Creating value with innovation: From centre of expertise to the forest products industry

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Abstract

The innovation of products and processes is seen as a promising answer to many of the challenges faced by the forest products industry. Centres of expertise are used by governments and industry to create and transfer the innovative knowledge at the base of these innovations. The specific missions and objectives of forestry centres of expertise vary according to the sources of their funding and their targeted audience. However, we believe that even given the diversity of centres, a common objective can be extrapolated: that is to create value using research and innovation. The great number and varied nature of centres of expertise in the forest products industry illustrate their importance for the diverse actors of the industry. Their role, and in particular their role in the Canadian industry, is analyzed in this paper from the perspectives of innovation and value. An innovation value matrix is presented to describe the innovation process from the perspective of the value that is created and perceived by the various actors of the innovation process. Based on exploratory interviews with two centres of expertise dedicated to the industry, this model includes findings from other authors and proposes a new perceptive related to the value perceived and effected by the actors involved in an innovation process. Through the use of the innovation value matrix the authors examine the different actors' understanding of innovation and value. The authors believe that, by improving the understanding of the concept of value creation from innovative knowledge, centres of expertise can develop a better understanding of their own processes and in turn develop better tools to transfer knowledge so that it is used to create effective value for the forest products industry.

Key words:

Centre of expertise; Forest products industry; Innovation; Knowledge management; Innovation value matrix

1. Introduction

Currently, the global forest products industry finds itself faced with many challenges. These challenges are multifaceted and complex, and the need for the application of innovative ideas and solutions is obvious. However, the process from innovative knowledge to implanted or consumed innovation is not clear. There are many sources of innovative knowledge, from internal R&D departments to universities and centres of expertise. In particular, centres of expertise, financed by public and private sectors, have a large role to play in the creation of innovative knowledge and the process of turning that knowledge into innovation.

The first part of this paper presents the challenges currently faced by the industry in general and the forest products industry in Canada and the province of Quebec in particular. Following this, the roles of centres of expertise are discussed. Next, an overview of the literature in the fields of knowledge management and innovation is given. The fourth section of the paper presents two generic models of the innovation value chain and the results of interviews with two centres of expertise working in the forest products industry. The fifth section presents the innovation value matrix that has been developed by the authors. Following this is a discussion of possible supporting factors. Finally, the conclusion will present the future research needs of the authors.

2. Industrial context

The forest products industry is an active player in the knowledge revolution that has changes the structure of many economies (Simard, 2000). Moreover, sustainable growth and development, both in ecological (Innes, 2002) and economical terms, have become priorities. Economic, environmental and social considerations have become the basis of future plans of industry players (De la Roche and Dangerfield, 2002; McDonald and Lane, 2004). Juslin and Hanen (2002) have identified four major trends facing the industry:

- restructuring, consolidation and search for profitability
- cost reduction through production optimisation and technological innovation
- customer orientation, centred on differentiation and adding value
- confronting environmental challenges.

World wide overcapacity and low prices led to the consolidation and restructuring of many companies. Larger companies have emerged that are integrated along the supply chain. Network thinking and collaborative methods are replacing information and operations silos. This has encouraged research in the fields of supply chain management, industrial engineering, operations planning and new communication and information technologies to support e-business endeavours (Epstein et al., 1999; Frayret et al., 2005).

Much research has been done and resources invested to optimise production and implant technological innovations (Haarla, 2003). These hardware oriented technologies have allowed companies to reduce costs and increase productivity (Juslin and Hansen, 2002).

However, progress still needs to be made to integrate these technological innovations that optimise production with software oriented technologies and the overall coordination of value added networks.

Following other industries, the forest products industry is increasingly focused on the end customer. To improve customer service levels the industry needs to innovate to better manage its value creation network. Knowledge management practices also need to be developed (Simard, 2000; Innes 2002; Van Horne et al., 2005) in order to pull information from customers so as to develop new products and services that meet, or even create, the needs and desires of an increasingly demanding customer base.

