agency. It is another way of looking at how diverse communication strategies go from unconscious habit to tangible physical affects on the contemporary moment. It uses algorithms and parametric modeling to explore the process by which the gestural and sensory contribute to the emergence of conscious behaviors in the physical world.

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Clarissa Ribeiro Biography

Clarissa Ribeiro, Ph.D. in Arts (ECA USP/CAiiA node Planetary Collegium), Former Fulbright Post-Doctoral Scholar in Arts (UCLA, Art|Sci Center/James Gimzewski Lab), M.Arch. (IA USP), B.Arch, member of the UCLA Art|Sci Collective, chair of the first Leonardo/ISAST LASER talks to be hosted in Brazil/Latin America. She is the principal of OI.SE.AU Office for Sentient Architecture, directs the CrossLab research group and art collective and the LIP – Lab for Innovation and Prototyping at the University of Fortaleza. As an independent artist, working in collaboration with artists, scientists, research groups and art collectives in her home country and abroad, she has been producing and exhibiting internationally experimental interactive installations exploring cross-scale informational and communication dynamics. In a broader spectrum, her artistic and re-search interests converge in the exploration of consciousness and the self, creativity, and affection as emergence from local and non-local communication phenomena in macro, micro, molecular and subatomic scales.

Claudia Jacques Biography

Claudia Jacques, Ph.D. (CAiiA node Planetary Collegium), MFA (SVA/NYC), is a Brazilian-American interdisciplinary technoetic artist, designer, educator and researcher. Intersecting art, technology and science, she researches perceptions and processes in the user-information-interface relationship through the lens of Cybersemiotics. She photographs and designs interactive hybrid art and information environments that aim construct experiences in consciousness to promote the expansion of human knowledge. She collaborates with many artists exhibiting and presenting both in the US and abroad. She has published in Leonardo, TEKs, Art & Engine, etc., and serves as Art+Web Editor for Cybernetics and Human Knowing journal. She has been collaborating with UCLA's ArtSci Center since 2011 as an Information and Instructional Designer and is the founder and creative director of Knowledge Art Studios. Jacques teaches studio, digital and communication arts, at CUNY (Bronx) and SUNY (Westchester) community colleges and her studio is in Ossining, NY.

Liz Lessner Biography

Liz Lessner is a sculptor whose work combines traditional fabrication techniques and emerging technologies to create novel sensory experiences. These often interactive objects stage encounters that reframe common occurrences and routine happenings. She was a 2019 Fulbright Scholar affiliated with the University of Fortaleza in Ceará, Brazil. Lessner has had solo shows at Honfleur Gallery in Washington, D.C.; Big Orbit, a Center for Exploratory and Perceptual Arts Project Space in Buffalo, NY; and an upcoming show at VisArts in Rockville, MD. She has exhibited her work nationally and internationally including the Guapamacátaro Center for Art and Ecology in Michoacán, Mexico, A.I.R. gallery in Brooklyn, NY, and Everard Read's Circa Gallery in Cape Town, South

Africa. Her research into embedded electronics' ability to create novel sensory experiences has been supported by grants like the Mark Diamond Research Fund, fellowships like the Eyeo Artists Fellowship, and awards like a Fulbright Research Award.

POSTERS

#MFGA: Make Floors Great Again

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Abstract

Using an applet created with the IFTTT platform, The Resistance Roomba reacts to Donald Trump's twitter feed. Each time Trump tweets, the Roomba begins a cleaning cycle.

Keywords

Internet of Things, Twitter, Activism, IFTTT, Applet, Critical Making, Tactical Gizmology

Introduction

MFGA (Make Floors Great Again) is a robotic performance piece. Using an applet created with the IFTTT platform, The Resistance Roomba reacts to Donald Trump's twitter feed. Each time Trump tweets, the Roomba begins a cleaning cycle.

I believe this subversion can be used to provoke action as a part of a participatory/critical art practice. Technology is so undeniably embedded in our daily lives in the form of house appliances, media platforms, electronic gadgets, we can become almost blind to it. By hijacking everyday technologies or even making our own, we can jolt ourselves into questioning the ways in which they are created, marketed, and used. Using these pervasive technological systems in ways they were not intended produces an opportunity for guerilla art tactics.

IoT as Performance & Action

Technology is so undeniably embedded in our daily lives in the form of house appliances, media platforms, electronic gadgets, we can become almost blind to it. By hijacking everyday technologies or even making our own, we can jolt ourselves into questioning the ways in which they are created, marketed, and used. Using these pervasive technological systems in ways they were not intended produces an opportunity for guerilla art tactics. In *At the Edge of Art*, Joline Blais and Jon Ippolito compare digital art to antibodies, stating "digital art perverts codes, arrests normal operations, recalls latent information or meaning, executes instructions, triggers mechanisms to recognize its activity and preservers in memory [1]."

MFGA (Make Floors Great Again) is a robotic performance piece. Using an applet created with the IFTTT platform, The Resistance Roomba reacts to Donald Trump's twitter feed. Each time Trump tweets, the Roomba begins a cleaning cycle and sends him a thank you tweet. The more the US President tweets the cleaner the floors become. With the passing of the impeachment inquiry in the House of Representatives and the upcoming election, I expect the floors will be cleaner than ever. The Roomba, lovingly named Rupert Murdock, is gilded in faux gold leaf giving it a kitsch aesthetic worthy of Trump Tower (Figure 1.).

Platforms such as IFTTT, designed to increase usefulness of IOT technologies, can be a way for tactical media artists to create tools in the form of applets that push the critical potential of this interconnectedness outside and beyond the systems and corporations that created them.

Figure 1.

Conclusion

This project seeks to subvert the power of the rich via the connectivity of the internet and exploring how we as artists can combine these interconnected technologies to create a new medium for art. I cannot help but be satisfied knowing a man that has never cleaned a floor in his life unknowingly cleans mine multiple times in a day.

We are coming to terms with the consequences of largely unregulated optimism about all of this interconnectivity. Rita Raley stated in her book *Tactical Media*, "Tactical media is performance for which a consumable product is not the primary endgame; it foregrounds the experiential over the physical [2]." As we enter the second decade of the twenty-first century, we sit

upon a huge stockpile of consumer convenience technologies all connected to the internet of things. There has been a rich history of instruction art as a form of critical media that I am interested in exploring through tactical connectivity. By strategically exploiting the ability for anyone to make connections between these technologies, we can combine them to have a more democratic discussion not only about these consumer technologies, but also the systems that drive them.

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Raley, Rita. *Tactical Media.* Minneapolis: University of Minnesota Press, 2009.

Author Biography

Janna Ahrndt received her MFA in Electronic and Time Based Art from Purdue University and is currently the Visiting Assistant Professor of Digital art at Indiana University. She is a part of a wave of new media artists rejecting the notion that craft and technology are directly opposed. Her work explores how deconstructing everyday technologies can be used to question larger oppressive systems and create a space for participatory political action. Her activist and social art practice seeks to blur the lines between the materiality of craft and the digital realm of new media technologies to create socio-political interventions. She has presented research on the use of DIY electronics as a medium for participatory political art at ISEA 2019 in Gwangju South Korea and facilitated workshops in collaboration with the Science Gallery in Melbourne Australia, the Science Gallery in Dublin Ireland and the NEoN Re@ct festival.

The Primary Experience of Sentience – Exhibitions of Art and Media as a Parkour for Participative Visitors. Field Report and Critical Reflection

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Abstract

Works of art influence our perception in different ways. In exhibitions we pass the often successively lined up works of art and let ourselves be "touched" by them in different ways. But works of art are only one part of an exhibition. An exhibition is a framework, a grammar and in view of the changed visitor behaviour, the following questions arise:
How can sentience be transferred to the strategies of exhibiting and what possibilities do media, especially interactive media, offer to stimulate and enrich our sensibility?
How can a sequence of works of art be brought into a constellation in such a way that the exhibition creates a flow that supports sentience in various ways and leads to an added value?
Using the example of the various strategies used for the exhibitions *The Age of Experience* (Hong Kong 2015, Vienna 2016), *ISEA 2016 Hong Kong Cultural R>Evolution* and *Future Memories. Utopia Dystopia Nature* (Hong Kong 2020), the exhibition's various artworks, locations and narratives, the design and media of mediation can be mixed with the curator's goals to create a rich spectrum of experiences for participative visitors. To discuss the curatorial strategies in individual discussions, this field report will be submitted as a poster.

Keywords

Sentience, primary experience, visitor participation, curatorial and design strategies for exhibitions, media art.

About the grammar of a exhibition

Without sensibility, experience and the reflection of this experience is hardly possible. Works of art influence our perception in different ways. In exhibitions we pass the often successively lined up works of art and let ourselves be "touched" by them in different ways. An exhibition is a language spoken in a space. But often both the artworks and the curatorial intention behind the exhibition are not easy to understand by the audience. This concerns works of art of all genres and epochs, but especially works of contemporary art and media art. The importance of the exhibition as a superordinate framework, as a grammar, is often not used enough to support the interplay between the different elements of an exhibition. The challenge for the curator is how to visualize the system of signs, references and semaphores of the individual works of art, while at the same time integrating them into a larger system of dialogues, opposites and confrontations. On the basis of four exhibitions the different tasks, the sequence of the works as narrative are presented and the resulting solutions in the form of dramaturgies are reflected and discussed.

The Age of Experience (2015/2017)

In exhibitions, the primary experience is actually in the foreground, but only in a few exhibitions is the experience made the actual theme of the exhibition. Two different strategies were applied in the context of this exhibition: In Hong Kong the idea of the kaleidoscope and for Vienna the idea of a parkour with four main themes. [1][2]

ISEA 2016 Hong Kong

Starting from a framework of dialogues and confrontations, responses and reflections, the works of 140 artists were exhibited at 4 venues in Hong Kong during ISEA. The locations had different themes and linked the works together. the thematic constellations created dialogues or confrontations between the artworks. [3][4]

Future Memories. Utopia Dystopia Nature (2020)

This exhibition with works by 21 artists, which will be shown in Hong Kong in November 2020, consists of a labyrinth with two paths that provide food for thought for dealing with nature and lead visitors to utopian or dystopian lounges. [5][6]

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Exploring Social Coordination through Computationally Augmented Artifacts using Auditory Feedback

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Abstract

This project aims to design a novel way of rethinking cultural and social behavior by influencing social interaction using a series of interactive utensils. These devices provide different types of auditory feedback when used within a variety of social contexts. They foster social engagement by means of the habitual as well as explorative sonic gestures that they afford within everyday contexts. We discuss the design of this work-in-progress by introducing prior related work and current models, the methodology involved, and by offering some thoughts on its next generation.

Keywords

Computationally augmented interface, affective social interaction, auditory and visual perception.

Introduction

This project explores modes of augmenting social frameworks by enhancing and mediating human perception through gestural interaction and auditory feedback. This experimental approach enables people—who may start out as strangers—to cultivate meaningful social relationships using everyday objects embedded with sensing technologies and microcomputers. The main aim of the project is to create a set of new "musical interfaces," in order to inspire participants to playfully explore and discover new modes of engagement within various social contexts such as in bars or during a dining experience. By using expressive

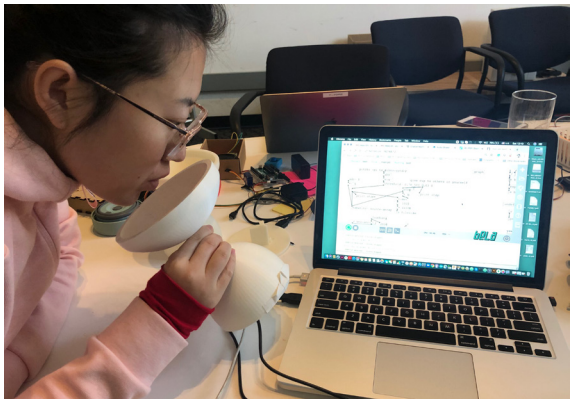

Figure 1. Sonic bodystorming: Vocal sounds are recorded and sound is manipulated by shaking a prototype cup in 3 dimensions.

sonic manipulation, the space in between the habitual and the unfamiliar in human interaction can be explored through the intensification of human affective engagement.

Methodology

1.1 Related Work

We build on prior related work including *Flops* [1], a glass embedded with an orientation sensor allowing the generation and control of virtual sounds through different explorative gestures; *Audio Shaker* [2] where sounds can be mixed by interacting with an ordinary cocktail shaker; and *GameLunch* [3], a sonically augmented dining table. These projects employ a range of approaches to sonic interaction design, often involving humorous or unpredictable responses in order to challenge users' expectations and proactively compel participants to engage in conversation.

1.2 Design Framework

Building on these ideas, this project moves beyond single dyad interaction forms to extend to multiple social models by devising a range of sonic expressions associated with specific gestures. Three social interaction forms are explored: Individual, Dyad (two people), and Collaborative (three or more people). The gestures are recognized via sensor data and include *spinning*, *toasting*, *tilting*, and *shaking*.

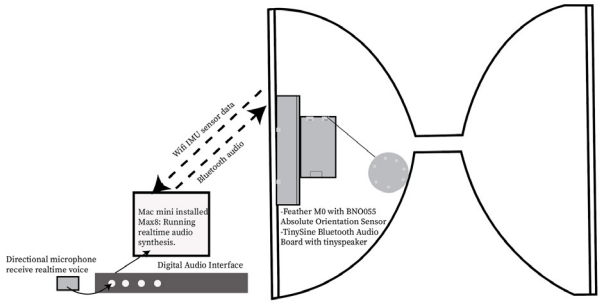

Figure 2. Diagram of the sounding glass with embedded microcomputer, sensor and speaker.

