Transport Canada | Transports Canada
Transportation Development Agency | Centre de développement des transports

CANADIAN HIGHWAY SYSTEM STUDY

NEW TECHNOLOGY AND CANADIAN HIGHWAYS

A Preliminary Assessment 1972-1982


277
QVEBEC

V. Setty Pendakur

Neal A. Irwin

CANADIAN HIGHWAY SYSTEM STUDY

NEW TECHNOLOGY AND CANADIAN HIGHWAYS

A Preliminary Assessment 1972-1982

AUGUST 1972

TRANSPORTATION DEVELOPMENT AGENCY
of the Ministry of Transport
Montreal, Canada

CENTRE DE DEVELOPPEMENT DES TRANSPORTS
du Ministère des transports
Montréal, Canada

FOREWORD

The Canadian Highway System Study was initiated in 1971. The main objectives of the study are to obtain a unified federal and provincial effort to help the direction of Canadian highway development; and to carry out multimodal studies as appropriate in selected areas. It is a study conducted in the national context with the co-operation of and participation by the provinces.

An Advisory Committee consisting of representatives of the Provincial Ministries of Highways and Transport, the Department of Indian Affairs and Northern Development and Ministry of Transport, Government of Canada, Roads and Transportation Association of Canada, Canadian Automobile Association, and Canadian Trucking Association was constituted in November 1971. The study is conducted under the guidance of, and assistance from the Advisory Committee.

The main purpose of the study is to assess the problems of and prospects for Canadian Highways. It does not include the consideration of roads and streets within urban and metropolitan areas. In the remaining rural system, only those highways that are relevant to Canada as a whole are the focus of the study. For the purposes of convenience and research logistics, the study has been divided into several parts, one of which is: New Technology and Canadian Highways; a Preliminary Assessment, 1972-1982.

Parts of the Canadian Highway System Study which have been completed thus far are: 1) Federal Interest in Highways; An Historical Review, 2) Population Projections. Research is continuing on the economic aspects, social aspects, environmental aspects, the age of leisure and a review of the Railway Grade Crossing Fund. Concurrently the existing Canadian Highway System; its problems and prospects, are being reviewed. The study is expected to be completed by December, 1972.

The research underlying "New Technology and Canadian Highways, 1972-1982", was conducted within the framework of Highway Development in Canada. The results and recommendations of this research ought to be used with caution since technological change and breakthrough are subjected to the impetus of financial inputs of public and private enterprise.

Transportation Development Agency
2085 Union, Montreal 111, Quebec
August 1972.

John Gratwick
Chairman

CANADIAN HIGHWAY SYSTEM STUDY
ADVISORY COMMITTEE

Mr. John Gratwick	Chairman, Transportation Development Agency Chairman of the Committee
Dr. V.S. Pendakur	Project Manager, Transportation Development Agency Secretary of the Committee
Mr. M.J. Dolinsky	Chief Planning Engineer Alberta Department of Highways & Transport
Mr. E.B. Wilkins	Chief Planning Engineer B.C. Department of Highways
Mr. J. Peacock	Chief Engineer Manitoba Department of Highways & Public Works
Mr. R.P. Lynch	Chief Planning Engineer New Brunswick Department of Highways
Mr. R. Wasmeier	Planning & Design Engineer Newfoundland Department of Highways
Mr. W.P. Kerr	Deputy Minister Nova Scotia Department of Highways
Mr. G.H. Johnston	Director, Systems Planning Branch Ontario Department of Transportation & Communications
Mr. John Gilmore	Deputy Minister P.E.I. Department of Highways
Mr. Jacques Charland	Assistant Deputy Minister Quebec Department of Roads & Transport
Mr. R.P. Couturier	Planning Engineer Saskatchewan Department of Highways & Transportation
Mr. A.L. Peel	Director, Highways Branch Canadian Surface Transportation Administration
Mr. Julian Hawryszko	Acting Head of the Resources & Transportation Section - Economic Staff Group Department of Indian Affairs & Northern Development
Mr. Marius Gendreau	Associate Executive Director Canadian Trucking Association
Mr. C.W. Gilchrist	Managing Director Roads & Transportation Association of Canada
Mr. Leo Laviolette	Director, Government & Public Affairs Canadian Automobile Association

PREFACE

This study, "New Technology and Canadian Highways - 1972 to 1982", was initiated in June, 1972 and completed in August, 1972. The objective of the study is to discuss the possible impact of new technology and innovative management techniques on intercity highway transportation. Conclusions are drawn as to whether or not any of these approaches appear to hold promise for more cost effective intercity highway transportation during 1972-1982.

The study was organized and conducted by the Transportation Development Agency as a staff effort, with the assistance of the members of the Advisory Committee. Mr. Neal A. Irwin of Kates Peat Marwick and Co. was responsible for much of the research and acted as a consultant. Mr. D.F. Sturgess assisted in the research. The research was carried out under the direction of the principal author, who assumes complete responsibility ofr the methodology, analysis and consequently for errors and omissions.

Transportation Development Agency
2085 Union, Montreal 111, Quebec
August 1972.

V. Setty Pendakur
Project Manager
Canadian Highway System Study.

TRANSPORTATION DEVELOPMENT AGENCY

John Gratwick - Chairman

R.B. Campbell - Director, Implementation and Management

RESEARCH TEAM

Dr. V.Setty Pendakur - Project Manager

D.F. Sturgess - Project Staff

CONSULTANT

Neal A. Irwin - Kates, Peat, Marwick & Co

CONTENTS

TABLES

PART 1
INTRODUCTION

This study is concerned with the possible impact of new technology and innovative management techniques on inter-city highway transportation in Canada. The discussion focusses upon the approaches which appear to hold promise for more cost-effective inter-city highway transportation during the period 1972-1982.