Finally, the environment has become a key issue for all stakeholders of the forest products industry. In fact, environmental management (including harvesting and forest operations), forest certification, and environmental labelling (Juslin and Hansen, 2002) are inescapable issues for the industry.

There are numerous centres of expertise working on these problems around the world. The following section first proposes a definition of a centre of expertise. Then, it discusses the roles that these centres play in the creation and implementation of innovation knowledge.

3. Centres of expertise and their roles

A centre of expertise is a centre, whether virtual or physical, that regroups experts from multiple disciplines to study complex and multidimensional problems in a team environment, in order to create and transfer new knowledge and insights to concerned

stakeholders. According to their sources of their funding, their mission may serve various purposes and "customers/audience" (Van Horne et al., 2005). However, the authors believe that even given the diversity of centres, a common objective can be extrapolated: that is to create value using research and innovation.

Narula (2001) explains that companies use their in-house R&D for issues and technologies related to the company's competitive advantages. Of course, this knowledge should not be shared. However, more collaborative approaches are interesting, especially when the benefits of the research area are unknown or marginal (Narula, 2001). Many authors have also demonstrated that when companies wish to acquire a new technology, or know-how, they are more prone to cooperate in collaborative type relationships (Poulin, 1994). Nakamura et al. (2003) list five motivating factors that are behind a company's decision to enter into cooperative research: internalise externalities, pursue R&D cost reduction, gain expertise and information, share risks and coordinate strategies.

Particularly in Canada, where the federal and provincial governments own 95% of commercial forests, cooperative forestry research is significantly supported. This of course is a major financial incentive for companies to join these centres and profit from research into both common and specific problems. In fact, in 1995 Paprican's budget (a nation-wide centre doing research in the pulp and paper sector) accounted for over 30% of all R&D performed in the sector and in that same year over 90% of R&D expenditures in the solid wood sector were performed by Forintek (a nation-wide centre) (Nakamura et

al., 2003). In this way, the collective challenges faced by the industry are often studied by network based centres of expertise.

These centres do more than research. Extension activities play a vital part of their role in the industry. The transfer of technologies and innovative knowledge and assisting in the implementation of innovations to create effective value is an important part of their work (Nakamura et al., 2003; Van Horne et al., 2005). Moreover, the process that centres of expertise use to create value from innovation has never fully been studied. The authors believe that by improving the understanding of the concept of value creation from innovative knowledge, centres of expertise can develop better tools to transfer knowledge so that it is used to create effective value for the forest products industry.

4. Knowledge management and innovation

Knowledge is information that has been read, understood, interpreted and applied to a specific work function (Lee and Yang, 2000). There are two types of knowledge, tacit and explicit, although absolutes are rare. Tacit knowledge, also called procedural knowledge, is personal and difficult to formalise. It is our hunches, insights, know-how and cognitive knowledge and is based on our beliefs, ideals, values, schemata and mental models (Nonaka and Noboru, 1988; Nonaka, 1991; Schmoldt and Rauscher, 1994). Explicit knowledge, also referred to as declarative knowledge, can be expressed in words and numbers and shared in the form of data, equations, specifications, manuals, reports, etc.

The literature on knowledge management is vast but a common definition has yet to be developed. A useful definition is provided by Simard (2003): knowledge management is "developing organizational capacity and processes to capture, preserve, share, and integrate data, information, and knowledge to support organizational goals, learning and adaptation." Consequently, knowledge management is not simply organising information or sharing it. In fact, the goal of knowledge management is to create value from organisational and individual knowledge.

The benefits derived from good knowledge management are multiple, and include: reduced duplication of effort, creation of new knowledge, and increased efficiency and productivity. Furthermore, innovation is one of the many by-products of knowledge management. In fact, some authors consider innovation as the greatest payoff of knowledge management (Majchrzak et al., 2004). Baldwin and Hanel, (2003) argue that innovation is the dynamic force that changes the economy and it is at the heart of entrepreneurship. Moreover, knowledge and innovation are the building blocks of sustainable competitive advantage (Porter, 1985), and therefore are a source for sustainable development and growth for enterprises.