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Immersive Dreams: A Shared VR Experience

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Abstract

This paper reports on a project that aimed to break apart the isolation of VR and share an experience between both the wearer of a headset and a room full of observers. It presented the user with an acoustically playable virtual environment in which their interactions with objects spawned audio events from the room's 80 loudspeakers and animations on the room's 3 display walls. This view into what the wearer of the headset was doing allowed the audience to connect their movements to the sounds and images being experienced, effectively allowing them all to participate in the installation simultaneously.

Keywords

Virtual Reality, Immersive Audio, Interactive Installation

Introduction

This project intersects with both the fields of VR and sonic interaction design. Within the field of VR, some concerns exist such as how it can be an isolating experience [1]. People put a VR headset on and enter into another universe all alone. This digital escapism has definite potential to be abused. Too much time in the digital world could make people feel disconnected from the real one. When the virtual world allows one to be anything they want to be and doesn't do anything to keep them grounded in the real world, there's nothing in place to keep them from wanting to leave the real world behind. To remedy this, here is a VR project that creates an immersive experience for the wearer of the head mounted display (HMD), while also keeping them in touch with the audience in the room by having the wearer think about how their actions are guiding the experience for those around them. The research question explored with this installation was "How could VR be made more of a shared experience with the use of loudspeakers and multiple displays?".

Results

During a public showcase of the project, people were invited to come to the Networked Imagination Laboratory at McMaster University and experience this work for themselves. One at a time, each participant got to try on the headset and lead the experience for the other people in the room. When the leader would gesture towards one of the objects on the displays in the room, the others would turn their heads towards the appropriate display. This revealed that a clear connection was made thanks to the alignment of the virtual and physical worlds. This also required that the person wearing the headset was positioned so that they started off facing the correct wall. While slightly limiting, this was not at all a problem for anyone. The sound for each of the objects was also emitted from the same wall the player would gesture towards, making it even more clear for them and the audience that the response was coming from their gestures.

Conclusions

In conclusion, the potential to share VR beyond one individual provides a large area of exploration and research for people interested in this technology. The early results from this experiment indeed show that the isolating VR experience can be opened up to audience members with the use of loudspeakers, external displays, and aligning the virtual and physical worlds. It is truly exciting to see where this work might lead and what groups might be interested in it. The opportunity to explore these virtual rooms together by playing the environment allows for engaging experiences to be had by both the person wearing the headset and the audience members in the room.

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Preserving the Past:
ISEA and SIGGRAPH Archives Research and Development

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Abstract

Our poster focuses on the development of innovative archives for the SIGGRAPH Art Shows and the International Symposium on Electronic Art (ISEA). Our team created a custom content management system and taxonomies as well as coded templates and queries. The system allows cross connections between data in a myriad of ways and also automatically populates pages with information from thousands of data fields. The two archives are built using the same platform with variations to address the complexities of the two organizations.

Keywords

Archive, digital art, electronic art, digital humanities, content management system, SIGGRAPH, ISEA

Introduction

Because digital art has existed outside of the mainstream fine arts world, seminal works are often not well documented. This makes it very difficult for media historians or other researchers to access the information. Fortunately, in the 1980s, two organizations recognized the significance of this newly discovered form of artistic expression and began exhibiting and documenting it (ACM SIGGRAPH and ISEA). These organizations also called for academic papers that focused on this new movement's relationship to theoretical, cultural and aesthetic contexts. It was the need to document this exciting new art form that inspired our team to develop an innovative online structure to archive the materials.

The Organizations

ACM SIGGRAPH hosted its first annual digital art show in 1980 and now hosts the SIGGRAPH Asia art show and the Digital Arts Community exhibitions. The SIGGRAPH archive also includes artist talks, art papers and collections. The International Symposium on Electronic Arts (ISEA) had its first symposium in 1988 and features scholarly paper presentations, panels, round tables, posters, artist talks, workshops, numerous art exhibitions, concerts and dance performances.

The Archives

Collectively the archives now include information about 94 exhibitions and symposia, over 7000 contributors, 5125 artworks and performances, 1939 abstracts and papers, and 90 workshops. A contributor's personal page contains all their contributions over the years. Both archives were developed using the PODS framework which enables us to program a custom content management system including page templates, custom fields, queries and taxonomies within a WordPress environment. We embedded metadata and utilized digital preservation international standards for identification of material and contributors. We are now in the process of developing the ability to export the data for use by data visualization artists.

Figure 1. ISEA Symposium & SIGGRAPH Art Show Archives

The URLs

https://isea-archives.siggraph.org
https://digitalartarchive.siggraph.org

VVV: Volumetric Video in Videogames

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Abstract

VVV: Volumetric Video in Videogames is a research-creation project aiming to advance experimental development using volumetric video (a computational fusion between captured depth data and video images) in expressive videogames by drawing upon successful patterns from early game design practices foregrounding captured media. Such exploration is essential given the complexity of hybrid capture images. This ongoing project presents new ways of understanding captured media within highly interactive postmedia forms.

Keywords

volumetric video, research-creation, art games

Introduction

VVV: Volumetric Video in Videogames is a research-creation project aiming to advance experimental development using volumetric video (a computational fusion between captured depth data and video images) in expressive videogames. While volumetric video is increasingly popular in non-fiction storytelling (particularly in VR/AR), the materiality of captured media makes it challenging to incorporate into highly dynamic interactive forms like videogames. *VVV*'s objective is to push deeper into interaction design paradigms for hybrid image forms like volumetric video, and ideally present a viable channel for engaging captured content in videogames.

Preliminary Project Outcomes

Here we will briefly describe our initial outcomes from this project, including an early stage art game prototype, the development of a design guide for creators, and our exploration of multiple strategies for research generation and translation.

Interaction Patterns

For *VVV*, we looked to accelerate interaction design by drawing upon successful patterns from early game design practices foregrounding captured media. Through a systematic pattern analysis of these works, we sought to make-visible common design patterns and highlight their potential role in addressing the unique affordances of captured media forms like volumetric video. To this end we conducted a design pattern analysis of over 100 FMV (full-motion video)/interactive cinema games, incorporating both historic and more recent examples in this niche genre. Using the HACS (Historical-Analytical Comparative System) system [1], common and potentially useable patterns were identified, evaluated, and later translated from formal pattern language into more accessible descriptions for use in design ideation and/or troubleshooting (see Fig 1 for examples).

Example Pattern	Description
Seen through media	Framing volumetric video *as* diegetic media in the gameworld e.g. a projected hologram or other sort of recording, or something operating like a video (a memory, a ghost). Can be used to manage player expectations for how they might interact with the volumetric video (like a recording, or alternately that they should just view).
Activated looking	Interacting indirectly with the volumetric video by looking, noticing, examining etc. This is typically formalized as a game mechanic (in other words, it's not just looking, but looking that is noted and acted upon by the game state). In VR/AR games, this can also take the form of gaze triggers (activations conditional on the player's gaze). Can be used to present more player agency during otherwise linear moments of video play.
Perform and response	The player is asked to perform an action or sequence of actions to trigger a volumetric video sequence. The gameplay sequence then alternates between player actions, and activated cinematic sequences. At a basic level, this could be as simple as choosing a dialog option from a menu and watching a response play out. This structure allows for the sequencing of dynamic and static modes of interaction.

Figure 1. Example VVV design patterns (excerpts from forthcoming design guide). Illustrations by Kat Verhoeven.

While some prominent patterns can be associated with design trends from past eras, genre conventions unrelated to captured media, or in some cases issues specific to the limitations of 2D video, many reflect persistent design challenges that still exist for creators using volumetric video: notably relating to the more static nature of video recording (as opposed to the dynamic mutability of digital animation), and the often heavier data load of recorded material.

Making visible these patterns can give creators working with volumetric images in interactive contexts access to this design knowledge formerly embedded within an obscure corpus of work.

Material Affordances

To explore the material affordances of volumetric video through practice, we are also in the process of developing an interactive work. This game reconstructs an emergent storytelling performance in the form of a live-action role playing game (see Fig 2), suggesting new ways of integrating sentient actors into interactive digital contexts.

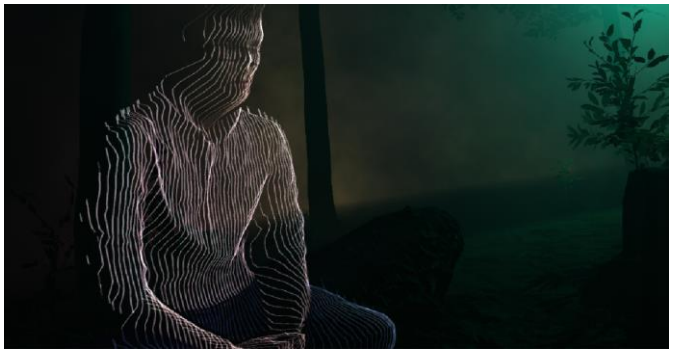

Figure 2. Still from *As the End Drew Near* (working title), a volumetric full-motion videogame (non-commercial art game), in development. Figure by author.

As the End Drew Near (working title) is a VR experience optimized for the Oculus Rift S. It is a fully interactive narrative game that incorporates the volumetric video recording of a stand-alone LARP (live-action role playing game), written and designed by author Natalie Z. Walschots (Hench). The narrative is constructed through three iterations of the LARP enactment, importantly including the framing construct for the narrative (worldbuilding and exiting). It is influenced by fiction-blurring works like Hirokazu Kore-eda's *After Life* (1999), and is informed by design patterns identified in the first phase of our project.

In the game, players are charged with materializing key details and timelines in the narrative, as they scrub through different instances of the performance that evoke different details, highlight particular emotions, or are simply performed in a distinct way. Having repaired glitches and multiplicities in the timeline, the players' last task is to anchor the memory in one otherwise non-extraordinary moment which stands out as sublime. The result, we hope, is a work that speaks to the blur between fictive and non-fiction performance, narrative networks and instances, and transparency and immersion in VR. To create the entangled narrative storylines of the game, the LARP was performed three times: each time as an unscripted improvisation, structured by pre-determined story beats. The player experience is of a singular narrative that at glitch points slips out of joint between three alternate realities.

It is particularly challenging to capture the game-performance hybrid known as LARP. This (often misunderstood) genre has none-the-less shown extraordinary critical potential as an immersive form, in part because of the necessary entanglement between immersive role-play and embodied enactment [2]. *As the End Drew Near* features a narrative construct, but otherwise is emergently performed by non-actors. Volumetric recording allows for the capture of the gestural excess of this live collaborative storytelling, as the performers negotiate in-game and out-of-game roles.

Through this creation process, we have been able to expand our understanding of the material affordances of volumetric video for interactive experiences. These included activating qualities of indexical images (including situating the subject within the actual world, abducting qualities of the subject, and offering evidence or warranting), expanding VR/AR workflows to encompass a filmmakers (as opposed to an animators') skillset, and using volumetric video's depth affordance to evoke spatial presence, particularly for human subjects.

Expanded Practice

In two key ways this research-creation project aims to expand and accelerate current practice in interactive volumetric video beyond the creation of a singular art game: via formal (applied pattern analysis) and rhizomic approaches (jams/workshops).

A concern from the project onset was how we might translate the results of our design pattern analysis back into design tools that can be more fluidly integrated into the design process, at either stages of ideation or the point of design frictions. Inspired by other work translating game design patterns for creators [3][4], we aim to develop a guide that can more readily be referenced to inform future design work using emerging captured media forms such as

Figure 3. Dames Making Games VVV Game Jam (2018, Toronto Media Arts Centre). Photo credit: Henry Farber.

volumetric video. As is demonstrated in an early form by Fig 1, useful design patterns from our initial analysis of early FMV and interactive cinema games are in the process of being translated into a short illustrated format. This approach attempts to bridge formal models and design practices.

The second approach is rhizomic: by conducting game jams and workshops introducing this media format to new audiences, we have aimed to generate insight through opening up more creator experimentation into interactive volumetric video. Our initial game jam (Fig 3) was held at the Toronto Media Arts Centre in 2018, in partnership with our technology partner Scatter, and community organization Dames Making Games. The experimental wayfinding of formats like game jams and workshops can reinforce knowledge pulled from a formal pattern analysis, by allowing for new solutions, and indeed new problems, as creators explore interactions, themes, and techniques not directly drawn from past practice.

Acknowledgements

I would like to thank my VVV research collaborators, without whom this work would not be possible: Carl Therrien (Université de Montréal), Nic Hesler (Sheridan), technology partner Scatter (Depthkit), and Graduate Research Assistants Maxwell Lander and Jean-Charles Ray. Thank you also to our community partners Jennie and Henry Farber (Dames Making Games/Toronto Media Arts Centre).

More information about the development of this work: https://www2.ocadu.ca/research/gameplay/project/vvv-volumetric-video-in-videogames

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Author Biography

Cindy Poremba is a digital media researcher, gamemaker and curator. They are an Associate Professor in Digital Futures at OCAD University (Toronto, CA) and Co-Director of the game:play Lab. Cindy has presented internationally at conferences, festivals and invited lectures, on topics relating to game art and curation, capture in postmedia practices, and interactive documentary. Their research and critical writing has been published in journals such as Eludamos, Loading and Games & Culture, as well as edited collections, art catalogs and magazines. Cindy also organizes non-traditional exhibitions as an independent curator, including Joue le jeu/Play Along (FR), and XYZ: Alternative Voices in Game Design (US). Their award-winning game and “New Arcade” work as a member of the kokoromi experimental videogame collective has been featured in both international game and digital art exhibitions.

Towards a Postcolonial Ontology of Sentience

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Abstract

The paper takes the criticism of colonial metaphysic as its point of departure - in which Euro-centric worldview depicts Other as not fully sentience in relation to the western subject. While the violence of such reductionist and essentialist perspective has been greatly criticized, however such criticism is built upon a Western philosophical tradition that inherently requires a compliance to specific definition of a sentience. As such, the critique only manages to liberate the Other from the confinement of colonial paradigm but on the ontological level, anything outside the western subject is denied a proper existence. This paper sets out to critically examine the meaning of sentient from a post-colonial perspective. Specifically, by looking at the pioneering works on 'tradition' by Malaysian new media theorist Ismail Zain, this research argues for an accountability that recognizes the inherent biases in discourse on sentience that restrict the method of enquiry. In doing so, the paper aims to shift the question from asking 'why sentience' to 'which sentience', that, in turn, opens the way for an acceptance of a sentience outside the Euro-centric worldview.