The general approach taken is, first, to consider the most important factors influencing inter-city highway transportation services and requirements, and, from this, to determine the various strategies and strategy elements which are most likely to lead to improvement. The next step, was to review the literature on pertinent new technology and innovative management approaches, select the more promising ones based on a number of specified criteria, evaluate these approaches, and discuss the important economic, social, environmental and functional trade-offs which must be considered in this process. Finally, the conclusions of this analysis are presented.

There are a number of background considerations which form the bases of this study. First is the five to ten year time horizon, which tends to eliminate the more technologically advanced approaches. In fact, a number of approaches are considered in this study which are not likely to become operational in less than 15 years; they are included here for purposes of comparison with other, more near-term approaches.

A second important consideration is the existing over-whelming preponderance of highway transportation for inter-city person movement in Canada and the great importance of highway transportation for certain types of short- and medium-haul goods movement, in particular general cargo. While exact statistics do not exist, it is estimated [1,2,3] that between 50 per cent and 85 per cent of inter-city person movement is by private automobile, depending upon the length and traffic intensity of the inter-city corridor. This tends to work against attempts to substitute other modes for the private automobile, since very large increases in the ridership of another mode would be required to cause a notable reduction in highway travel volumes.

In considering this point it is important to understand what is meant by inter-city transportation in the context of this study. "Inter-city transportation", in this context, means movement between centres of population or significant economic activity. No attempt has been made here to quantify this concept. For example, some would argue that movements between centres separated by less than 300 miles are not nationally significant, while others would argue that shorter movements are indeed of national significance if they are of sufficient volume and importance. Still others would like to consider only centres of more than 10,000 (or 100,000) population; such a limitation would omit major commodity movements to and from remote mine or refinery sites which are clearly of national significance. When more data become available, it will be desirable to rank inter-city movements in Canada, by pairs of centres, in

1 *Inter-City Passenger Transport Study, Canadian Transport Commission, Research Branch, Ottawa, September 1970.*
2 *<u>Passenger Marketing</u>, Kates, Peat, Marwick & Co., Toronto, February 1968.*
3 *<u>National Inter-City Travel Development and Implementation of a Demand Forecasting Framework</u>, the U.S. Department of Transportation, Washington, D.C., 1970.*

terms of the annual person-miles and ton-miles passing between them. Threshold levels can then be selected, above which person travel or goods movement between two centres is considered to be nationally significant. Until this is possible, the more qualitative definition given above is suggested.

A third background consideration is the observation that approximately 10 to 20 per cent of observed vehicular volumes on highways are goods vehicles. While goods transportation by highway is obviously exceedingly important to the Canadian economy, the preponderance of passenger vehicles means that person travel is of much more importance in determining peak hour volumes and highway design capacities. Both person and goods transportation are considered in this study, but person travel is emphasized for the above reason.

Additionally, it is important to realize that the criteria used in this study to evaluate alternative approaches relate primarily to the economic, social, environmental and functional trade-offs among these approaches, with little or no attempt to consider broader national objectives. For example, national unity, defense, and the intangible benefits of cheaper inter-city transportation as such are not considered explicitly here. Hopefully, the insight provided by these slightly more restricted analyses will provide a context within which the broader national goals can also be considered.

Finally, it should be recognized that the *conclusions drawn herein* are of a *preliminary nature* since they are based on fragmentary data and broad reasoning. They are to be interpreted as a strategic overview aimed at identifying promising strategies which will, in turn, require more accurate data and detailed study as a basis for action.

PART 2

POSSIBLE STRATEGIES FOR INTER-CITY HIGHWAY PLANNING

Before attempting to select and evaluate new approaches, it is instructive to consider the factors upon which highway planning is based and the strategies which might be used to influence these factors.

As illustrated in Table 1, the main basis for anticipating the need for additional inter-city highway capacities is the existing and projected annual volume of vehicles using various links of the Canadian Highway System. In addition to their *spatial* distribution, the *time* distribution of these volumes is also important, since highway capacities are normally designed on the basis of providing a reasonable level of service during peak periods.

BASIS FOR ANTICIPATING NEED FOR ADDITIONAL INTERCITY HIGHWAY CAPACITIES AND INVESTMENTS	ANNUAL VOLUME OF PRIVATE AUTOS, TRUCKS AND BUSES USING EACH LINK OF THE CANADIAN HIGHWAY SYSTEM				SEASONAL, DAILY AND HOURLY PEAKING OF AUTO, TRUCK AND BUS TRAFFIC ON EACH LINK	
Primary Influencing Factors	Regional Growth Rates and Per Capita Demands for Intercity Person and Goods Movement	Modal Split	Highway Capacity for Vehicular Flows	Vehicle Occupancy	Work Week Patterns and Leisure Time Activities	Negative Aspects of Peak Period Highway System Use
Possible Strategies to Reduce Future Rates of Investment in Intercity Highways	Reduce Growth Rates and Strive for More Uniform National Distribution of People and Jobs with Stabilized Per Capita Transportation Demand	Increase Attractiveness of Non-Highway Modes	Increase Per Lane Vehicular Highway Capacity	Increase Person and Goods Occupancy of Highway Vehicles	Restructure Working Hours, Days, Weeks and Seasons to Achieve More Uniform Time Distribution of Traffic Demands; Provision of Recreational Facilities to Reduce Inter-city Peak Traffic Demands	Pricing and Operating Strategies to Encourage Off-Peak Use of Highway System
Possible Strategy Elements Involving New Technology and/or Innovative Management Approaches	Improved and/or Lower Priced Communications as a Substitute for Transportation	Improved and/or Lower Priced Guided Ground Transport (GGT) and/or Air Modes	Automated Highways	Shared Use of Autos; Larger and More Fully Loaded Trucks and Buses		Planned Congestion, Road Access Metering, or Tolls as Measures for Road Space Rationing in Peak Periods