Edvinsson et al. (2004) define innovation as the reuse of existing insights and knowledge combined with new knowledge which is then commercialised or used by a company. Thus, an innovation is the use of innovative knowledge so as to create effective value for the stakeholders of the industry. There are two types of innovation, incremental or continuous and radical or discontinuous. Incremental innovation is the most common type of innovation and consists in incremental changes to current products or processes. This type of innovation is often pulled from customers (Darroch and McNaughton, 2002).

In contrast radical innovation tends to make certain skills and knowledge redundant and is often the result of the development and application of new technologies and is science based (Veryzer, 1998). Both are needed by the forest products industry to create value and sustainable development and growth.

An important problem faced by the industry is the implementation of new and innovative knowledge into its processes and products. This problem is faced by both companies and the centres of expertise that develop knowledge and need to transfer the technologies developed to the industry (Globerman et al., 2003; Kremic, 2003; Nakamura et al., 2003).

The literature on innovation systems, particularly in forestry, studies the systems used to diffuse innovation. These systems, as described by Kubeczko and Rametsteiner (2002) and Côté and Perron (2001), are networks of organisations (e.g., research institutions, private enterprises, government agencies…) and resources that facilitate the innovation process. Interactions between actors are privileged for study over the roles of particular actors. The authors strongly recognise the importance of networks in innovation processes. However, we claim that the particular roles and the perceptions of values held by each actor also needs to be further studied.

5. The Innovation Value Chain

5.1. New Product Development

The process of innovation per se has been thoroughly studied by many authors in the academic community (Rogers, 1983, 2003; Cooper, 1990, 1994; Balachandra and Friar, 1997; Krishnan and Ulrich, 2001; Cooper et al., 2002; Marxt et al., 2004; Reid and de

Brentani, 2004). Rogers (1983, 2003), for instance, describes it as a six-phase progress that involves (1) recognizing a problem or a need, (2) doing applied research, (3) developing the innovation, (4) commercializing the innovation, (5) diffusing it and finally (6) adopting the innovation. Much research has focused on New Product Development (NPD) and its frameworks, models and processes (Veryzer, 1998; Cooper et al., 2002; Marxt, et al., 2004; Reid and de Brentani, 2004). Other authors focus on success factors (Balachandra and Friar, 1997; Cooper, 1999). In contrast, Krishnan and Ulrich (2001) write that NPD is a business process involving many generic decisions and argue that adopting a decision perspective is advantageous as the "how" of NPD can change while the "why" remains more constant.

The Stage-Gate Model developed by Cooper (1990, 1994; Cooper et al., 2002) is widely studied in the NPD literature (Balachandra and Friar, 1997; Veryzer, 1998; Krishnan and Ulrich, 2001; Marxt, et al., 2004; Reid and de Brentani, 2004). Cooper describes a five gate and five stage innovation process, where gates represent go/no-go decisions and are guarded by "gatekeepers" responsible for making the decisions necessary to end the project or push it to the next stage. The process begins with an idea and then passes through the following gates and stages: Gate 1, initial screen; Stage 1, preliminary assessment; Gate 2, second screen; Stage 2, detailed definition; Gate 3, business plan review; Stage 3, development; Gate 4, post development review; Stage 4, testing and validation; Gate 5, pre-commercialisation business analysis and Stage 5, full production and market launch (Cooper, 1990).

5.2. Exploratory interviews

In order to compare these generic concepts with the reality of two centres of expertise from the Canadian forest products industry we conducted preliminary interviews with two people in charge of the organisation of the innovation process in their respective centre. Personal and semi-guided, three hour long interviews with the director of Equipment Development, from the CRIQ, and the vice-president of the Eastern Division of Forintek were conducted in the spring of 2004 in Quebec City, Canada.