Keywords

postcolonial critique, non-western ontology, tradition

Synopsis

in 1978, a Malaysian artist and theorist named Ismail Zain presents an essay titled "Masa depan Tradisi – dikhususkan kepada pengalaman Kuno di Malaysia" (The future of Tradition – as per the antiquated experience in Malaysia). [1] In this essay, Zain highlights the problematic linearity of history that define things of the past as antiquated. He critiques the emphasis on progress in the name of modernity and calls for a rethinking of the term 'tradition' beyond the scope of its anthropological purpose. For Zain, tradition needs to be released from rationale of history, specifically history as defined by universal conditioning of the European thought.

He argues for the rethinking of tradition as a 'transmission of inner quality of being' rather than an objectivist conservation of the cultural past. He further elaborates such transmission is made possible through oral tradition that transmits memory and operates outside the linearity of time as defined by history. Crucially he draws a parallel between 'tradition' and electronic technology by pointing at the ability to create 'time'.

This paper takes up Ismail Zain's idea with reference to 'tradition' as an accountability that recognizes the conditions of postcolonial societies such as Malaysia. By having Ismail Zain's essay as the basis, the paper aims to uncover the underlying dependent upon Western philosophical method that inherently requires a compliance to an ontological foundation that enables a particular system of enquiry. This is achieved by implicitly pointing out the philosophical division between reason and theology in European society as becoming the universal vision of human politics, and arguably in defining a sentience.

The struggle here with this universal conditioning is that it delineates the meaning and purpose of 'existence', bearing the entire burden of European thought upon all living beings, including the Non-European subject. This does not mean 'reason' is dismissed altogether. Instead, this research paper aims to openly profess the way in which the question of sentience is accepted uncritically – without acknowledging the inherent ontological biases in such definition that cuts itself off from a self-reflective consideration of its relationship to cultural and political dominance, deluding itself as pure and autonomous.

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Author Biography

Roopesh Sitharan is an artist, researcher and an enthusiast of digital culture. His primary research interest is to examine the intersection between Malaysian art, new media technologies and contemporary cultures. Such interest has led him to be actively involved in several national and international projects, showcases, seminar and conferences on art, culture and technology such as Gwangju Biennale, ISEA and Siggraph.

Preface

On October 16, 2020, during the ISEA2020 symposium in Montreal, Canada, a full-day networking summit takes place to discuss a multitude of issues related to archiving new media arts. The event is coordinated by representatives of the ISEA online Symposium Archives, the Archive of Digital Art, the Ars Electronica Archive, and SIGGRAPH Digital Art Show Archive. The aim of the summit is to discuss roads towards realising the Liverpool Declaration goals related to Media Art Archiving collaboration, funding and formats.

The Liverpool Declaration makes a case for the need to establish international and sustainable funding structures. This includes the development of a cooperative process of knowledge transfer between artists, institutions and researchers internationally. Through the supported alliance of art organisations, media art archives, and individuals, a system of sharing data, resources, and expertise can be established. This declaration was signed by close to 500 leading experts and institutions in the field of new and electronic media art.

The summit opens with a keynote speech by Oliver Grau, Department for Image Sciences, Donau-Universität Krems, Austria. Fifteen plenary presentations address topics related to international support, project infrastructures, new strategies, archiving technologies, documentation of artifacts, collections, preservation and new approaches to archiving new media art. Break-out sessions will allow for discussions on common concerns. The summit concludes with a moderated discussion which outlines a structured roadmap and concrete proposals.

The Liverpool Declaration: http://www.isea-archives.org/docs/MediaArtHistoryDeclaration.pdf

Summit Committee:

Wim van der Plas, ISEA Online Symposium Archives http://www.isea-archives.org/
Oliver Grau & **Wendy Coones**, Archive of Digital Art, http://www.virtualart.at/nc/home.html
Bonnie Mitchell, SIGGRAPH Digital Art Show Archives & ISEA Online Symposium Archives https://digitalartarchive.siggraph.org/ & https://isea-archives.siggraph.org/
Veronika Liebl & **Christina Radner**, Ars Electronica Archives, http://archive.aec.at/

Museum Network for Digital Arts: A concerted collection, documentation, and conservation strategy

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Abstract

In the past five decades, Media Art has evolved into a critical field at the intersection of art, science and technology, however, a significant loss threatens this art form due to rapid technological obsolescence and static documentation strategies. This talk will give an outline for research, documentation and preservation of digital art by: a) developing international archive-research infrastructures, similar to those already available in the natural sciences, b) contributing to the development of infrastructures with museums, which are interested in bringing the art of our time into their collections through concerted networks of scholarly and mostly technological expertise. In this way relatively small units, museums, can also deal with the very demanding challenge. The Archive of Digital Art (ADA) www.digitalartarchive.at addresses these issues through an innovative strategy of 'collaborative archiving', social Web 2.0, 3.0 features foster the engagement of the international Media Art community, web 3.0 elements are integrated through a 'bridging thesaurus' linking the extended documentation of ADA with other 'traditional' art history databases to facilitate interdisciplinary and trans-historical comparative analyses. ADA informs a needed concerted museum network, to collect, exhibit and preserve digital art forms.

Keywords

Digital Art, Digital Humanities, Archive, Museum, Preservation, MediaArtHistories, Museums&democratic Problem, Image Science

Hard Humanities: Media Art Histories & Image Science

Over the last five decades, Media Art has evolved into a significant contemporary field. It encompasses art forms produced by the very digital technologies that are fundamentally revolutionizing our world as well as how we perceive and interact through images with globalization, the Internet, social networks, Web 2.0 and 3.0. Media Art can take disparate forms, and includes genres such as genetic, database-art, animation, glitch, interactive installations, net art, telepresence, and virtual reality art.

Through the study of MediaArtHistories the most pressing socio-cultural questions of our time are investigated: artworks dealing with big themes of our time, like media and image (r)evolution, climate, finance, virtualization or surveillance. While the critical lexicons of classical art history are relatively fixed, the classifying language of Media Art is defined with dynamic terminologies that are continually in flux. Yet, despite worldwide recognition, strategies for documenting the 'art of our times' continue to be met with serious challenges within the memory institutions of our societies. As Media Artworks frequently have functionalities across variable media substrates, and these constituted by the latest technologies as well as characterized by a rapid obsolescence, the work of Media Artists complicate both object-oriented preservation methods as well as static indexing strategies. Consequently, artworks originating even just ten years ago can often no longer be exhibited. Although there are hundreds of festivals with tenth of thousands of participants since decades, Museums and Libraries rarely include more complex Media Art in their collections, and those that do struggle to sustain finance, expertise, and technology for the preservation of artworks through strategies such as migration, emulation, and reinterpretation. Further, that Media Artists engage the most contemporary digital technologies leads to the production of artworks that are necessarily "processual," ephemeral, interactive, multimedia-based, and fundamentally context-dependent.

It is specifically the subject of the MediaArtHistories conference series, a biannual world conference held on various continents. A number of documentation projects have also been established over time, some continue to exist online, but they lost key researchers, funding expired, or projects terminated. Consequently recently expressed in the International Liverpool Declaration, signed by more than 450 scholars and museum heads from 40 countries, there is an urgent need to create a stable international platform of interoperable archives. Indeed, it is no exaggeration to state that we continue to be threatened with a significant loss of this critical art form, both in the archives of art history and for future scholarship [1].

Media Art (R)Evolution and the Archive of Digital Art

Since the year 2000, the Archive of Digital Art (ADA) has grown into the most complex research-oriented resources available online as a platform for both scientific information and social communication. Hundreds of leading Media Artists are represented by several 1,000 documents, with more than 3,500 articles and a survey of 750 institutions. Besides the artists, there are also more

than 250 theorists and media art historians involved in making ADA a collective archiving project.

Because of the singular structure of Media Art, the Archive of Digital Art developed an "expanded concept of documentation." ADA's data model includes biographical and bibliographic information about the artist, inventions, awards; exhibitions, and publications; information on software and hardware configuration; technical instructions; interface and display, as you see here; references and literature about the artists; information about the technical staff; institutions; and copyright [2].

The system offers a tool for artists and specialists to individually upload information about works, people, literature, exhibits, technologies, and inventions. Over the last fifteen years some 5,000 artists were evaluated, of which 500 fulfilled the criteria of five artworks and/or published articles to become a member of ADA. Resulting in the documentation of many of the most relevant artists of the field. In Austria we were just awarded 1,2 Mill. Euro by the federal ministry for such an infrastructure. Moreover, artists of the University for Applied Arts and the Art University Linz will develop new and accessible entries to the archive. Also, ADA begun 20 years ago at the Humboldt University can and will function as an information pool for the pending task in Germany.

Documenting Media Art: Implementing 2.0 3.0 Features

For the Archive of Digital Art, the first online collaborative archive that is both scholarly and social in either art history or media studies, documentation is understood as a process that integrates a continuous exchange between users, scholars and artists. An essential aspect of its *Interactive Archive and Meta-Thesaurus for Media Art Research* project (AT.MAR) was thus to transfer ADA into a Web 2.0 environment. The database was opened up on the 'retrieval-side' by making data available and easier to share for users, and on the 'archivist-side' by allowing contributions of diverse individuals in order to facilitate a collaborative and more balanced preservation practice [3]. Newly innovated ADA features support the group engagement and foster motivation. A messaging system and "News" section allow archive community members to interact with peers. Contribution monitoring and a function for colleague 'following' provide updates on the research and activities of other Archive members. In addition, collaborative processes of peer-reviewing and content curation integrate the community's decision-making and agenda setting into ADA itself.

Members also engage in selecting an artist or scholar who is featured on ADA's homepage, social media, and through web newsletters. This "Featured Artist/Scholar" introduces ADA visitors to artists and scholars distinguished by their peers; allows Archive members to commemorate achievement within the discipline or recognition within the community; and supports active participation in content direction. Additionally, ADA's "Light Box" feature is both scholarly and social. Promoting the comparative analysis of Media Artworks on the Archive, this tool permits community members to assemble individual arrangements from the extended documentation. These "Selected Items" can then 'enlarge' and 'overlap' so that relevant image details can be compared and analyzed.

Indexing Media Art: The Bridging Thesaurus

Keywording is bridge building! Important innovations such as, 'interface' or, 'genetic art' were considered along with keywords that play a role in traditional arts— such as 'body' or 'landscape'— with a bridge-building function. For the 'bridging thesaurus' of the FWF funded AT.MAR project it is the intent to establish a framework that allows for the classification of the aesthetics, subjects and technologies of artworks. New Keywords are empirically selected to achieve a comprehensive overview of the knowledge domain of Media Art, but also a manageable one, this vocabulary is limited to around 250 terms [4]. In relation to other vocabularies, ADA "Keywords" have a unique hierarchical schema based on a categorical triad of 'aesthetics', 'subject', and 'technology'. This top-down distinction of categories allows for the contextual specification of vocabulary as well as for the conceptual analysis of these levels by users: Aesthetics: ranges from phenomenological observations such as 'immaterial' to ontological qualities such as 'site-specific' and 'object-oriented'. Subject: The 'subject' category encompasses iconographic terms established in art history and Media Art Histories, in subcategories like: 'Body and Human', 'Magic and Phantastic', 'Nature and Environment', 'Technology and Innovation', 'Power and Politics', 'Psychology and Emotion'. And there is a 'Technology' section as well. The resources of terms and concepts used in the development of AT.MAR define the very foundation of this controlled vocabulary. They include (1) 'traditional' art history iconographical terms from the Getty Art and Architecture Thesaurus (AAT) and the Warburg-Index, as well as (2) Media Art databases, like GAMA, Langlois Foundation and Netzspannung and festivals, like Ars Electronica; FILE, ISEA; Transmediale and (3) several thousand titles of research literature.

Future Media Art Research: The Göttweig Collection

A second main step of contextualizing media art can be done based on an internationally unique situation, combined with the 45,000 prints of the Göttweig Collection. ADA thus has an important art historic collection in highest resolution emphasizing Renaissance and Baroque works on its side— representing a library of 150.000 volumes going back to the 9th century, like the Sankt Gallen Codex. The Göttweig collection is effectively an index of Renaissance and Baroque visual knowledge. Abbot Bessel (1672-1749) sent his agents over Europe to

buy 30,000 prints in less than 10 years—a visual encyclopedia of almost all available knowledge of the time—a unique attempt to collect the world—here you see image collection plus *Wunderkammer*. ADA strives to achieve the goal of a deeper mediaarthistorical cross-pollination. This context will be explored deeper through the "Thesaurus Bridge." Just as the MediaArtHistories conference series bridges a gap, the combination of the two and additional databases offers further historic references and impulses. The collection also documents subjects from the 'representation of knowledge' and 'history of science, like the history of optical image media, intercultural concepts, caricatures, illustrations of landscapes in panoramic illustrations. For the future, this may provide resources for a broader analysis of media art.

Thesaurus keywords, navigable as "Hierarchical," "Alphabetical," and "As Cloud," stimulate users to bridge the 'traditional' artworks and the Media Art of ADA, providing complex image resources for a richer analysis of Media Art.

The collective Archive of Digital Art counts many Digital Art Installations, and it is important to contextualize them within media art histories, for example the one of immersion. We also have to consider the histories of artificial life, telematics, panoramas of phantasmagoric imagery, automata, etc. There are hundreds of historic traditions and given that there is a common ground with media art history collections, we might better decipher what we need to collect and to preserve digital art in our memory institutions, and also to understand what is really new in digital media art and in (hard) humanities.