Table 1 - Strategy Elements for Intercity Highway Planning

The number of persons and the quantity of goods moving on an inter-city highway link are functions of the size and per capita travel demand rates of the cities or regions joined by the link. Inter-city traffic has tended to grow at approximately three per cent per annum in Canada. While this demand could be influenced by national policies affecting regional growth rates and the distribution of regional growth, it is by no means clear without more detailed study, what the effects of such policies might be on inter-city transportation demand. For example, it could be argued on the one hand that a more uniform distribution of people and jobs throughout Canada would provide a more even distribution of transportation loads over an already-extensive highway system, such that the incremental cost of required new capacities would be reduced. On the other hand, it could be argued that inter-city transportation demands would be much reduced if all or most new growth were to take place within a small area (e.g., Southern Ontario) in order to minimize the distance between major concentrations of people and economic activities. There are trade-offs of national and provincial policies, land prices, traffic densities and corridor lengths in this question which go beyond the scope of this study. There is, however, one technological approach which could affect the overall demand for inter-city transportation: the provision of improved and/or lower priced long distance communications as a substitute for inter-city transportation. To consider an extreme, it seems likely that free, widely available video phone communication between cities would tend to substitute for a certain number of inter-city person trips, both for business and non-business pruposes. This is therefore included as one approach for consideration.

Another factor obviously influencing the need for new and improved highways is the modal split of person and goods traffic: private auto, air, rail and bus for person travel; and truck, air, rail and water for goods transportation. Reduced pricing and/or improved services via non-highway modes should divert transportation demand from highways, thereby reducing required new highway investments. The obvious trade-offs to be considered here include capital and operating costs required to improve the other mode or modes versus those which would have been required to improve the highway system, as well as relative levels of service and environmental effects of the alternative approaches. This type of strategy - improvement of other modes to divert transportation demand from highways - generates the largest number of specific approaches examined in this study.

The requirement for new highways is also influenced by existing highway capacity. If the efficiency with which roadway space is used can be increased, more vehicles can be increased, more vehicles can be moved through a particular highway section than previously. Apart from conventional traffic engineering measures, which are assumed to apply already to the Canadian Highway System, automated highways appear to offer the most significant potential increase in per lane vehicular highway capacities, by providing electronic guidance and speed control such that automotive traffic can move at closer headways under high speed conditions, achieving increased throughput and greater safety. As before, one needs to consider whether the incremental cost of achieving a given increase in throughput by means of highway automation is greater or less than that of building an equivalent amount of conventional highway, as well as considerations of safety, land requirements and development costs.

A significant factor influencing the number of persons and volume of goods which can be carried by a highway is the vehicle occupancy. If the average number of persons per vehicle could be doubled, the effective capacity of our highways would also be doubled at no direct additional capital cost. Clearly, there are reasons why the average inter-city passenger car occupancy of about two persons cannot easily be increased to four persons. A recent attitude survey of inter-city travellers shows that privacy, low travel time, ease of baggage handling, comfortable seating and low cost per person are strong reasons for the use of private automobiles in inter-city travel.[4] Attempts to increase vehicle occupancy would tend to reduce all of these

4 *Survey of Traveller Attitudes Between Montreal and Ottawa*, *Transportation Development Agency, Montreal, March 1972, unpublished results.*

advantages except cost, and many car users would probably resist them strongly. Nevertheless, it possible that an innovative management approach, possibly operating on a commercial basis, might lead to more shared use of automobiles, and this approach is therefore selected for study. This general strategy could include trains of buses and trains of trucks, which make more efficient use of both roadway space and driver labour.

The seasonal, weekly, daily and hourly peaking of traffic have a substantial effect on required highway capacity. Peak hour demands on a typical day are usually about 10 per cent of total 24 hour demand and may be twice the average daylight hourly demand. Summer traffic is typically substantially higher than winter traffic. If these seasonal and hourly variations could be smoothed out, the effective capacity of our highways would be significantly increased. One way of achieving this would be to reorient our work week patterns and leisure time activities. Another way of levelling the peaks would be to use pricing and operating strategies to encourage off-peak use of the highway system. This could be accomplished by planned congestion and road access metering (allowing new vehicles to enter a given roadway only when they will not cause traffic volumes to rise above a threshold congestion level). Tolls can also be used as measures for rationing road space during peak periods.

The manner in which these factors and strategies have been applied to develop criteria and select and evaluate specific new approaches is described in Part 3, following.

PART 3
SELECTION AND EVALUATION OF NEW APPROACHES

SELECTION CRITERIA

The criteria which were applied in selecting specific new technology and/or innovative management approaches for study are listed in Table 2.

IMPACT ON INTERCITY HIGHWAY USE Must be expected to have an impact on: - total volume of persons and/or goods moving between cities,and/or - peaking of intercity highway traffic (reduced peaking),and/or - proportion of total intercity traffic which goes via highway (modal split),and/or - efficiency of use of roadway space (increased vehicular capacity), and/or - efficiency of use of highway vehicles (increased vehicle occupancy)
TIME HORIZON Must have significant impact within five to ten years.
COST-EFFECTIVENESS Must show promise of favourable trade-offs relative to continued expansion of conventional intercity highways in terms of: - capital cost and/or - operating cost and/or - environmental reliability and safety factors affecting public acceptability and/or - degree of risk in terms of time and cost to implement and/or - compatibility with existing modes and/or - ease of expansion and flexibility to meet changing circumstances such that the new approach might be favoured in terms of overall net gain.