The first interview was conducted with the Centre de Recherche Industrielle du Québec (CRIQ). The CRIQ is an industrial research centre, funded by the government of Quebec and it employs 350 personnel and has over 1,000 clients each year. It was created in 1969 and is a source of innovation and expertise in the areas of manufacturing technologies, the environment, industrial information and standardization. A large portion of their R&D efforts is concentrated in the forest products industry. In particular, the CRIQ develops various types of equipment used in the timber and pulp and paper industry. The interviewee oversees most parts of the entire innovation process, from the identification of a need to its diffusion to the industry. In brief, at the CRIQ, the innovation process often begins with industrial companies that arrive with a problem to fix or an idea to develop. The interviewee explained that a common feature of such companies is a certain amount of technological dexterity which allows them to be on the leading edge of the industry. The first task of the CRIQ is to evaluate the technological potential of the initial idea and then they assess the value of the technological potential for the client and the industry as a whole. Once the decision to go further with the idea is

made, researchers of the CRIQ search for available solutions to the problem, or promising technologies.

After the research is completed, a prototype is built to be exploited by the industrial partner of the project. Again, this step is only taken if a potential value for both the centre and the industrial partner is perceived. Finally, if actual value can be demonstrated from the use of the technology (e.g., productivity increases, cost reduction, waste reduction or energy savings) then the new equipment or process is considered to be made available to other member companies or even commercially.

Several factors for success were noted by the interviewee. In particular, the importance of a network of researchers and people working in the industry was highlighted. These relationships allow competencies (both theoretical and practical/industrial) to be effectively combined. They also help the industry be "ready" to accept new technologies. During the interview, it was noticed that there is often an intermediary or boundary-spanning individual between the researcher and the industrial partner. This "spokesperson" is able to popularise scientific language and can also translate the needs of the partner into potential research directions. Finally, the interviewee noted that a network of support is also needed. Financial, material and managerial support must follow the process, from the early stages to the adoption of the innovation.

The second interview was conducted with Forintek Canada Corporation. Forintek is a private Canadian organization which is funded by public monies and membership fees industry companies. There are over 220 employees (170 research professionals) employed by the organisation. The interviewee is responsible for the high level

organisation of the innovation process and is actively involved in ensuring the efficiency and effectiveness of Forintek's innovation processes.

At Forintek, the innovation process also often begins (but not necessarily) when an industrial member of Forintek arrives with a problem. If the problem is industry wide, the research that initiates the innovation process begins with Forintek funds. If not, the process is contract-based, and research is funded solely by the partner, with the consequence that results are not shared. Next, if Forintek does not have the internal competencies to solve the problem, they investigate to see if the required knowledge has already been developed somewhere else. The interviewee mentioned that knowing where to find competencies and knowledge is a strategic competency for a centre of expertise such as Forintek.

As an example of a typical and successful innovation process at Forintek, the interviewee described the case of an innovation process dealing with a common problem to many sawmills in Quebec. This problem concerns the distinguishing of fir and spruce planks in sawmills when logs are not sorted. Up to this point, highly trained employees have been used to make such a differentiation. However, with the lack of skilled employees, this is not an efficient way to solve the problem. In order to find a solution, Forintek proposed an initial technological idea and developed into this into a prototype. The idea was a color-changing chemical detector that is applied on planks to distinguish between the two species. An industrial partner was found and involved early in the innovation process, which finally resulted in a technology made available to industry through a partnership with a private company that produces and distributes the innovation.

Once again, the interviewee mentioned the importance of having a project champion, to follow and sell the project throughout the various stages. The importance of collaboration and having close working relationships with their industrial members and other centres of expertise was also highlighted.