For a concerted Museum-Network of Digital Art

The worldwide museum community is more than 55,000 institutions strong. The US has more than 17,000 alone, Japan 5,700, and Germany 6,300, Canada hundreds with flagship institutions like the Musée d'art contemporain de Montréal in Stockholm... It may seem that this infrastructure in all its diversity and history is such a mighty monolith that drastic change would be difficult to imagine. However, the digital age enters with force and alters that status quo. It comes with new tools to present, collect, access (cultural artefacts), connect, explore, analyze, manage, and visualize data. It comes with its own digital-born arts and cultures, which have their own history of more than five decades. Digital arts and cultures play a role in 200 biennials around the world and in more than 100 specialized festivals. However, digital art is not collected systematically in a concerted strategy by museums, because the basic structures of the 240-year-old institution date back to a time when different artistic media prevailed. That is why we as citizens are facing a massive problem in terms of democratic discourse via art. Although in Europe or Canada most museums are financed by our taxes, they can´t fulfil their official tasks in the range of digital contemporary art. A systematic preservation requires the cooperation of museums and libraries into specifically funded working groups and expertise networks.

The museum setting in our contemporary world has diversified not only due to the digital revolution that has come to permeate global culture and interaction, but also due to many other non-digital transitions that have come about alongside or due to digital developments. Digital technology has introduced new multifarious ways of expression that change the nature of the object to be collected, as well and changing the expressive methods available for displaying and archiving collections. These new objects and the techniques used to preserve and interpret them embrace interactivity, make use of linear and non-linear structures equally, and encourage new methods and ever-deepening degrees of participation.

Empirical investigation shows that although Digital Art deals with thematic clusters of high political relevance for our democracies, including: climate change, genetic engineering, new extremes of surveillance, virtual financial economics, migration as well as the image and media (r-)evolution, this art form of our time has not been introduced to our permanent collections so far. It will be completely lost if there are no modifications in cultural collecting policies around the world.

The importance and urgency of the preservation of the digital cultural heritage was articulated in the Liverpool Declaration for digital art and in the UNESCO Charter on the Preservation of Digital Heritage for Digital Culture. ICOM is working on an appropriate definition which will be decided in Australia this year. However, we continue to be almost completely detached from reflections on our time based on its arts -- this seems to happen unintentionally as a form of system failure. In societies whose art system is largely tax-funded, such as in Europe, we are simultaneously facing a civic democracy problem.

One strategy to enable the museum to fullfill its duties in a globalized and networked democratic society would be the establishment of a concerted Museum-Network of Expertise and Preservation. Although in Europe most museums are financed by our taxes, they can´t fulfil their official tasks in the range of digital contemporary art. A concerted collection policy would be located over the level of a single museum, and this meeting is a glimpse of such a development to overcome single institutional limitations to protect 21th century art, endangered by a lack of personal, budgetary and technical restraints. A regional or nationwide network of expertise could help to preserve digital art with the systematic help of main strategies developed in case studies, strategies such as emulation, recreation and interpretation. However, it depends on the will of those who are responsible for cultural policies. Federal structures in Germany, Austria and other countries could help through a practice of shared responsibilities. If only 5% from Germanys 700 Museums dedicated to Art would participate in a cross-federalized framework, Bavaria for example could—say with 5 Museums—be

responsible for the preservation of— interactive Installations and build up adequate expertise, Saxony for Bio Art, Brandenburg for net art and so forth. This alliance could be informed by ADA Networks, ZKM, Ars Electronica and in Switzerland by HEK etc. We could help to protect not all but the most important digital Art works and bring them into public discourse. This is a big task, but just one challenge in the wide range of digital strategies for the transforming Institution Museum.

In this mode, a museum in Frankfurt, for example, can rely on the expertise of the museums in Bavaria if it wants to buy an interactive installation or only exhibit it for a while. Conversely, the Bavarian museums would be able to count on Hesse for NetArt. The conservation service can barely be measured in comparison with the restoration of traditional art forms and could lead to the creation of specialized StartUp companies and also offer the necessary services to collectors of digital art and thus alleviate this art's breakthrough in private collections.

At the same time we know that there are countless studies on the conservation of digital art: EU research projects, museum research by for example TATE, Gugenheim, SFMoma, ZKM; many colleagues here have conducted basic research - Netherlands Institute for Media Art, Department for Image Science with its Erasmus Joint Master MediaArtsCultures, studies in France, Australia, Poland, Brazil, Canada and many more. In the coming months it is necessary to bring together the technical art genres and their main works with the conservation studies that were developed in the last decades in a single information pool in order to prepare a concerted policy for the museums. A large part of the conservation research, listed here as examples, was or is being conducted in individual studies. It is now necessary to form a museum network of digital art and to support the political decision makers. A national, coordinated strategy for the long-term preservation that also includes the important stakeholders is pending. Due to the complexity of the task, a concerted collection policy must begin above the level of the individual houses.

Approved procedures for the preservation of digital technologies, interactive installations and other elements of the digital arts have already been developed. Digital art and its storage media have caught our archive systems unaware, so to speak: Although methods for the long-term preservation, such as emulation, migration, and recreation do exist, they are not implemented within a concerted-networked collection policy that our federal museum system for the classical modern or post-war art realized in an exemplary manner. The establishment of a competence network one level above the level of the small-scale museums has not yet been set into place. Not even the three to six percent of the art works that according to estimates have survived from the art of earlier centuries can be preserved -- this does not even represent the most important works of artists exhibited worldwide. If we do not do anything now, we will lose the entire digital art of the present day -- a tabula rasa that is quite comparable to that of iconoclasm and war losses.

Historically *Wunderkammer* and *studiolo* were places of play, where the practice of *ars combinatoria* created something new each viewing by recombination, chance, or instant linkage and inspiration. Creative process and knowledge production essentially were driven by comparison and (inter-)active combination. Today, the active component, which was later restricted by the object-oriented museum, is re-entering the digital Museum and Archive. In the current setting of digital media and the enveloping windowless dark space, which functions again now as a precondition and enforcement for a digital ars combinatoria, digital artworks, object representations, and clusters of image worlds can now be partly experienced interactively, influenced by the audience and recombined.

The massive developments in digital-born media art and popular culture have been growing exponentially for decades now. Consequently, this requires that among the thousands of existing museums for traditional art media, a significant percentage of Museums and Archives must be dedicated to fulfil their fundamental functions to collect, preserve, explore, mediate, and taxonomize the digital cultures of the last decades.

Media Art also requires the owners of soft- and hardware companies, of new social networks who are in a position and responsible to help museums to preserve art on the technology that made them rich. We need an appropriate structure to preserve at least the usual one to six per cent of present media art production, the best works.

To achieve this, we need a concerted policy of collection and preservation on a much larger scale, appropriate to serve digital culture of the 21st century. If we compare the worldwide available budget to preserve and explore traditional art forms compared to electronic art forms, then we understand how inadequate the support for our present digital culture is; it is almost statistically immeasurable. The faster this essential modification to our cultural heritage record can be carried out, the smaller the gap in the cultural memory; shedding light on the dark years, which started about 1960 and lasts until now. Only when we develop systematic and concerted strategies of collecting, preservation and research we will be able to fulfill the task which digital culture demands in the 21st Century.

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University in 2005 and has held more than 350 lectures and keynotes at conferences worldwide. Grau's publication "Virtual Art", MIT Press 2003 is with approx. 1800 citations internationally the most quoted art history monograph since 2000. His main research areas include histories of media art, immersive images, emotion, the history of artificial life and digital humanities. Grau conceived new scientific tools for image science developing the first international Archive for Digital Art (ADA, since 1999). Since 2005 Grau has led the development of the database of Goettweig's Graphic Print Collection, Austria's largest private collection with 30,000 works, from Duerer to Klimt. In addition, Grau has also developed new international curricula: MediaArtHistories MA, Image Science, Digital Collection Management, the EU supported Program joint master in MediaArtsCultures. Grau was the founding director and is chair of the MediaArtHistories Conference Series. 2014 he received a doctor h.c., 2015 he was elected into the Academia Europaea, 2019 received the Science Award of L. Austria.

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Preservation Begins at Creation: Integrating an Embedded Digital Archivist Within an Academic Media Art Program

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Abstract

One of the key insights from the InterPARES project investigating the preservation of electronic records was the observation that preservation begins at (record) creation. While the numerous challenges of preserving media art are documented to some extent, the literature largely reflects a conservation paradigm wherein actions are taken to repair damaged works. The proposal to integrate an embedded digital archivist within an academic media art program instead adopts a preservation lens with the intent of reducing or preventing the degradation of media art by equipping students with digital preservation skills early on in their artistic career.

Keywords

Digital preservation, preservation of media art, media art conservation, archiving digital art, embedded librarianship, embedded digital archivist.

Introduction

One of the key insights from the multi-year International Research on Permanent Authentic Records in Electronic Systems (InterPARES) project was the observation that *preservation begins at creation*;[1] that is, in order to preserve authentic, accurate and reliable digital records for long-term access and use, it is important for record preservers to work together with creators of records to consider what preservation actions should be taken from the outset. [1] Many media artists, however, are unlikely to be practicing in contexts with trained records managers or archivists as colleagues; indeed, media artists must often act as the steward of their own records until they enter the custody of an art museum or gallery. The importance of developing the capacity of media artists to preserve the works they create, then – such as determining which file formats are deemed to be archival, how often to refresh digital files, what metadata ought to be captured and so on – cannot be overstated.

Much of the existing literature regarding the preservation of media art, though, can be characterized as theoretical guidance relating to the work of conservators and curators, informed by the reactive stance of a conservation paradigm. Falcão and Ensom of the Tate Gallery highlight the conceptual and technological contributions of digital preservation to the field of digital art conservation, but do not make specific reference to collaborations between conservators and creators of media artworks at the point of their creation. [2] A coordinated strategy aimed at establishing the research infrastructure required to support the long-term preservation of works of media art and other records of media artists' practice must therefore build upon the (art) conservation approach – remediating damage after it has occurred – with the objective of minimizing or preventing degradation presupposed by a (digital) preservation approach. One possible means towards achieving the latter is by embedding a digital archivist within academic media art programs.

Embedded Librarianship & Archival Work in Academic Institutions

Embedded librarianship in an academic institution implies an integrated and collaborative presence within teaching, learning and research activities rather than requiring users to seek out library services. [3] It frequently – though not always – involves an instructional component, as an extension of the literacy promotion facet of the librarian's role. An embedded librarian may work closely with a faculty member on the design of a research assignment or offer reference help directly within an online course, for example. The aim of embedded librarianship is to provide better access to library resources by reaching out to user communities, reflecting a larger shift in the library profession towards a more user-centric service orientation.

Archivists within academic institutions have also begun to explore the possibilities afforded by an embedded role. Case studies documenting the experiences of embedded archivists suggest that, to date, the emphasis in these collaborations has been on the use of primary sources and supporting the development of learners' archival research skills;

[1] The project, based out of the University of British Columbia and led by archival theorist Luciana Duranti, explored the knowledge domain requirements for preserving authentic records created or maintained in digital form, and was undertaken in four phases – InterPARES 1, 2, 3 and InterPARES Trust – between 1999 and 2018.

that is, instructional activities grounded in the assumption that students are users of archives. Another significant area in which an embedded archivist could contribute, however, is in teaching students digital preservation practices with the acknowledgement that they are also *creators* of archives. Extending the early intervention logic implied by "preservation begins at creation" to the record creators themselves, students in media art programs stand to gain the necessary competencies to preserve their works at the beginning stages of their practice through tailored instruction and other discipline-specific support provided by an embedded digital archivist.

Digital archivists, in academic settings and elsewhere, perform a wide range of duties related to preserving and providing access to born-digital archives, or those archives created within a digital environment (as opposed to physical documents that have been digitized). They often work with a variety of digital objects – including audiovisual media, websites, software, databases and so on – equipping digital archivists with both the conceptual and methodological expertise to enrich media art students' understanding of the preservation requirements for the media they create with. The technical nature of a digital archivist's work, however, may lead to fewer opportunities for them to interact with students in a public service or instructional capacity. Academic digital archivists seeking to embed themselves within their institution's media art program, then, may need to actively advocate for the importance of establishing the role.

The Embedded Digital Archivist in Practice: Relationship-Building with the University of Windsor's School of Creative Arts

Early in the Winter 2020 academic term, I began the relationship building process with faculty members in the University of Windsor's School of Creative Arts (SOCA). Although an academic media art program may derive a considerable benefit from the support of an embedded digital archivist, it is also necessary to recognize the additional labour involved for faculty partners to accommodate the archivist within their teaching or research activities, and the time it takes to build the trust central to any collaboration. Having trained as a media artist and, in fact, graduated from the school's fine arts program allowed me to quickly establish a rapport with the SOCA media art faculty. Nonetheless, planning in Winter 2020 was approached with the objective of instituting the embedded digital archivist role in the Fall 2020 term. Potential activities of interest to faculty included developing digital archiving and preservation workshops for specific disciplinary areas, participating on panels of guest speakers, providing individual consultations to media art students and advising on the preservation of Master's theses.

Initial discussions with SOCA faculty also surfaced a pivotal insight: while media artists can conceptualize the complex preservation challenges associated with their work, communicating the urgency of performing preservation actions early in the work's lifecycle and the artist's responsibility in effecting them will foreseeably be a core function of the embedded digital archivist role. That is, one of the most significant barriers to promoting digital preservation competencies among media art students may be attitudinal; an interview with artist Roberto Cuoghi when asked how he thought his audio installation works would "age" is illustrative:

> I don't really know what destiny the things I'm doing will have. Aging ceases to be acceptable only when the work begins to be objectively compromised. Intervening becomes necessary when the work's "functioning" starts to be compromised. [4]

Though the question was framed from a conservation perspective, Cuoghi's response suggests that media artists and students of media art may not act to preserve their work until there are appreciable signs of degradation or loss; indeed, some artists may welcome or even invite technological obsolescence as an intrinsic feature of the work. Media art students intending for their work to endure, however, may be motivated to perform a feasible set of preservation actions when gradually introduced and reinforced through interactions with an embedded digital archivist.