Table 2 - Selecting Specific New Technology and Innovative Management Approaches

In general, the approach to capital and operating cost considerations is to determine the approximate costs of providing needed additional capacity by improving the conventional highway system versus the additional costs of some other new approach. It is, of course, necessary to distinguish between theoretical capacity to carry additional persons or goods and the actual additional persons or goods which would use the improved or new facility. An attempt is made herein to follow the latter course, but the approach is, of necessity, *very approximate* in the absence of detailed demand modelling, system costing, and cost-benefit analyses.

Environmental criteria include visual, noise and air pollution, erecting of a barrier to human and animal uses of land, and related ecological impacts. Safety to users and non-users is also included, as is all-weather reliability of operation, since these factors will all effect the public acceptance of a new or improved transportation facility. Another criterion included is the degree of risk assumed in developing a new approach, in terms of the time and cost required to implement the approach, and the amount of uncertainty in these estimates. This will obviously be higher for approaches with a higher content of new, sophisticated technology; a subjective rating has been applied for this, as for most other criteria in this analysis.

Two other important criteria are compatibility with existing modes, and ease of expansion and flexibility to meet changing circumstances. Compatibility is important in a system as extensive as the inter-city highway system, since an attempt to move to, for example, a completely new system could require an enormous new investment in new vehicles as well as guideway, involving many years of inconvenience and added expense to the travelling public. Ease of expansion is important in high density corridors of rapid urban growth, and flexibility to meet changing circumstances is probably more important at the other end of the scale, in the more remote areas of mid-Canada where transportation demands to develop differing resource bodies will change substantially from decade to decade.

These criteria were applied in a general way to the various new technology approaches suggested in the literature as well as to various innovative management approaches and combinations of both approaches which were suggested by the various strategies discussed above.[5] There are but few studies relevant to the Canadian context.[6] While well over 200 new technology approaches are described in the literature, many of these are eliminated by the 1972-82 time horizon chosen for this study, high development costs, low expected impact on highway use, or a combination of these factors.

SELECTED NEW APPROACHES

The 15 new items selected for this study are listed in Table 3. In general, their selection follows directly from the strategies identified in Table 1 and the application of the criteria listed in Table 2. Items 1 to 5 follow directly from the strategies of Table 1 and were discussed earlier in general terms. They relate either to an attempted substitution of communications for transportation (Item No.1), or more efficient use of roadway space either through increased vehicle occupancy (Items 2 and 5), levelling of peaks (Item 3), or increased vehicular capacity (Item 4).

5 *Inventory of Advanced Urban and Regional Surface Transportation Systems*, Transportation Development Agency, Montreal, April 1971.
Canadair Ltd., *Guided Ground Transportation Study, Parts I and II*, Transportation Development Agency, Montreal, November 1971.
R.A.C. Lockhart, *a Survey of Transportation Modes*, Ontario Ministry of Transportation and Communications, Toronto, November 1970.
"Automated Highway Systems", *Report No. FRA-RT-70-30*, TRW Systems Group, April 1970.
E.T. Canty, *The Metro Guideway - An Integrated Urban Transport System*, Research Laboratories, General Motors Corp., Warren, Michigan.

6 *Transportation and Communications as Instruments of National Policy*, the Department of Communications, Government of Canada, Ottawa, August 1971.
"The Wired City", *Proceedings* of the Telecommunications Seminar, University of Ottawa, June 25-28, 1970.
E.T. Canty and A.J. Sobey, *Case Studies of Seven New Systems of Urban Transportation*, Research Laboratories, General Motors Corp., Warren, Michigan.
N.A. Irwin, *Public Transit and the Quality of Urban Living*, Paper prepared for the First Canadian Urban Transportation Conference, September 1968.
R.G. O'Lone, "Canada Weighs Arctic Resources Airlift", *Aviation Week and Space Technology*, May 22, 1972.