5.3. Innovation value chains

On the basis of the mentioned literature and these interviews, it is possible to draw a parallel with and adapt Porter's value chain framework to the process of innovation. This analysis results in the proposed activity view of the innovation value chain (see Figure 1). On the one hand, Rodger's six stages of the innovation process represent what may be referred to as the primary activities. On the other hand, other necessary activities, not directly involved in the process of creating the innovation per se, can be identified and recognized as being what Porter call support activities. These activities involve notably the management of the competencies, the technological and research infrastructures, and the knowledge required to create the innovation, as well as the management of the innovation process itself. This is in line with what Marxt et al. (2004) refer to as the function-process matrix where the various enterprise activities are divided into stages of the innovation process and which the entirety is supported by the social organisation (collaborative and project management and communication) and risk, quality and knowledge management processes.

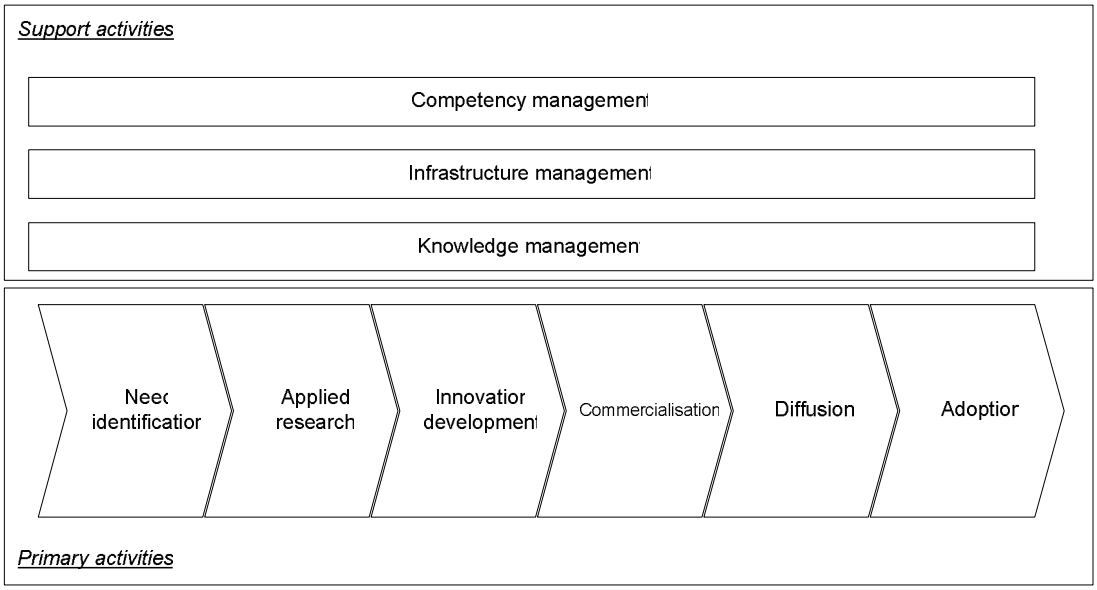

Figure 1: Activity view of the innovation value chain

From the perceptive of the innovation, the innovation value chain may be represented differently. Indeed, innovation starts from an idea that is often embedded with an innovative knowledge, to become somehow a prototypical invention, to finally become an innovative product or piece of technology that is industrially exploited or even commercialized. These stages of the innovation, different from the stages of the process of innovation, can thus be represented by a three-stage model of the innovation value chain that can be seen as the innovation view of the innovation value chain (see Figure 2).

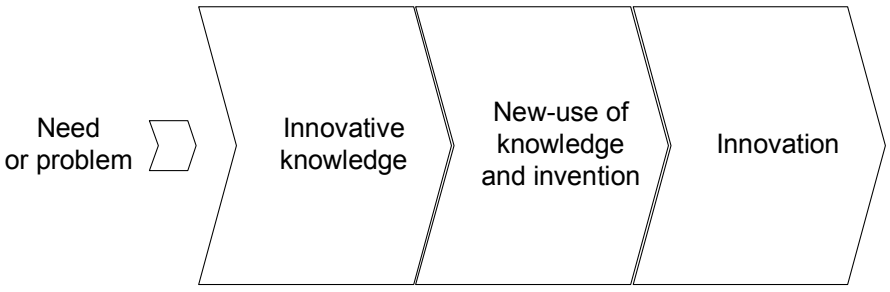

Figure 2: Innovation view of the innovation value chain

From the initial idea, which triggers the development of the innovative knowledge to the consumed innovation, the innovation view of the innovation value chain builds on the literature (Edvinsson et al., 2004) and defines three main outcomes of the innovation process: innovative knowledge (new knowledge and ideas), new-use of knowledge and invention (application of the innovative knowledge) and the innovation itself (exploitation and new-use of innovative knowledge).