Developing the requisite skills and knowledge to preserve one's body of work is particularly difficult for media artists; it is telling that the second phase of the InterPARES project focused heavily on the preservation of artworks, noting the challenges posed by the diversity of record outputs in creative fields. A one-time workshop teaching the basics of personal digital archiving is likely to be inadequate in preparing media artists to preserve the variety of formats they will work with over their lifetime. To address the specific concerns related to preserving media art, then, the personalized and sustained instruction enabled by embedding a digital archivist within an academic media art program suggests a more fitting approach. Providing media art students with a foundational grasp of digital preservation not only has the potential to facilitate the subsequent work of media art conservators, it also reciprocally promises – through collaboration with students and faculty practicing in a range of media – to advance the digital archivist's own understanding of their practice, which can be shared with the media art preservation and conservation community.

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Archiving Interactive Art for Art Practitioners and Theorists

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Abstract

Due to limited exhibition spaces, art has been mainly consumed with specific documentation formats. Books or catalogs were key media to experience painting and sculpture. Later on, in addition to print media, video became a major platform to document installation art and performance art. However, documentation techniques of those formats do not fit for archiving interactive art due to its multifaceted properties including emerging technologies, audiences' participation, and spatiotemporal environments. This paper stresses that current documentation for interactive art needs an interlocked archiving system including conceptual, technological, and phenomenological approaches.

Keywords

Interactive art, Phenomenology, Archiving, Art-and-technology, Documentation, Conceptual art

Introduction

Recently, virtual museums with VR technology have been introduced so that visitors can see artworks in a long-take & long-shot without cinematic manipulations as if they were in a real museum. [1, 2, 3] The platforms provide visitors with a semi-spatial experience of artworks as compared to art archives online and offline. Specifically, this approach can be developed to provide audiences with active participations in interactive art. Even though this method can be valid for spectators who cannot take part in the real event, it has a phenomenological issue because virtual museums would be based not on a real process of interactive art, but hyperbolic visual-centric computer graphics of representing the process without tactile interactions.

Issues in Interactive Art Documentation

In the article, "Survey and Analysis of Interactive Art Documentation, 1979–2017," I examined that documentation for interactive art tended to use a cinematic language to make interactive art more appealing. [4] This cinematic approach, such as cutting shots and adding background music, can result in filmic illusionism. Most interactive art documentation gets divorced from interactive art. In other words, documentation for an interactive art project does not refer to the interactive art piece, but documentation itself becomes a new type of creative video work. However, a main purpose of archiving art is to document or record information on projects. As academic and practical literature, archiving is still required to providing neutral information to creators.

Three Degrees of Interactive Art Documentation

With cinematic documentation for interactive art, artists have a hard time finding practical information. Likewise, scholars need to spend more time researching interactive art to check out precise data from diverse resources. They should fully understand an art piece to interpret, criticize, and develop it. In this regard, interactive art needs a more critical and more organized archiving system for those creators.

Without detailed technological information, scholars are only able to focus on its "ideal" idea without "real" realization. Likewise, artists could not find an exact approach to making a specific interactive project while researching art pieces that use similar technologies to their work-in-progress. Both need to thoroughly figure out how specific technologies realize interactive art in a variety of approaches. For more practical achievements, I insist three degrees of interactive art documentation, which are interlocked with each other, can contribute to archiving interactive art.

Three Degrees of Interactive Art Documentation

For art practitioners and theorists, this paper suggests three degrees of interactive art documentation: 1) Concept, 2) Technology, and 3) Phenomenology.

First, the conceptual approach in interactive art has been reevaluated. Edward A. Shanken argues that interactive art has a strong relationship with conceptual art and explores how to incorporate it in the mainstream of contemporary art. [5] This approach focuses on a textual quality of art. However, the conceptual approach in interactive art should be different from texts for art in usual art literature. Rather, it can be similar to a home appliance manual. We could not fully research specific technologies from instruction manuals for home appliances, likewise conceptual documentation can include simple diagrams, illustrations, and conceptual texts to briefly show how a concept works with specific technologies. This documentation will be used to help creators understand how to operate interactive art and conceptually criticize interactions and technologies of interactive art. In this degree, it does not matter whether interactive art

properly works. This contributes to evaluating interactive art as a conceptual art project.

Next, the technological approach will be able to precisely describe interactive art in an engineering way. This can include similar detailed still-images of Greek sculptures in an art history book. This will be used to show detailed information including close-up parts of the installation, circuits, inventory lists, schematics, and coding from interactive art. Specifically, inventory lists can incorporate versions of applications & OS, specifications of electronic devices, and places where items were purchased. This information along with close-up pictures can help creators easily understand and fix a technical issue. For example, simulating input objects, aka.mouse and aka.keyboard, for Max/MSP do not work anymore after upgrading to MacOS Catalina due to an accessibility issue (See Figure 1). To run an art piece with simulating keyboard and mouse inputs, those objects must be replaced with other external objects such as 11clicks and 11strokes2. The detailed information should be shared with contemporaries. The original creator can help others to save time with less trials and errors, and creators can support the project to be sustainable. To share with creators on the world wide web environment, Creative Commons can also apply to this technological documentation.

Finally, the phenomenological approach will be able to film interactive art with less visual exaggerations. Most documentation for interactive art tends to be illusionistic and cinematic. [6] This documentation style discourages viewers from understanding interactive art with an invisible camera filter. Technological issues can be hidden by cinematic montage techniques. It is also necessary to study how the documentation can convey the phenomenological work to the viewer in a realistic way as film critic Andre Bazin argued with the illusion of montage. [7] Russian filmmaker Andrei Tarkovsky's long-take and long-shot camera technique can apply to this phenomenological video documentation. While audiences take part in interactive art, this phenomenological documentation "witnesses" their interactions with the project without any intentional interventions. This will be used to show how interactive art physically works with few cinematic exaggerations although it cannot provide the audience with a real tactile experience.

Those three approaches could hardly provide creators with significant archives separately. Instead they should be interlocked with each other to give creators an organic archiving system for researching and creating interactive art, which is a more complicated form of art.

Conclusion

Most major art conferences and festivals in the field of interactive art request applicants to upload texts with specific templates and moving/still images with specific codecs and dimensions. By developing an application system based on the three degrees of interactive art documentation, those art events will be able to keep well-organized archives of interactive art and help artists and theorists understand, research, and develop interactive art projects. In addition, applicants can save time documenting their projects separately.

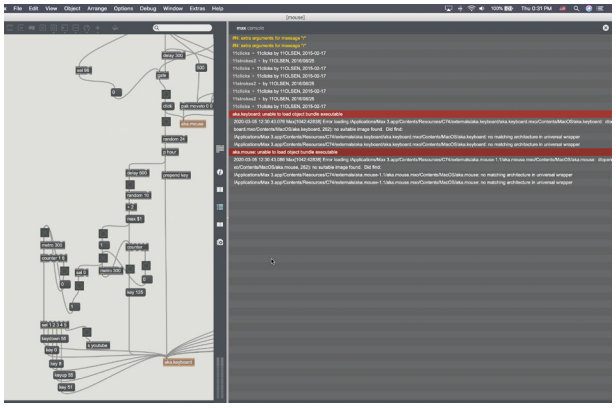

Figure 1. An error message from Max/MSP Jitter 7. ©Respect Copyright.

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VR as a Preservation and Simulation Tool for Media Art Installations

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Abstract

David Hall (1937-2014) was one of the pioneers of video art in the UK, beginning with *TV Interruptions* that he made for STV in 1971 as part of the Edinburgh Art Festival. He continued to make single screen video works, but his main focus was the creation of video sculptures. Most of these sculptures used old cathode ray tube monitors. Although these are still available and working at the moment, over time it will become more and more difficult to find any working examples. Due to these problems with technological obsolescence, many of Hall's and numerous other artists works may not be so easily replicated in the future. With this in mind, other ways to present these works need to be considered to allow them to be appreciated by future audiences. One way to do this is by using virtual reality. This paper summarises the recreation of two David Hall video installations in VR. Viewers experienced the work by being immersed in a 3D virtual gallery. This gave the viewer an idea what the work would be like in real life. The process of creation, maintaining the integrity of the work, authenticity and the user experience will be examined.

Keywords

Video, art, electronic, virtual reality, VR, obsolescence, immersive, media, installation, sculpture

Introduction

Media Art and the problems of technological obsolescence and deterioration is well known, particularly those artworks which rely on the failings or quirks of the technology to achieve their aim. [1] Although many artists using analogue video had been careful to keep their original tapes, less attention was paid to keeping the equipment needed to display these works in an exhibition context [2]. This was perhaps due to the cost of the equipment for most artists and the expectation that the equipment would always be available. Artists such as Naim June Paik tried to keep his apparatus in most cases, but it has still suffered problems of deterioration, such as in his *The More The Better* (1988) installation at the National Museum of Modern and Contemporary Art in Gwacheon, South Korea. [3] There have been many documented projects to digitise and archive artists video tapes from obsolete formats, such as the REWIND project in the UK, but less so the equipment, which has become the reserve of the larger institutions and niche organisations in the museum and media art research sector.

Cathode Ray Tube Monitors

The most ubiquitous piece of apparatus used in early video art is the CRT (Cathode Ray Tube) monitor. Although many of these are still around and working today, they are no longer generally manufactured. The death knell was when Sony announced in 2008 that they would cease production of their sought-after Trinitron monitor and eventually those still in existence will stop working when the tube fails. [4] Although many vintage video artworks will work on modern flat screen displays or projected, there are various reasons why this might not be desirable. Firstly, the artwork may be sculptural, where the monitor itself is part of the work, and this may even relate to what is being displayed on the screen. Secondly, the quirks or idiosyncrasies of the CRT monitor may also be part of the work e.g. Paik's *Magnet TV* (1965) where an industrial magnet distorts the image on the TV, which wouldn't be possible on a modern display. Thirdly, most early video works were produced for 4:3 ratio monitors and it is difficult to find modern flat screens that are not 16:9 ratio, especially larger ones. This is particularly important when re exhibiting pieces created for video walls, which became increasingly popular in the 1980-90s, when video channel synching technology became available. Finally, the images that CRT monitors display have a certain aesthetic that may be important to the artwork. Older work can look 'better' on CRTs due to the correct display of interlaced work and the perceived reduction of video noise.

Virtual Reality

What happens then in the future if an artist, collector or gallery wishes to re-exhibit an artwork where the original equipment has not been collected or the equipment required is entirely obsolete and unavailable? One possible solution is to use Virtual Reality (VR). The widely used preservation model of either migration, emulation or reinterpretation can perhaps be used here, and would involve aspects of all three. [5] However, I suggest that a re-created piece in VR should be referred to as a simulation or an illustration rather than a version of the work itself. That way, any arguments about the lack of complete authenticity can be avoided.

The first time the author used VR was in 1991. At that time the technology wasn't advanced enough to use for this

purpose in any worthwhile way – the headsets were bulky and heavy, the latency of the display was high, which meant you had to move slowly, and the graphics required a low polygon count which resulted in a lack of resolution. The substantial cost of the technology meant that the main applications were restricted to arcade gaming, military and aerospace uses. [6]

It has now come to the point where substantial advancements in VR technology and computer speed have meant that VR can be used for considerably more applications in a useful way. The introduction of equipment from companies, which include HTC and Oculus, have made the technology much more affordable and accessible along with 'game engine' software such as Unity and Unreal. The fact that these are called 'game engines' highlights that this technology is still being driven by the gaming industry, but it is being adapted for use in many other areas.

Due to these advances in technology, the author decided to engage in some experimentation using VR to re-create media artworks susceptible to obsolescence. Duncan of Jordanstone College of Art & Design (DJCAD) at the University of Dundee already had a well-established 3D lab, and also the author was engaged in the preservation of media art through the REWIND research project and its associated projects. This resulted in two experiments featuring the work of pioneering UK video artist David Hall (1937-2014). The reason Hall was selected was due to his sculptural use of the CRT and that the author had worked with him previously on re-staging a number of his artworks, so there was a tacit understating of Hall's rational and philosophy. A summary of these two case studies now follow, which were permitted by David Hall's estate.

A Situation Envisaged: The Rite II (Cultural Eclipse)

This piece by Hall was first created in 1988-90, it consists of 15 CRT monitors built as a videowall 4 high by 3 across close to a white wall. All but one face the wall and are not seen. Pre-recorded TV broadcasts reflecting on the wall form an aurora of changing light. In the centre, on the only screen to be seen, is an image of the moon recorded using equipment similar to that used by John Logie Baird in the 1920s. The sound, by David Cunningham, is derived from multiple broadcast channels and composed as a musical score, which is heard coming from within the videowall. This piece was chosen as being a good test to ascertain how well this could be replicated due to the range of different videos playing on multiple CRTs and the reflection of these videos on the wall (Fig 1).