MODE	No.	CLASS OF CHANGE	CHANGE	PROBABLE CANADIAN APPLICATION	SAFETY	FUNCTIONAL RELIABILITY	CAPACITY	OPERATING SPEED (MPH)	COSTS			EARLIEST ANTICIPATED YEAR WIDELY AVAILABLE	EXPECTED IMPACT ON HIGHWAY SHARE OF INTERCITY TRIPS		EXPECTED IMPACT ON TOTAL HIGHWAY LINK VOLUME	PROBABLE ENVIRONMENTAL COSTS	PROBABLE CAPITAL COST OF INSTALLATION (900 Miles = Quebec-Windsor 720 Edmonton-Calgary 180) ($ MILLIONS)
									RESEARCH/ DEVELOPMENT ($ MILLION)	CAPITAL ($ MILLION)	OPERATING		CITY PAIRS 300-500 MILES APART*	CITY PAIRS MORE THAN 500 MILES APART			
NON-TRANSPORTATION	1	Technology and Management	Improved Long Distance Communi-cations	Subsidized Personal Videophones for Long Distance Service	Excellent	Excellent	N.A.	N.A.	Prototype in Operation	The Prototype of a Switched Coaxial Cable System is Estima-ted to be 3 times Present Cost of CATV and Telephone System (6)	Not Known	1975-80	Indeterminate	Indeterminate	Negligible	Reduced Relative to Present Situation	Not Known
HIGHWAY (BUS AND/OR TRUCK	2	Management	Auto Sharing Service	Commercial Car Pooling Service for Inter-City Trips Operating in Larger Canadian Cities	Relatively) Unsafe) No Change	Fair	Max. 6,000 Passengers Per Lane Per Hour Per Direction	50-60	Low	Low	User Arrangement (Probably Private Enterprise)	1973-75	Increased Person Trips and Decreased Vehicle Trips via Highway	Increased Person Trips and Decreased Vehicle Trips via Highway	Negligible	No Change	None
	3	Management	Highway Tolls	Tolls on all Controlled Access Links in the Canadian Highway System	Relatively) Unsafe) No Change	Fair	3,000 Passengers Per Lane Per Hour Per Direction	50-60	Low	.01 - .05 Per Mile for Toll Stations	Positive Net Revenue	1975	- 2-4%	- 1-2%	Negligible	Could be Negative Owing to Diversion of Motor Traffic to more Local Roads	10-20
	4	Technology	Automated Highway	Highest Volume Corridors, Eg. Toronto-Montreal Montreal-Ottawa	Presently Unproven. Should be much Better Than Conventional Highway	Unproven. Should be good	4,000 Passengers Per Lane Per Hour Per Direction	75-150	100-300 (Vehicle Costs Excluded) (10)	2.7 Electronics 0.25/Mile 2 Lane Highway 3.0 /Mile (10)	400 K/Mile/Year Control 44 K/Mile/Year Highway (10)	1990 (10)	+ 2-5%	+ 3.7%	Negligible	Negative Owing to Greater Density of Traffic on Automated Highway	2500-3000 (+ 80-200 for R & D)
	5	Technology	Bus or Truck Trains	Allow Them on 4-Lane Links, Outer Lanes Only, or Build Special Reserved Lanes	Presently Indeterminate (for Bus Trains)	Good	3,000-6,000 Passengers /Lane/Hour/Direction 600-1,200 Tons/Lane /Hour/Direction	50-60	Low	0.25 Per Mile if Reserved Lanes Built	Bus or Truck Operating Cost plus Vehicle Capital Costs and Profit Covered by Revenues	1974-75	Negligible	Negligible	Negligible	No Change	200-225 (Construction of 2 Bus Lanes)
RAIL	6	Technology	High Speed Rail (HSR)	LRC, Turbo or APT Applied to Quebec-Windsor Corridor and Possibly Others Such as Calgary-Edmonton	Good - Utilization of Existing Track Increases Derailment Potential	Good to Excellent	2-5,000 Passengers Per Hour Per Direction (1,9)	120-160	2-10 (8)	Track 0-2 Per Mile 5 Per Train	2-5¢ Per Passenger - Mile Covered by Revenues (9)	1974-80	- 5-10%	Generally not Applicable	Negligible	High Noise Output and Fenced R.O.W. could create Interference with some Species. The Fenced R.O.W. could be Aesthetically Intrusive. Generally better than Highway	800-850 (Track Improvement) 1000-20000 (for New Tracks) 20-30 (Trains)
	7	Technology	Tracked Levitated System (TLS) (Tracked Air Cushion) (Magnetic Levitation)	Bertin Aerotrain (1st Generation) or Hovertrain (2nd Generation) Applied to Montreal-Toronto or Quebec-Windsor Corridor	Good - Aircraft Standards High Safety Factor	Unproven. Should be good	2-5,000 Passengers Per Hour Per Direction	160-250	50-100	2-5 Per Mile (Double Track) (not including land costs) (1)	6-10¢ Per Passenger - Mile Covered by Revenues (1,8)	1980-90	- 10-25%	Generally not Applicable	Negligible	1st Generation very Noisy, 2nd Generation Using LIM will reduce the Noise Problem	1500-2000 Guideway and Vehicles
	8	Management	Same Train Auto Haul (STAH)	Summer, 1972 CN service Toronto-Edmonton can be expanded to Trans-Canada Service with more Auto-Haul Cars per Train	Excellent	Excellent	50-500 Autos Per Hour Per Direction 200-2,000 Passengers Per Hour Per Direction	60-80	None (Operational In Europe, U.S.A. & Canada)	10-20 Autos/Hour $2.0 2 Trains/Day >4 Trains/Day $100.0	5-7¢ Per Passenger - Mile Covered by Revenues	1973-75	Negligible	- 1-2%	Negligible	Very Small Improvement	$2.0 Experimental Trains >100.0 CP/CN - X Canada
	9	Technology and Management	HSR and Rented Auto at Destination	As for 6. above but with rented Auto in Destination City as Optional Package at Reduced Rates	Good	Good to Excellent	2-5,000 Passengers Per Hour Per Direction	120-160	2-5	As for 6	2-5¢ Per Passenger - Mile	1974-80	- 5-10%	Generally not Applicable	Negligible	As for 6 above	As for 6 above
	10	Management	STAH and Reduced Fares	As for 8. above but subsidized so that Family of 4 plus Auto can travel at 10¢ per mile	Excellent	Excellent	50-500 Autos Per Hour Per Direction 200-2,000 Passengers Per Hour Per Direction	60-80	Low	>100.0	Deficit of, say, 4¢ Per Passenger-Mile	1973-75	- 0.10% Dependent on Fare Reduction and Availability of Rail Service	- 5-10%	Negligible	As for 8 above	>100.0 CP/CN - X Canada
	11	Technology and Management	Container Unit Trains	Expansion of Service to all Major Corridors in Canada	Excellent	Excellent	1 Train = 200 Containers = 100 Trucks	50	Low	200 Containers = 0.5 2 Loco. = 1.5 50 Cars = 1.0 3.0/Train	1.0 - 1.3 Per Train Per Year	Available	2-5%	0.2%	Negligible	Small Improvement	Not Applicable
AIR	12	Management	Reduced Air Fares (CTOL)	Extend two-thirds fare Standby Service to all Ages of Travellers	Good	Fair	300-800 Passengers Per Hour Per Direction	300-600	Low	$10 per Attracted Annual Passenger	Deficit of, say, 3¢ Per Passenger-Mile	Potentially Available	Dependent on Fare Reduction and Availability of Air Service	Dependent on Fare Reduction and Avail-ability of Air Service	Negligible	No Change in Environmental Impact Expected	Assuming 25% Increase in Air Traffic, Could Result in an Additional 10-20 Capital Expenditure Per Year for the next 10 years.
	13	Technology	STOL Services	DHC7 (1st Generation) or Jet-STOL (2nd Generation) Service between all City Pairs at 300-500 Mile Distances	Good	Fair	100-500 Passengers Per Hour Per Direction	300-400	100-200(DHC-7)	Veh. Cost 1.8-5.8 STOL Port 5.0	4-8¢ Per Passenger-Mile	1975-6 (1st Gen.) 1980 (2nd Gen.)	- 3-6%	Generally not Applicable	Negligible	Significant Reduction in Size and Intensity of Noise Footprint. Significant Reduction in Utilization of Urban Land (Relative to CTOL).	10 Ports = 50) (10 Ports = 50 25 Veh. = 45)DHC7 AW (20 Veh. = 116 Total 95) (Total 166 (95-166)
	14	Technology and Management	STOL and Reduced Fares	Combination of 12 and 13 above	Good	Fair	100-500 Passengers Per Hour Per Direction	300-400	100-200(DHC-7)	As for 13 above plus $5 Per Annual Attracted Passenger	Deficit of, say, 3¢ Per Passenger-Mile	1975-6 (1st Gen.) 1980 (2nd Gen.)	- 3.?% Dependent on Fare Reduction and Availability of STOL Service	Generally not Applicable	Negligible	As for 13 above	120 - 216
	15	Technology	Large Freight Aircraft	Suggested LNG Carrier for Mid-Canada and Arctic. Also applied to Bulk Ore Carriage in Mid-Canada	Good	Fair	1,000 Tons Per Aircraft = 80,000 Tons Per Day Over 1,500 - 2,000 Miles With 40 Aircraft	300-500	500-1000	100 Per Aircraft = 4,000 for 40 Aircraft Plus Run-way and Loading Facility Costs	Not Known	1980-85	Not Known	Not Known	Negligible	Probably less Negative in Mid-Canada than Effects of Pipeline, Rail, or Highway	Not Applicable