Innovative knowledge is built from an initial idea or problem which may come from any actor of the innovation process. The four phases of knowledge transformation, as outlined by Nonaka (1991), are all used to create new explicit knowledge that is written and easily transformed and new tacit knowledge of the researchers. However this paper emphasizes the new knowledge which usually derives from the theoretical research of a centre of expertise. Rogers (1983, 2003) describes the innovation development process as a six-phase progress. Innovative knowledge is the outcome of Roger's first two phases (i.e., recognizing a problem or need and basic and applied research. **New-use of knowledge and invention** represents applied research, and application of the innovative knowledge. Once research has been applied, or "old" knowledge has been used in a new way, there is invention. This invention often takes the form of beta-systems, prototypes or applied concepts. Rogers (1983, 2003) refers to this as the outcome of the development phase of the innovation.

Finally, **innovation** results from the exploitation of the invention. Rogers (1983, 2003) refers to this as the outcome of the commercialization, diffusion and adoption phases. The consumer of the innovation can now make use of the innovation.

On the basis of the literature and the exploratory interviews the authors noted that value perception appeared to be the motivating factor that pushes a project through the next "gate", stage or step of the innovation process. Therefore it would appear to be advantageous to take a value perspective of the innovation process and to map out the values perceived by the different actors at the different stages of the innovation process.

6. Innovation value matrix

6.1. From centre of expertise to innovation

The innovation value matrix is a model (see Figure 3) which aims at analysing how the value of knowledge and innovation, perceived by the proposed actors of the innovation process, is tied to the process of turning innovative knowledge into an innovation. In order to do this, the model identifies generic roles that can be played by the actors of the innovation process, and analyses the value perceived of the three stages of the innovation view of the innovation value chain. These roles are generic in the sense that they are not specific to any particular type of organization. In other words, any one organization can play any role, or hold more than one role in the process. However, this model has been developed in a context where innovative knowledge is transformed into a consumed innovation and transferred from a centre of expertise to the forest products industry. Consequently, it still needs to be validated in a broader context.

	Producer of innovative knowledge	Consumer of innovative knowledge	Consumer of innovation
Innovation knowledge (new knowledge from which originates the innovation)	**Scientific value** - peer recognition - number of references	**Opportunity value** - relevance to real world problems - possible solution to a client's problem	**Potential development value** - relevance to actual problems - potential contribution to strategic goals
New-use of knowledge and invention (embodiment of the innovative knowledge into an invention)	**Implementation value** - patents - credibility/good will	**Potential business value** - in-depth market analysis - customers prospects	**Potential service value** - potential to improve competitive advantage or fulfill environmental regulations
Innovation (exploitation of the new-use and invention)	**Application value** - licensing agreements - licensed patents	**Effective business value** - number of users - sales	**Effective service value** - improved market position - increased sales - increased efficiency

Figure 3: The innovation value matrix

6.2. Roles in the innovation process

The proposed model identifies three main roles in the innovation process, which are: the producer of innovative knowledge, the consumer of innovative knowledge and the consumer of the innovation.