The VR model was created in 2017 with Rhoda Ellis who was a recent undergraduate in Art & Philosophy at DJCAD, who for her degree show had re-created sculptures in immersive VR. Before he passed away Hall had written reasonably detailed plans of a number of his installation works which he had editioned with his gallery, Richard Saltoun. These were used as the basis for the simulation, and as it is virtual, all of his 'ideals' could be accommodated without

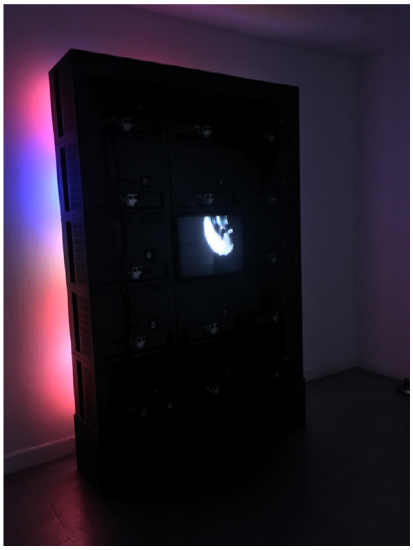

Figure 1. *A Situation Envisaged: The Rite II (Cultural Eclipse),* 1988-90 on display at Richard Saltoun Gallery, London, 2015 ©Adam Lockhart & Debi Hall.

the restrictions on equipment availability or compromised by the size and shape of the gallery. In fact, theoretically, one could choose to have the piece shown in a virtual version of any gallery in the world. The monitors which Hall specified were 26" minimum cube videowall monitors. It was decided to base the model on the Hantarex EQ/3 and the use of these would then determine the size of the gallery. Part of Ellis's process during her previous work was to scan sculptures using photogrammetry and laser scanning techniques, which would lead to the creation of the 3D models. This was attempted with an actual Hantarex monitor, but due to reflections on the glass and the lack of features on the black casing, this approach was problematic and subsequently abandoned. The monitors were then created directly in the VR game engine software, Epic Games' Unreal Engine, as boxes with the screen side curved and a photographic image of the rear of a monitor on the back. This software was also used to create the whole scene. Once the videowall was modelled, the gallery was built around this to an appropriate size, with the monitors near the back wall of the gallery. The original multichannel videos for the piece were already available in the REWIND archive and these were embedded on each of the monitors according to Hall's specifications. They were also 'projected' onto the back wall as a virtual light to create the reflective aurora (Fig 2). The sound for the piece was directionally located inside the videowall, as it would have been in the original piece, rather than just being heard as general ambient sound. A door was added on the opposite wall from the installation, with a lit-up information panel on the side wall to further create the feel of a gallery. Although it is possible for this model to be viewed and accessed via a 2D computer screen, the idea was that this should be a fully immersive piece to allow the experience to be as authentic as possible. In order to do this an HTC Vive headset was used with stereo sound, along with

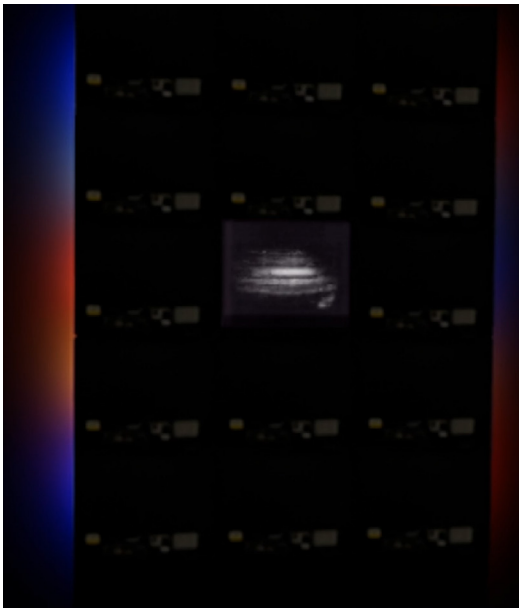

Figure 2. *A Situation Envisaged: The Rite II (Cultural Eclipse), 1988-90* VR simulation. ©Rhoda Ellis & Debi Hall.

motion sensor lighthouses which allow the headset's position to be detected in space.

The results from simulation were showcased at the NEoN Digital Arts Festival in Dundee, Scotland in 2017. This was located in a large disused factory building, so there were no issues of restrictive space. The virtual walls of the gallery were mapped onto the floor with tape, so that the 'arena' was the same size. This gave a good opportunity to discover reactions from members of the public, which yielded some unexpected results. Once the user entered the virtual gallery, by putting on the headset, they were located near the door end of the model, which would allow them to walk towards the installation. For many people, it was still the first time they had used immersive room scale VR so the novelty and amazement of the experience was more of interest to them than looking at the artwork itself. Another issue was that people who were not familiar with this particular piece couldn't quite work out what they were viewing, in respect to the virtual apparatus. This then had to be explained, which would have been unnecessary in the real-life installation. Therefore, three levels of explanation were required – the practicalities of the VR, what they were looking at in the virtual space and the interpretation of the work itself. Only the last of these would be required in the physical world. Those who were already familiar with the piece reacted quite positively and found that they were unintentionally able to see more of the piece than in the real world due to the lack of physical walls i.e. one could put one's head outside the virtual walls and look back in. This then revealed more clearly the content of the videos on the monitors which were not meant to be seen this way, but were there to provide the reflective aurora on the wall.

TV Interruptions (7 TV Pieces): The Installation

After the outcomes of the first experiment, it was decided to focus on a more accessible piece for the viewer to experience. In this case it was decided to model Hall's *TV Interruptions (7 TV Pieces): The Installation.* This piece was originally made for Scottish Television in 1971, as seven different short abstract interruptions to be broadcast unannounced throughout the duration of the Edinburgh Festival in the same year. This piece was then turned into an installation in 2006 in conjunction with the author as part of the REWIND project. The installation consists of 7 CRT monitors on plinths, placed in a cluster and facing in different directions. All of the monitors play out the full 7 TV pieces, but in a different order, so that the same one is not on at the same time. Again, instructions on the preferred type and size of monitor, in this case a Hantarex EQ/3, 25", and the distance apart of the monitors were stipulated by Hall in his specification.

For this experiment, the author partnered with a 3D animation specialist, Sang-Hun Yu, who is a colleague at DJCAD and a PhD student investigating the use of 3D modelling for forensic purposes. In this case, Yu used his skills as a 3D modeler to create the CRT monitors from specifications from The Block, a specialist monitor rental company and measurements from an actual Hantarex monitor. [7] This was carried out using Maya software and included such things as sockets and cables emerging from the rear of the monitor and proper textures added to the surfaces, all adding to the authenticity (Fig 3). Unity was used as the game engine to build the VR model in which Yu was more proficient, so this also provided an alternative to Unreal for a

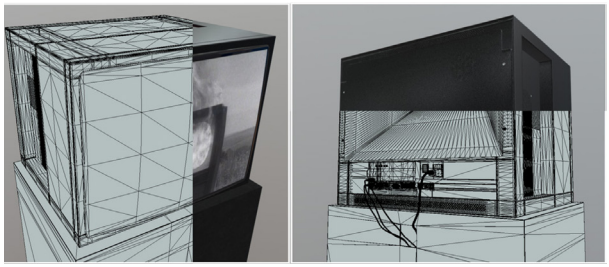

Figure 3. *TV Interruptions (7 TV Pieces): The Installation*, 1971/2006, VR simulation Monitor 3D Model. ©University of Dundee & Debi Hall.

comparison. The model from Maya was imported into Unity, replicated and placed on plinths into a gallery space built to fit with Hall's specification. The videos were then inserted into all 7 of the monitors, with the sound from each directionally coming from each monitor (Fig 4).

This simulation was exhibited at the Besides the Screen Conference, Kings College, London in July 2018. The HTC Vive headset and equipment were used again for this. The reaction from the users was much more positive in this case, in that it was more obvious what was being displayed, so the

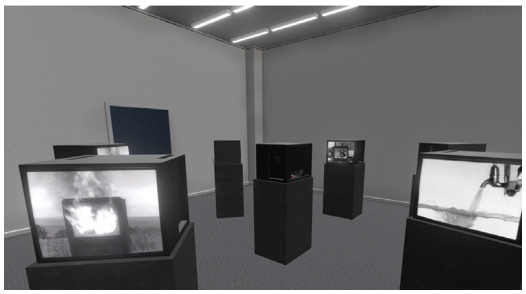

Figure 4. *TV Interruptions (7 TV Pieces): The Installation*, 1971/2006, VR simulation. ©University of Dundee & Debi Hall.

second explanation from the last experiment was not required. It was also more lifelike due to the superior 3D models and the videos played back well without any stuttering. The room in which the work was exhibited, was smaller than the virtual gallery, so care had to be taken to ensure the user didn't walk into the real walls. Interestingly the viewers tended to still walk around all the monitors on plinths even though they could actually walk straight through them.

An odd experience for some people in both of these examples was the lack of a virtual body and particularly their arms. The HTC Vive comes with handsets, but these were not required, as there was no interactivity in the scenes. Others were affected by mild virtual reality sickness, a form of motion sickness, but the time spent in the virtual space in these cases was short enough that this was not a significant problem. [8]

Conclusion

Overall these experiments were valuable but unexpectedly the main focus ended up being the experience of the viewer. Once immersive VR becomes more normalised in society, the novelty of the experience should dissipate enough to allow a more formalised study of the audience reaction. There is also the issue of preserving the VR simulations, which may become obsolete before the original artwork does, akin to the BBC Domesday project of 1986. [9] Tate are in the process of conducting a research project in the preservation of immersive media with results to be published in 2020. [10] The author intends to continue research in this area exploring further the capabilities of VR and augmented reality as the technology improves.

Acknowledgements

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A Database of Interdisciplinary Art in Russia

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Abstract

This paper looks at a new database of interdisciplinary art in Russia that is currently at the design and development stage. The database is intended as an open resource providing description and documentation of events and projects in the 20th and 21st centuries that involve early experiments and works of technological art, media art and art-science. The paper shows the specifics and aims of creating the database in the context of existing archives dealing with contemporary art in Russia. The paper presents an approach to data collecting and establishing selection criteria for the database materials and their basic structure. The paper concludes by description of opportunities in data analysis for those studying convergence of art, science and technology.

Keywords

Database; digital archive; Russian interdisciplinary art; interdisciplinary researches; art events; technological art; media art; computer art; net-art; art-science; digital analysis; data visualization; interactive anthology.

Introduction

The idea of the database and the context

The Database project of Interdisciplinary Art in Russia is aimed at gathering information about innovative experiments in art and at the investigation of art, science and technology convergence in a local and international context. At the beginning of the 20th century in Russia this convergence resulted in several inventions, such as Graphical (drawn) Sound (by Arseny Avraamov, Boris Yankovsky, Eugene Shelpo, Nikolai Voinov) or electronic musical instruments (by Lev Theremin), as well as in art practices inspired by scientific methods and technology (Meyerhold's Biomechanics for theater, Solomon Nikritin's Projection Theatre). Later, during the soviet period these kinds of experiments became marginal and in the main were related to kinetic art, experiments in cybernetics and activities by "Prometheus" group (Kazan). The Intensive appropriation of new technologies in art started in 1990s. Artists began to explore the possibilities of video, sound, computers and Internet. They started to search a language of expression by means of different media. At the beginning of 2000s the interdisciplinary (or transdisciplinary) practices of art involving technology became widespread. They already included methods of various sciences and were associated with the term "science-art". Due to the popularity of these practices and the attention to the "science-art" phenomenon, the interest to previous experiments arose. As a result, a need for understanding and rethinking of the development of Russian technological and media art in local and international context increased. However, not all art projects, and events have been carefully documented; the existing information about them is contained in various state and private archives. Most of them are not digitized yet. There is currently no full online media/technological art archive in Russia.

The most large-scale current project is The Russian Art Archive Network (RAAN) [1], aimed at preserving and digitizing archival documents and photographs related to Russian contemporary art. It is being implemented by Garage Museum of Contemporary Art (Moscow). The digital catalog of RAAN archive collections is regularly updated with materials from the collection of Garage Museum and its partner organizations. A collection of photo materials, press-releases, press publications and other documents, including those related to video and media art is located in the Scientific Archive of National Centre of Contemporary Arts (NCCA) [2]; all materials are accessible only in the NCCA library. The video art collection online available is gathered by CYLAND Media Art Lab [3], which has been holding Cyberfest festival since 2007. The collection includes works of artists who have participated in the festival. Descriptions of some significant projects in the field of media art developed by NewMediaArtLab (since 1993) and then MediaArtLab [4] (since 1999) can be found on the MediaArtLab's website. In contradistinction to the resources presented, the "Database of Interdisciplinary Art in Russia" focuses on

events exactly related to technological art, media art, “science-art” and discussions around relationships of art, science and technology as well as collaboration between artists and scientists. The purpose of the database is gathering information reflecting discussions, research and art projects formats, and also developing affordable tools to researchers (and a wide audience) to visualize and analyze collected data.

“Interdisciplinary art” in the title of database is an umbrella term which implies going beyond the boundaries of art practices to technology and science fields and vice versa. The results of this border crossing cannot always be considered as belonging to the field of art, therefore the database unit is not an artist or an art project, but an event, that is, a public presentation (for a wide or professional audience) of research, experiments and developments created at the intersection of art and technology or art and science. An exhibition, a symposium, a festival, a conference, a seminar, a public lecture, an artist’s talks, a workshop, etc. can be considered as an event. The database includes not only events organized in Russia but also international projects in other countries with participants from Russia. Thus, the database provides information to study the development of contemporary Russian “Interdisciplinary art” in relations with international context.

The selection criteria for the data

To formulate accurate criteria for the selection of events is quite difficult. Firstly, there are constant terminology transformations. For example, it is not clear if the term “computer art” covers art objects made with the use of microcontrollers or smartphones. Secondly, the formation of interdisciplinary practices or researches does not always take place under the auspices of art institutions. In the 1990s, the entertainment industry had a particular value, in the 1960-1970-s the first experiments bounded at the intersection of cybernetics and art took place within academies of science and universities. And finally, these practices and experiments took various started to take (video, installations, performances, concerts, CD-ROM, web projects, etc.). To overcome these complexities, an event was made the key unit of the database and basic criteria for events selection were formulated. An event becomes a part of the database if:

1) The event is accompanied by texts manifesting the boundaries erosion between art, science and technological invention;

2) The theme of the event relates to rethinking and interpretation of technology impact, scientific ethics, scientific data and strategies by means of art;

3) Art projects shown within the event include new technologies, methods, tools and equipment from applied or natural sciences, as well as systems of medical influence on a person (for instants, psychotherapy, psychology);

4) Art projects, demonstrated within the event have a goal to invent a new method of data obtaining, collecting or analyzing.