* Based on Example of Montreal-Toronto City Pair.

Table 3 - Characteristics of Selected Approaches

Items 6 to 15 all stem from the strategy of attempting to reduce highway transportation demand by means of improved service and/or reduced pricing on other, competing modes. Items 6 to 11 relate to the rail mode (or tracked levitated system (TLS), Item 7), while items 12 to 15 relate to the air mode.

A brief description of each item and its characteristics are included in the Appendix. Table 3 summarizes certain characteristics for each item,including the probable type of application in Canada,expected safety and functional reliability,capacity, operating speed, probable costs (R&D,capital,operating),earliest anticipated year in which it would be widely available in Canada,expected impact on highway system volumes (short or long trips), probable environmental costs, and probable capital cost of installation for some 900 two-way miles of the system (where applicable) assuming it were applied in the Quebec-Windsor corridor (720 miles) and between Edmonton and Calgary (180 miles). It must be emphasized again that many of the figures and statements in this Table are very approximate estimates, owing to the *preliminary nature of this study*. Not surprisingly, attempts to quantify system costs and probable impact on inter-city highway travel are highly judgmental, in the absence of more detailed studies. Where previous studies have been drawn upon, these are identified.

There is a very important point regarding the impact of new technological/management approaches on inter-city highway volumes which can best be illustrated by drawing upon recent studies,[7] which evaluate several high speed rail alternatives,a tracked air cushion vehicle (TACV) system[8] and a STOL system to serve future person travel in the Quebec-Windsor corridor. Based upon detailed travel demand and modal split estimates,system cost and relative cost/effectiveness studies,this study concludes that a form of high speed rail which does not involve massive rebuilding of track is the most cost-effective solution for improved public transportation in the Canadian Corridor. Based on their findings,however,it seems unlikely that any of the proposed public transport improvements would have a significant impact on inter-city highway investments in the Corridor during the coming twenty years. Their conclusions have the following rationale:

- Annual person trips by automobile between Montreal and Toronto (two-way) were about 661,000 in 1965.
- If we assume that inter-city automobile traffic is growing at about three per cent per annum, this volume would double in about 25 years, giving about 1,300,000 two-way automobile person trips between Montreal and Toronto by 1990.
- An estimated 850,000 annual auto person trips (two-way) would be diverted from highway to TACV by 1990 under certain assumptions. This represents only 200,000 one-way automobiles per year (assuming an average automobile occupancy of 2.15 persons) or approximately 65 automobiles per peak hour in each direction.
- While a very high speed TACV line might capture up to two thirds of the total annual person trips by automobile in 1990 between Montreal and Toronto, the number of peak hour automobiles diverted from the highway mode would be only about four per cent of the hourly capacity of one lane of highway.
- Through trips between Montreal and Toronto are only a very small proportion (probably one or two per cent) of the observed vehicular volume on Highway 401 at its point of high loading between Toronto and Oshawa. Even in the less heavily travelled portions east of Kingston, surveys of the Ontario Ministry of Transportation and Communications indicate that Montreal-Toronto traffic is less than 10-15 per cent of the total traffic.