From the perspective of the industry, the **producer of innovative knowledge** can be any qualified actor within or outside the organization. Culture (scientific rather than business), language (technical rather than practical) and vision (long-term rather than

day-to-day) are all aspects that create a physical and mental separation between the producer of the innovative knowledge and the consumer of the innovative knowledge. In Canada, external centres of expertise, using collaborative research, often fill this role (Globerman et al., 2003; Nakamura et al., 2003; Van Horne et al., 2005). The producer of innovative knowledge is responsible for recognising and demonstrating the scientific, implementation and application values outlined in the model. However, as the goal of technology transfer is to deliver practical benefit and value to the consumers of the innovative knowledge and innovation, (Kremic, 2003) the innovative knowledge that they develop must have demonstrated opportunity and potential development value.

The **consumer of the innovative knowledge** can be an organization or an internal unit of an organization that takes the innovative knowledge and uses the new knowledge to invent a new product or a new use of that knowledge. This role can also be filled by a third party business organisation that exploits the innovative knowledge to produce a prototype of an innovative product or service. Again, in Canada this role is often filled by organisation such as the CRIQ, Paprican, and Forintek. These bridging institutions have been recognised as valuable facilitators of technology transfer between research organisations and industry (Carr, 1992; Kremic, 2003). Based on the exploratory interviews and the literature the authors believe that the consumers of innovative knowledge must be capable of and are responsible for recognising the implementation and potential service value of an invention. A decision is then made to develop or not the innovative knowledge into an invention. Once this go-decision has been taken, they must demonstrate the opportunity, potential business and effective business value of the developed invention to push the innovative process into its final stage.

The **consumer of the innovation** is the organisation or individual who purchases, implements or directly benefits from a new product or service. Companies are generally the consumer of the innovations developed by the forestry centres of expertise for the authors consulted and in the literature (Globerman et al., 2003; Nakamura et al., 2003; Van Horne et al., 2005). The consumer of the innovation makes the decision to implement the invention based on its potential service value. However, to realise the effective service value of the innovation the consumer of the innovation must have the necessary resources and structures in place to facilitate the exploitation of the innovation.

6.3. Creating and perceiving value throughout the innovation process

For the transfer and transformation of the innovative knowledge to a commercialized or exploited innovation, the value of the outcome of each phase must be evaluated by the concerned actors, in order to trigger the continuation of the innovation process. A parallel can be drawn here with the Stage-Gate Process (Cooper 1990, Cooper et al., 2002), where value recognition could be considered as the impetus to pass through the required gates to establish the network requirements necessary to go to the next stage of new product development, or more generally the innovation process. The decision perspective of Krishnan and Ulrich (2001) is also interesting as decisions are often based on the value perceived by decision makers.

From the perspective of the innovative knowledge producer, innovative knowledge has **scientific value** that can be evaluated in terms of peer recognition. This translates into the number of published papers, in which journal and the number of times such papers

are cited in the academic community. When the innovative knowledge has been transformed into an invention, it has **implementation value** that can be judged by the number of patents issued that validate the credibility or goodwill that the scientist or centre of expertise has accrued. Finally, when the invention has been transformed into a consumed innovation it has **application value** that can be assessed in terms of the number of licensing agreements reached, that in turn contribute funds to further research activities.

From the point-of-view of the consumer of innovative knowledge, innovative knowledge has an **opportunity value** which means that the innovative knowledge is relevant to real world problems. In other words, developing the innovative knowledge could lead to a solutions (or be a part of one) to a problem of one of their clients. Preliminary market studies and the number of potential users can also be used to evaluate this value. When the innovative knowledge has been transformed into an invention, it has, **potential business value,** which is judged through customer prospects and an in-depth market analysis. Finally, when the invention has been transformed into a consumed innovation, it has **effective business value,** which would be calculated by the number of users, sales and the number of commercialisation agreements reached.

Finally, from the point-of-view of the consumer of the innovation, innovative knowledge has **potential development value** which again refers to the relevance of the innovative knowledge to actual problems. The value off innovative knowledge can also be assessed by its potential contribution to the strategic goals of the corporation. When the innovative knowledge has been transformed into an invention, it has **potential service value.** This value can be evaluated is evaluated by an invention's potential provide its

consumer with a service that could improve its competitive advantage, as well as its usefulness and ease of use. Furthermore, in the context of the forest products industry, it can be judged by its contribution to the fulfillment of environmental or certification regulations. Finally, when the invention has been transformed into a consumed innovation, it has **effective service value** which can be assessed with several variables: increased sales and efficiency, improved market position, decreased costs, etc. Overall an innovation will be judged by its contribution to the sustainable growth and development of a corporation.