However, in the process of working on the project, these criteria can be adjusted. It is also assumed that when the database is finished and accessible, new information can be added according to the recommendations received from users.

The 1990s, the period of active appropriation of new technologies by artists in Russia especially in Moscow and St. Petersburg, served as the starting point for the database. The database is started from “Archive of Interdisciplinary Art of St. Petersburg of the 1990s”, created by curator Irina Aktuganova, and belonging now to RAAN. It is assumed that the period from 1990 to 2020 will be covered in most detail in the database; however, work on the project is going in two directions from the 1990s to the beginning of the 20th century and to the present moment.

The basic data structure

The database has a relational structure. The main spreadsheet contains basic information about the event - date, city, type and the title. Other data categories that can be divided into subcategories or, conversely, be absent are placed in related spreadsheets.

The database contains the following categories of information: date of event; type of event (conference, exhibition, etc.); title; location; description / announcement of the event; organizers; partners; names of curators and participants, as well as information about their status and place of residence; titles of projects or paper of participants; photo and video materials of artists' projects; links to digital archives containing documents or information related to the event (RAAN, Ars Electronica Archive, ISEA Symposium Archives, etc.).

The sources for the database are archival documents, publications (announcements, press releases, etc.) accompanying the event and interviews with participants. Texts describing the events in the spreadsheet are placed in their original view, without any changes. All texts written by researchers or based on the recollections of the

participants are posted separately. Each event will be accompanied with English annotation.

Data analysis

Structuring the information in the database implies the possibility of selecting and arranging events according to the chronology, type or topic, by the names of institutions, names of participants, technologies used in projects, etc. Thus, the database can be an interactive anthology that builds material according to specified criteria. In addition to these functions, it is assumed that data visualization (timeline, map, social networks) and statistical analysis will be available.

The project is currently at the data collection stage and is being implemented at European University at Saint Petersburg in collaboration with Techno-Art-Center (St. Petersburg).

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ePPA project: Telling Peru's video art histories through a unified platform

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Abstract

ePPA – Espacio/ Plataforma de preservación audiovisual (ePPA – Space/ Platform for Audiovisual preservation) aims at making Lima Art Museum (MALI) and Hi-Andean Technology's (ATA) video art collections available to a wider audience. By creating a platform, the project provides remote users with descriptive information of the artworks, and museum visitors with full access to the collection of video art. This paper discusses the challenges faced by the project in creating a platform that would work as a comprehensive database and, at the same time, would narrate the possible histories of video art in Peru.

Keywords

Video Art, Media Art, Archives, Platform, Research.

Introduction

ePPA – Espacio/ Plataforma de preservación audiovisual (ePPA – Space/ Platform for Audiovisual preservation) is the result of the joint efforts of the Lima Art Museum (MALI) and Hi-Andean Technology (ATA) to preserve their moving-image based works, relevant to the understanding of the history of visual arts in Peru. The two largest video art collections in Peru, owned by these institutions, comprise more than 200 works in videotape formats (form the 70' to the 2000', in U-Matic, VHS, Betacam, and miniDV), digital formats and recently digitized works in film (from the late 60', in 16 and 35mm). The aim of the project is twofold. On the one hand, it aims at providing a physical space where users would visualize the full contents of the works in modules installed in the library of the museum. On the other hand, users would have remote access to information about the artworks through an online database. When no copyright restrictions are being infringed, a link to the artwork is embedded. These two ways to access the collection respond to the need to open it to a wider audience: to researchers and students but also people visiting the museum that are not necessarily familiar with video as an art form. The challenge we faced was to create a comprehensive database that would, at the same time, tell the possible histories of video art in Peru. The chosen tool for this purpose was Collective Access, an "open-source software for managing and publishing museum and archival collections"[1]. This paper aims at discussing and contextualizing the complexity brought by the different objectives of the project by looking at the characteristics of the collections and the state of moving-image archives in Peru.

In the following paragraphs, a brief description of the state of moving image archives in Peru will be provided. The characteristics of the collections will be analyzed and the ways in which we extracted information from both will be analyzed in the second and third parts. In the last part of this short paper, the structure of the platform will be described in relation to the project's objectives of archiving and making the collections easily navigable.

In the absence of a National Film Archive

To this day, Peru does not have a publicly run film archive. However, a certain number of private institutions and individuals hold valuable funds that are progressively being made available to a wider audience. Although numerous voices have been claiming for a government intervention regarding this issue, concrete measures are yet to be executed. Even though actions have not been taken yet that seem to lead to the creation of a reclaimed National Film Archive, the Ministry of Culture, through the Directorate of Audiovisual, Phonography and New Media (DAFO), has created a grant scheme which enables archive owners and other cultural managers to get funding to develop projects for media preservation (e.g., film, video, etc.). ePPA was a recipient of this grant scheme in 2018, along with six other projects of very diverse nature and objectives (from the digital restoration of films by a well-known Peruvian film collective to the digitalization and cataloging of a vast rural participative video collection). This brief contextualization of the project is meant to highlight the fact that the basis for film and moving image preservation are in the process being made, following different paths, related to the different professionals' career paths and priorities. Even if state-run institutions such

[1] https://www.collectiveaccess.org/

as the Peruvian National Archives or the National Library of Peru hold audiovisual collections (Wiener, 2015), there is no unified national policy related to preservation standards and homogenized cataloging criteria. The relative newness of the field allowed ePPA to explore and follow its own path, attending to the diverse yet particular needs of MALI and ATA's collection. In particular, the project allowed to point out the specificity of the artwork with regards to other kinds of time-based works. Indeed, as it will be explained in further detail, it was important for the project to emphasize that these artworks are part of a museum collection on the one hand and a historical archive of the beginnings of video art in Peru on the other.

Two stories in one: collection profiles

Alta Tecnología Andina (Hi-Andean Technology) was created in 1995 as a non-profit organization that would become the epicenter of multiple cultural events dealing with art, science, and technology. Between 1998 and 2003, ATA organized the International Festival of Video and Electronic Art (Festival de Video/Arte/Electrónica) in the city of Lima that would then, under the direction of Realidad Visual, expand to other cities (Delfin, 2019). These Festivals became the heart of cultural activities related to the moving image and sound-based artistic practices, showcasing recent work by novel artists as well as connecting them with the broader circuit of global video art (Mariátegui, 2019). Artists, scholars and cultural managers converged in this annual meeting. Parallel to the organization of this showcase of Peruvian art, ATA –inspired by spaces like the CICV, Centre International de Création Vidéo– ran a space dedicated to experimentation with video, from 1998 to 2004. Artists and people coming from different disciples, with a shared interest in the production of the moving image, converged in the headquarters of an advertisement agency, where, during the night, the equipment was available for other kinds of –more creative– uses. It is from this six-year experience that the ATA archive comes from. The video pieces, that transpire the social concerns and aesthetic values of the Peruvian early 2000 can be seen as a first period of intense creative work in that media. Although it is not the first generation of artists using video or film, this group occupies an interesting place in the history of moving-image creation in Peru, in the sense that they were neither dependent on the logics of the teamwork that characterizes film production, neither on independent, one-men/woman crew that would characterize the next generation of creators in Peru.

Probably not coincidentally, the Lima Art Museum holds another crucial set of artworks that help the viewer have a rather comprehensive idea of the history of contemporary art in Peru and what does video art represents within this practice. This set of artworks are authored by Peruvian artists that studied and live(d) abroad and whose pieces circulate in an international market, such as those by Gabriel Acevedo, Marco Pando, Ishmael Randall Weeks, Maya Watanabe, David Zink Yi, among others. MALI also holds other important pieces that do not necessarily fall into that category, such as a historical piece by Teresa Burga as well as video artworks by non-Peruvian artists, not to mention sound art pieces and techno-sculptures. These video artworks are part of a large collection that spans from pre-hispanic times to our current year; they respond to curatorial decisions that are different from those of ATA. MALI's collections have a decisively more historical approach and the place video art has within these collections should be considered in relation to the eighteen thousand art pieces that the museum holds. Contemporary art in general, is, in MALI's collection, integrated within a larger history (Lerner, 2013) and a broader geographical context. In that sense, ePPA benefits from the presence of artworks from international artists. Although video art is by no means the most well-known art form in Peru it has, in the past ten years, had a consistent presence in the gallery circuit. Private collectors are interested in purchasing video art (Hernández-Calvo, 2019) but this is not necessarily the case for museum collections, with the exception of the MALI.

The above-mentioned collections, ready to be hosted by a museum institution with a public library and archive, are revealing of diverse modes of production and the reflection of different timelines of Peruvian video art history. Their modes of preservation and the information available for both collections is also revealing of their provenance. A first step towards the creation of ePPA's website was thus unifying the categories through which we would describe the artworks. Borrowing from valuable sets of documents written by leading institutions and projects dealing with media art preservation (DOCAM - Documentation et conservation du patrimoine des arts médiatiques; Matters in media art), ePPA team came up with a set of fields to be used in the description of their artworks. We adapted those recommendations to make the most of the information we had on the artworks but, most importantly, to properly convey the specificity of this two-part video collection that would henceforth find in the museum institution its place of existence. How to create a space for consultation that would, at the same time, speak to the project of a museum facing important changes? How to remain aligned with archival best practices while at the same time remain relevant to any visitor of the museum? How to highlight the specificity of ATA and MALI's collection while, simultaneously, weaving an intertwined history? How to tell possible histories by means of a database? The response to those questions would have to be solved in the immateriality of the platform we were to create and sometimes –against the grain– of what platforms (as they come in their predetermined form) suggested to us.

Excel sheets and unnamed fields

The detailed information on the artworks we aimed at providing, pushed ePPA team to dig into the history of each artwork, their numerous iterations (especially in the case of video installations), the historical context in which they arrived at the collections and the curatorial criteria for their purchase or donation. The attempts to properly organize these diverse and non-homogenous pieces of information into excel sheets had the benefit of helping us visualize the overflow of data we didn't really need and, in some cases, were not allowed to share (contracts, internal correspondence, etc.). It was important to know the information that was missing to understand the history of each collection. On the one hand, we had detailed information on how some video artworks entered the MALI collection (the conditions of purchase, the amount paid, etc). This rich data, along with other documents (e.g., curatorial reports, technical reports, preservation conditions) were useful to understand the criteria behind the integration of video into a larger collection. This qualitative data would fit, with difficulty, into Collective Access' predefined fields, even if the election of that tool was based on the flexibility it allowed. These pieces of information might not fit into those fields but are valuable in order to write a history of video art curatorship from the perspective of the museum. On the other hand, ATA's video pieces are rich in histories that link each piece to a broader, collective movement. Here, again, we're facing the kind of information that would slip between the cracks of the fields, even after an important effort of customizing Collective Access to our needs. To summarize, we were trying to create an archive with information that largely exceeded that purpose. We would quickly realize that the frustration produced by what seemed a misunderstood outcome for the project would transform into what we needed to achieve a second stage for the project: that of conveying the diverse narratives of video and media art in Peru.

How to give a proper account of these complex sets of information is a challenge intimately related to the affordances of Collective Access, the presentation software chosen to harbor the collections. Creating a template to document the artworks amounted to establishing a dialog between the non-systematized media art collecting practices in Peru with that of world-class institutions and research initiatives that have been working in the field for at least a decade. Also, we attempted to modify a pre-configured standard (Dublin Core) taking into consideration the information that was already available in the MALI's collection management software (The Museum System - TMS). Also, the process of translation, adaptation or refutation of, among others, the Media Art Research Thesaurus and DOCAM's *Glossaurus*, made it clear that we weren't simply (re-)cataloging the pieces but, to a certain extent, re-writing a part of video art history in Peru.

Creating entry points to the archive

An application programming interface (API) and a graphic user interface (GUI) provided us with the means to create a second layer of information that significantly differs from the type of data gathered for documentation purposes. Narrative threads were woven that would allow users to delve into the collections. These entry points are not innocuous, they inevitably shape the user's understanding and even visualization of the history of video art in Peru. A first version of the database was not supposed to include this second layer of contextual information. A group of professionals in charge of user experience design suggested that we provided some guidance to the visitor. They were right. And they were right not only because it would provide a more user-friendly interface to the collection, but because they made us realize we were assuming there was a more or less well-known history of video art in Peru. If it is true archives provide historians and researchers with invaluable material, it might also be true that it is valid to provide visitors with cues to navigate this archive.

We decided not to create two separate buttons for each collection (ATA / MALI) and chose four main "journeys" to be displayed on ePPA's homepage. These journeys are thematic but also historical. One of them is dedicated to the history of VAE festivals and, another, to "rescued" film works that are either experimental or that are valuable documents to understand art practices of a certain time period (i.e. art production during president Juan Velasco Alvarado regime). The challenge for ePPA is to be useful for museum's library and archive visitors –from general audiences, to students, academics or researchers– that are not expecting to curate their own journey through the archive while at the same time, acknowledging that the histories it features are incomplete and elements of the archive will be less visible than others. Ideally, access to the collections will provide researchers in the field with the information needed to write new, challenging narratives.

Conclusion

The context in which this project is being carried out might, in many ways, not seem ideal. There is much to be done for the preservation of materials and the maintenance of such efforts throughout time, to mention only two urgent needs. But on the other hand, this context also allows for enriching dialogs within different kinds of archives, exchanges that should tell us something about the specificity of the materials we preserve but also about the shared common ground: that of revealing untold or less visible histories. At a regional level, a survey was carried out by ATA, revealing the need to create cataloguing and storage standards. It is, in that sense, a propitious moment to think about the tools we're using and how they shape the projects we are carrying out.