7 *Intercity Passenger Study, op. cit.*
8 *Similar in level of service characteristics to the TLS presented as Item 7 in Table 3.*

This example illustrates both the strength of the highway mode for inter-city travel and the difficulties of trying to find a more cost-effective approach. Because of the do-it yourself flexibility of automobile travel,highways carry a vast number of short and medium length trips which completely swamp the smaller numbers of long,through trips except on very long,isolated sections of highway. Therefore,while improved public transportation from city to city may divert significant numbers of highway travellers between a given city pair,the impact upon the number of people using the highway will be negligible in most cases. The argument for improving the public transportation must therefore rest more upon providing greater diversity of travel modes,service for those without access to an automobile,reliability in winter weather,greater speed,safety and comfort,and similar arguments[9],rather than upon expected savings in highway investment.

It is probable that this reasoning applies,to a greater or lesser extent,for most links of the Canadian Highway System. If it does,the obviously high degree of uncertainty in the cost and highway volume impact estimates of Table 3 does not greatly effect a central conclusion of this study: that new technology/management approaches to improving inter-city transportation in Canada must be justified on grounds other than expected net savings resulting from reduced highway investment. This is discussed further under Conclusions, Part 4, following.

EVALUATION OF SELECTED NEW APPROACHES

Bearing in mind the large uncertainties referred to above and the highly subjective nature of the exercise, a very approximate evaluation of the 15 new approaches listed in Table 3 was carried out in terms of 14 criteria, as illustrated in Table 4.

EVALUATION CRITERIA / NEW APPROACH	Reduced Intercity Person Traffic	Reduced Peaking of Highway Traffic	Reduced Proportion of Person Traffic via Highway	Reduced Proportion of Goods Traffic via Highway	Increased Capacity of Existing & Future Highways	Increased Vehicular Person Occupancy	Increased Vehicular Goods Occupancy	Reduced Capital Cost per Unit	Reduced Operating Cost per Unit	Improved Environmental Compatibility	Improved Reliability and Safety	Less Time/Cost Risk in Implementing	Improved Compatibility with Existing Modes	Greater Flexibility and Ease of Expansion	Total Score
1 Improved Communications	+?	0	0	0	0	0	0	0	-?	+	0	0	0	0	1?
2 Auto Sharing Service	0	0	0	0	0	+	0	+	+	0	-	0	0	0	2
3 Highway Tolls	0	+	+	+	0	0	0	+	+	-	0	0	0	0	3
4 Automated Highway	0	0	0	0	+	0	0	0?	-?	-	+?	-	-	0	-2?
5 Bus or Truck Trains	0	0	0	0	0	+	+	0?	+	0	0	0	0	0	3?
6 High Speed Rail (HSR)	0	0	+	+	0	0	0	0?	-?	+	+	0	0	0	3?
7 TACV	0	0	+	+	0	0	0	-?	-?	+	+	-	-	0	0?
8 Same-Train Auto-Haul (STAH)	0	0	+	0	0	0	0	0?	0?	+	+	0	0	0	3?
9 HSR & Rented Auto at Destination	0	0	+	0	0	0	0	0?	-?	+	+	0	0	0	2?
10 STAH and Reduced Fares	0	0	+	0	0	0	0	0?	-?	+	+	0	0	0	2?
11 Container Unit Trains	0	0	0	+	0	0	0	+	+	+	+	0	0	0	5
12 Reduced Air Fares	0	0	+	0	0	0	0	0?	-?	0	0	0	0	0	0?
13 STOL Services	0	0	+	0	0	0	0	0?	0?	0	0	0	0	0	1?
14 STOL and Reduced Fares	0	0	+	0	0	0	0	0?	-?	0	0	0	0	0	0?
15 Large Freight Aircraft	0	0	0	+	0	0	0	+?	0?	0?	0	-	0	+	2?

Legend: + = Better than Conventional Highway
0 = Equal to Conventional Highway
- = Worse than Conventional Highway

Table 4 - Evaluation of Selected New Approaches

9 *Oshawa Area Planning and Development Study, Goals Quantification - Transportation Level of Service Analysis*, Oshawa, February 1971.

This was a relative evaluation in which each new approach was compared with the alternative of building more conventional highway: a "+" indicates that some improvement is anticipated; a "0" indicates no improvement; and a "-" indicates that the new approach is expected to be worse than conventional highway in terms of the stated criterion. Question marks indicate where the degree of uncertainty is particularly high. The total score of each approach is obtained by noting the algebraic sum of the + and - signs; no attempt was made to weight the various criteria, owing to the highly approximate nature of the evaluation.

Some comments on the ratings given for each criterion follow:

- Reduced Inter-city Person Traffic: improved communications is the only approach expected to have this effect.

- Reduced Peaking of Highway Traffic: highway tolls are the only approach expected to have this selective impact.

- Reduced Proportion of Person Traffic via Highway: highway tolls and all the rail and air alternatives except container unit trains and large freight aircraft are expected to have the desired impact.

- Reduced Proportion of Goods Traffic via Highway: highway tolls, high speed rail, tracked levitated systems, container unit trains, and large freight aircraft could all have a positive impact.