7. Discussion

The model of the innovation value matrix identifies the nature of the perceived value of the innovative knowledge, the invention and the innovation throughout the process of innovation. However, whatever the form of innovation process, several strategic decisions need to be made or gates opened for the innovative knowledge to become an innovation. Reid and de Brentani (2004) in their extensive literature review of NPD process, note that these gates are guarded by gate-keepers who judge and then direct information about the innovative knowledge. These individuals are often the same as an organisation's "boundary-spanners" who cross the boundaries of their own organisation into another and facilitate knowledge transfer. Both our interviewees can be seen as individuals holding these two roles. The authors believe that these types of individuals are ideally placed to evaluate the value of the different stages of the innovation process.

On the basis of the interviews and the reviewed literature, established networks of people and partners appear to facilitate the innovation process. The ability to find, use, or even

create such networks would therefore appear to be an advantageous skill for all the actors of the model. The network (Poulin et al., 1994) of financial and material support needs to be composed of several actors whom will act as the gate-keepers, boundary-spanners, allies and champions (Akrich et al., 1988; Poulin, 1994; Cooper, 1999; Reid and de Brentani, 2004; Krishnan and Ulrich, 2001). The actors support and guide the passage from one phase to another, to speak with other actors and sell the value of the innovation (from knowledge to commercialisation).

The producer of the innovative knowledge must have the ability to understand the real and future needs of the consumer of the innovation and the creativity to foresee potential needs as well. For example, the growing demand for certified products in other industries forecasts a future demand in the forest products industry. Therefore, another vital competence would be the ability to propose solutions that will help solve the current, future and potential challenges of the industry to ensure its long-term viability. An important competence of the consumer of the innovative knowledge is the ability to develop and apply that knowledge and transform it into an invention. They must be able to build workable beta-systems and accurate prototypes. Finally, the consumer of the innovation must be able to use and adopt the innovation and moreover have the ability to adapt existing processes to ensure the successful exploitation of the new product or process.

The use of the proposed model to represent specific innovation processes needs further investigation. From the interviews and the literature the authors remarked that innovation processes are indeed not linear and the relationship between the different perceived

values and the innovation process needs to be further analysed so that success can be replicated and failure avoided. The factors of success cited in the current literature are numerous (Cooper, 1994; Balachandra and Friar, 1997) and are largely dependent on the nature of the innovation, the industry and the external and internal context of the consumer of the innovation. Therefore, the authors believe that using a generic value perspective will aid organisations make the necessary decisions to continue or not the innovation process.

8. Conclusion and further research

Innovative ideas, processes and products can be used to obtain sustainable advantage and growth. However, the process from innovative idea and knowledge to an implemented innovation in the context of centres of expertise needs further study. This paper presented a value-based model that can aid our understanding of the many complex mechanisms involved in the process of innovation. This model emphasises the roles played by the actors of the innovation process and the values that are perceived by the actors to make these decisions. We believe that, by improving the understanding of the concept of value creation from innovative knowledge, centres of expertise can develop a better understanding of their own processes and in turn develop better tools to transfer knowledge and technologies so that it is used to create effective value for the forest products industry.

The proposed model, though it has already been useful to better understand how a centre of expertise can contribute to the process of innovation, is still in its infancy. Many aspects need to be investigated. In particular, the role that governments and government

agencies play in the network needs to be further researched. In effect, in Canada governments create both the environment and the impetus for much of the research carried out in the industry. Governments also provide some of the necessary connections with the industry through regional public development agencies to foster technological transfer. It thus seems pertinent that their role be analysed.

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