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Author Biography

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Carving out a Path.
Building Research and Knowledge Environments (RKE) in a Digital Culture

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Abstract

This paper presents the work done at the NT2 lab (UQAM) designing a digital ecosystem specialized in research on contemporary imagination and digital culture. The very first Research and Knowledge Environment (RKE) was put online in 2005, specializing in Hypermedia Art and Literature. That experience led the NT2 Lab and the Figura Research Center to join their forces to build and promote the Observatory on Contemporary Imagination at the core of a research-based digital ecosystem.

Keywords

Digital culture; digital ecosystem; research and knowledge environments (RKE); hypermedia; hypertext; research community; contemporary imagination; directory; research-creation.

Introduction

I am first and foremost a semiotician, one interested in the way signs and discourses can be produced and understood, how they enable knowledge to evolve. Knowledge seems to be a simple notion, one we can easily grasp, but it represents a highly complex activity. In fact, it's more a process than a result or a quantity. We say: I know this, I know things. As if it were a simple possession: I have what I know, and nobody can take it away from me. This is my knowledge. But what part of it is personal, what part is public? Why do I remember this instead of that? How does that knowledge evolve throughout time? Not just on the historical level, but on the personal one as well? Knowledge never stays stable, making it more a flux or a process than a static form. So how can we be part of this process, individually or collectively?

Imaginary Network

When I was doing my undergraduate studies in literature at the University du Québec à Montréal in the 1980's, my roommate was doing his studies in computer sciences. While I was reading literature, especially contemporary American literature, he was finetuning his lunar landing skills on his micro-computer. He was programming on a cassette deck, jacked to a motherboard bought at Radio Shack and connected to an old Sony Trinitron television. It was tedious work, but highly engaging.

This was the time of arcade parlors and video games, Space Invaders, Pacman, Asteroids. Even though we didn't have modems or access to ARPANET, he was still playing a multi-user interactive fiction, a game based on the Colossal Cave Adventure developed for a mainframe. The game he played, that *we* played since he got me interested really quickly, was of the galactic empire and war genre. The mainframe was somewhere in the USA. My roommate and I controlled a fleet of spacecrafts. Every week, we would receive notice of our allies' and opponents' moves, learn of battles and wars fought in our sector; we could then plan our own moves, were allowed one phone call to another player, and then would send our own set of moves by mail. We had to wait a week, before receiving a new list of moves, which told us of the consequences of our actions and those of our allies and enemies. It was a really slow process, advancing at a snail-mail pace. But somehow it didn't matter. The computer opened up a realm of possibilities, a whole universe of interactions and fictional creations. The computer wasn't just a tool, it was also becoming the ground for symbolic forms to develop. A galactic war was a stereotypical form, embedded in the space opera subgenre, but still, it was played live, across the North American continent, and it was as thrilling as MMORPGs were when they first started.

This game told me, above all, that a new cultural form was evolving, one as fascinating as literature

could be. It also illustrated the compelling aspect of a network, even a rudimentary network, in fact more the illusion of a network than a network per se. And finally, having vanished almost completely from the surface of the earth, the game spoke of the precariousness of such cultural artefacts.

As a professor, I became a specialist of contemporary American literature. One of my main areas of interest was the complexification of literary narratives and its burden on readers. Metafictions and postmodern fictions were highly addictive; works where texts and images bonded called for a renewal of literary theory, even before the heydays of graphic novels; the intricate plays between literature and cinema called for the development of an intermedial theory; games on identity and on genre imposed a new theoretical and political standpoint. My own research dealt with the labyrinth as a guiding metaphor representing narrative and cognitive complexity. Quite understandably, as soon as they appeared, I got into fictional hypertexts, which easily represented the most elaborate narrative labyrinths ever conceived. They appeared to be the future of literature. They didn't rely on the book or on paper; therefore, they could only be read on a computer. They were non-linear, interactive, iconotextual works. Think about Michael Joyce's *Afternoon a story*, Stuart Moultrop's *Victory Garden*, Shelley Jackson's *Patchwork Girl, or A Modern Monster*, to name the most prominent ones.

At the same time as hyperfictions were appearing, the Internet became public, a hypertextual network of interrelated websites. And new forms of literature started appearing, like hyperfictions and hypermedia projects that didn't require an editor or an umbrella company, such as Eastgate Systems, but simply started spawning across the web. As early as the turn of the XXI century, their number always on the rise, they appeared to be the beginning of a new cultural form, of a new culture, manifestations of which could already be seen.

But, for the game my roommate was playing these works were as compelling as they were ephemeral. As soon as the operating system would evolve, they would become obsolete, unreadable. This situation prompted me to propose an extensive project, which, once funded in 2003, became the NT2 Lab. The basic argument for the NT2 infrastructure was simple: a new culture was emerging due to the development of the Internet, and we had to start studying it if we wanted to understand what was happening. Such study required the same type of infrastructure as the one used to produce these cultural artifacts. The focus was on the computer not as a tool but as a media, a mode of representation and mediation; the reading process of complex forms based on hypertextuality and interactivity; the development of strategies for studying new forms of texts and art, as well as for publishing research; and finally the impact of this new media and screen- based culture on contemporary imagination.

Our first task at the NT2 Lab was to build a directory of hypermedia works, more specifically an online open-access and process driven directory, a database accessible through our website. We identified and collected information gradually on over 4,000 works from Canada, the USA, France, Spain, Portugal, and more. One of the first consequences of the open access of our database was the interest it attracted. Artists and writers wanted to be part of the Directory. Professors and students wanted to know what theory or metalanguage to use to study these works. We realized that just putting a resource online wasn't sufficient, we also had to complement it with strata of information, critical discourse and tools (a taxonomy, a bibliography). The website had to become more than just a hub of activity for our group, but a source of knowledge and insight. The NT2 directory became our first Research and Knowledge Environment (RKE); this is the expression we used and started to promote (following the first INKE conference in Victoria BC, organized by Ray Siemens). It became our official publishing strategy. A Research and Knowledge Environment is an online encyclopedic platform offering the results of ongoing research, through layers of analysis that exploit a theme. Our hypothesis was that such a resource can become to digital culture what the codex has been to the book culture, i.e. its primary mechanism of organization, transmission and valorization of information.

The first RKE was the NT2 Hypermedia Arts and Literature Directory, which we worked on extensively for fifteen years. The Directory can be searched by a faceted search engine. Each of the more than 4000 entries identifies a hypermedia work, incorporates extracts, some screen captures or a filmed navigation, gives information on the author or authors and lists the work's URL, since most of them are on the Internet. A description of the work itself is provided, focusing on specific aspects, namely the forms of interactivity. To these entries are added, and this is where the concept of RKE became real, a set of thematic dossiers which highlights topics pertinent to these works, a series of blogs written by the NT2's researchers, and a series of virtual publications. We have our own podcast channel, Radio ALN|NT2, on which 46 podcasts have already been broadcast.

We also started doing online exhibitions curated by members of the team, namely by Professor Joanne Lalonde, an art historian and the NT2 co-director. Five such exhibits have already been shown, three of which

are notable. The first, *The Web Alphabet* (*Abécédaire du web*), received the Gold Web Art award at an international museology festival in 2012. The second, *Uchronia|What if?,* was presented at the 2017 Venice Biennale as part of the HyperPavilion project and later selected to be part of the 36th edition of the Rendez-vous Québec Cinéma in 2018. The third, *Re|Search*, is currently presented at the ISEA 2020 conference.

The Directory was an important part of the ecosystem we started to put together; it was a stepping stone and a lot of lessons learned while doing the project were put to use deploying the various RKEs we ended up designing. Before getting to this ecosystem, I want to describe one immediate offshoot of the directory: the project *Archiving the Present. Exhaustivity as an Aesthetics in Contemporary Cultural Practices*. This RKE, which is online since late 2018, is a direct consequence of the Directory. Having spent 15 years describing and cataloguing digital and hypermedia art, in a truly abductive manner (cf C. S. Peirce's notion of abduction), we realized that a new paradigm in the creative process had appeared, one where, to put it in a nutshell, systematicity was favored over originality, fascination or obsession for an object over mastery of an art or a technique, and exhaustivity of description over precision of execution. This paradigm shift is present not just in digital aesthetics or in what Lev Manovich calls info-aesthetics, but in all types of artistic and cultural practices. So we set out to prove this hypothesis, and to do this we conceived the *Archiving the Present* RKE. The central piece of the project is the Collection, a Directory of all types of works based on a systematic approach. These works range from literary texts to found footage, videos, photography and post-photography, to collages, performances, artist books, etc.

Ecosystem

At the same time as I was directing the NT2, I was also the founding director of Figura, the Research Center on Text and the Imaginary, funded by the FRQSC (Fonds de recherche du Québec: société et culture). Figura brings together more than 55 professors and 400 graduate students, from 5 universities and 4 colleges. I approached my colleagues with the possibility of imagining new strategies to publish research, namely in the form of RKEs, and to help convince them we gave out internal grants to help organize and put their projects online. Thus, at the NT2, we started receiving proposals for RKEs. We did not just theorize the advantages and forms of RKEs, we set out to establish them on a major scale. We didn't develop the content management system we were using from scratch, instead we chose the open source CMS Drupal and used it to answer the needs of our community. Our aim was not to build a prototype, but to deploy an ecosystem of online RKEs, and to see it evolve. The objective of this ecosystem was and still is to renew the way research is carried out and published on the Internet, by creating structured research platforms that are institutionally recognized (by being part of a Research Center for instance) and linked by the same search engine.

At Figura, we went on to propose as our core project, not a book-based publication, but a web-based one, an online encyclopedia devoted to contemporary imagination, studied from the point of view of artistic, cultural and literary practices. Thus, the Contemporary Imagination Observatory (oic.uqam.ca) was created in 2009. Now in its third version, the Observatory is set up much like the NT2 Hypermedia Arts and Literature Directory, as a website publishing research in an ongoing manner. It has multiple layers of discourses and analyses. For instance, as of this winter, the OIC has brought online:

117 conferences (42 videos, 76 audios)
61 symposiums, 27 workshops, 46 round tables for a total of 1306 talks, of which 548 are recorded videos
48 remediated publications from the Figura series of *Research Papers* (485 articles)
136 republished articles from Figura's researchers (part of the Patrimoine section)
27 research blogs (323 entries)
11 publications from the *ReMix* series (125 articles)

One of the main features of the project is its search engine, a faceted search engine based on our own taxonomies. For a word such as "ville/city", we get over 1800 results. We can refine our search in terms of types of results (bibliography, articles, etc.), historical periods, geography, disciplines, artistic movements, cultural practices, figures and motifs used, theoretical aspects. Not only is this search engine faceted, it functions across multiple websites. Using the expertise acquired while working on the CELL project with ELO, the Electronic Literature Organization, we started adjusting our projects so they could be harvested by the Apache Solr engine. Thus, when do you do a search on the Observatory, you get results from up to seven distinct projects. The results for "ville/city" are located not only on the Observatory database, but also on *Revue Captures*, our peer reviewed journal; *Magazine Spirale*, a cultural journal covering the arts and the humanities; *Hochelaga Maisonneuve*, a creative writing website exploring a

Montreal district through a geopoetic stance; *Pop en stock*, an RKE specializing on popular culture, from comic books to television and video games; and *Revue Postures*, a UQAM student journal in literary criticism.

The search engine is a gateway to our ecosystem devoted to contemporary imagination and cultural practices, from the traditional to the virtual. Our next objective is to put in place a website centered on the search engine, which will serve as a centralized access point to all the affiliated projects. In the meantime, our ecosystem is visible through the search result on the Observatory and on the banner atop the website, which list all the 26 projects connected. Our Observatory was initially research driven. Now, as research-creation becomes more popular and graduate programs incorporating it multiply, the impetus for having a web presence is becoming stronger. Our next major project will be to develop a centralized website, *La Fabrique de l'imaginaire contemporain*, granting access to the resources in research-creation put online by our community of creators and researchers.

Conclusion

I could go on and describe all the projects assembled in our ecosystem, but that would be tedious. Let's just say that all our major projects are still going strong, new ones have appeared and continue to enrich our ecosystem. To say the least, they are an extraordinary window on our community's numerous activities.

On a more personal level, if I look at how far I've come since the early interactive games we played through letters and phone calls across North America, the path seems strangely clear-cut. I started out being preoccupied by the fate of hyperfictions and web-based art and literature which disappeared as soon as the medium they relied on evolved, preoccupied therefore by our capacity to experience and, especially, conserve these fleeting forms; and I ended up building an ecosystem dedicated to the study of contemporary imagination, an ecosystem built by a research community interested in the numerous cultural, artistic and literary practices that make our world. I was driven by a simple directive: Know your world and share your findings. Know your world through its representations, whatever the medium or the technology; and share it, whatever way available. And do it before it becomes obsolete and disappears. This directive, I must admit, has never lost its meaning.

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Bertrand Gervais holds the Canada Research Chair in Digital Art and Literature. Full professor in the Literary Studies Department at the Université du Québec à Montréal (UQAM), he is the founding director (1999-2015) of Figura, the Research Center on Textuality and the Imaginary, and of the NT2 Lab, the Research Laboratory on Hypermedia Art and Literature. He teaches American literature and literary theory, specializing in theories of reading and interpretation, and in contemporary cultural, artistic and literary practices as well as in electronic literature and digital aesthetics. Member of the Canadian Royal Society, he has published and edited numerous essays on contemporary theory, literary aesthetics, semiotics and symbolic processes. He is also a novelist.

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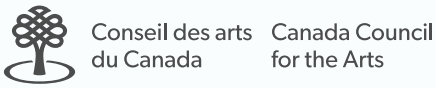
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