- Increased Vehicular Capacity of Existing and Future Highways: the automated highway is the only approach which would have a positive impact.

- Increased Vehicular Person Occupancy: the auto sharing service and bus trains are the only two approaches having a positive impact.

- Increased Vehicular Goods Occupancy: truck trains are the only approach having a positive impact.

- Reduced Capital Cost Per Unit (cost of acquisition, regardless of the means of depreciation or capital recovery): the unit referred to in this case is generally the person-mile or ton-mile, although comparability is difficult, particularly in view of the approximate estimates available. The auto sharing service, container unit trains and large freight aircraft are estimated to have a positive impact in terms of this criterion, while the tracked levitated system is expected to cost appreciably more than conventional highway per unit. Within very large error limits, the other approaches are expected to be fairly similar to conventional highway in per unit capital cost.

- Reduced Operating Cost Per Unit (Actual operating cost less direct user charges): the auto sharing service, highway tolls, bus and truck trains, and container unit trains are expected to have a positive impact, while improved communications, the automated highway, high speed rail, tracked levitated system, high speed rail plus rented auto at destination, same-train car-haul with reduced fares, reduced air fares, and STOL plus reduced air fares are all expected to have relatively higher per unit operating costs than conventional highway. Again, the error limits are very wide.

- Improved Environmental Compatibility: all rail modes are expected to have a positive impact: highway tolls are expected to have a negative impact because of possible diversion of vehicular traffic to more local roads, and the automated highway is expected to have a negative impact owing to the increased intensity of automobile traffic flows. The other approaches are expected to be relatively similar to that of conventional highway, it being assumed that air and highway have approximately equal negative environmental impacts, although localized in different places.

- Improved Reliability and Safety: all rail modes and the automated highway are expected to have a positive impact, although the latter must be proven in this regard. The auto sharing service is expected to have a negative impact, both because of the uncertainty of having a relative stranger in one's car and because of the added time required to pick up and deliver the additional passenger or passengers at each end of the trip. While the air modes have a better safety record than highway per passenger mile, their all-weather reliability record is probably somewhat worse, at least as perceived by the travelling public.

- Less Time/Cost Risk in Implementing: no approach is expected to be better than conventional highway in this regard. The approaches with higher new technology content (automated highway, TLS, large freight aircraft) rate negatively in terms of this criterion.

- Improved Compatibility with Existing Modes: no approach is expected to rate better than conventional highway. The automated highway and TLS are rated worse.

- Greater Flexibility and Ease of Expansion: all approaches are rated equal to conventional highway except the large freight aircraft which is rated better. This approach is considered mainly for application in Canada's Mid-North, where it could be used for bulk shipments of ore, liquified natural gas, and possibly oil. One of its major advantages as a means of shipping natural resources from the minehead to market is its flexibility to shift to new resource sites at minimum cost, unlike either road or rail with their large, fixed infrastructure investments.

Recognizing the approximate nature of this evaluation, the relative total scores of the 15 selected new approaches are worthy of some comment:

- the container unit train approach rates highest with a score of 5, primarily because of its higher cost, environmental and reliability performance relative to truck traffic. This strategy is already being actively pursued by the railways with some considerable success, and it can be expected that economic forces will continue to divert longer haul general cargo traffic from highway to containerized rail traffic without the need for government intervention. This is probably much more true for import-export trade commodities than for domestic goods flows; the relevance of this point will therefore depend on their relative growth rates.

- highway tolls, bus and truck trains, and same-train auto-haul all rate next with a score of 3. The use of pricing, as in the highway toll approach, is theoretically attractive as a means of leveling peak volumes and using roadway space more efficiently. However, the large negative impact on the public of attempting to introduce widespread tolls on roads which have been built with public funds, coupled with the extensive toll facilities which would be required and the probable negative impact of diverting traffic from through roads, makes this a politically unacceptable alternative. Some limited truck trains are already in use in this country as elsewhere. Bus trains are not used here, probably because the demand does not really warrant it. One advantage of bus travel is the relatively frequent departure of buses between major city pairs; this would not be economically justifiable if each unit were capable of carrying twice as many passengers. In any case, government intervention would not be required to cause more widespread use of bus or truck trains if economic forces tend to lead in that direction. The construction of a reserved lane for such trains would certainly not be justified unless their use became more widespread.

The same-train auto-haul concept has some attraction for Canada, not as a means of reducing highway investments but as a means of helping Canadians to see and get to know their own country at ground level. If such service were introduced in the Trans Canada Corridor, it seems likely that it would attract a significant volume of users; the service to be introduced in 1972 by the CNR between Toronto and Edmonton will be an interesting demonstration, although use will probably be capacity-restrained by the one rail car which will be available for automobile transportation on each train.

The high speed rail approach also has a score of 3; in line with the conclusions of the Inter-city Passenger Transport Study of the Canadian Transport Commission it is concluded here that this alternative to conventional highway transportation is attractive for short and medium distance corridors with relatively high volumes, such as the Quebec- Windsor Corridor and the Calgary-Edmonton Corridor. The capital cost of this approach is relatively low owing to its use of existing road bed. It can provide a high level of service from city centre to city centre which is competitive with both highway and air travel in many cases, with greater reliability and less negative environmental impact. While again unlikely to decrease required highway investment, high speed rail service will add significantly to the choice of travel mode and quality of transportation service between relevant city pairs.

- the auto sharing service, high speed rail plus rented auto at the destination, same-train auto-haul with reduced fares, and large freight aircraft all rate somewhat lower with a score of 2. The auto sharing service is expected to have little or no impact among higher income population segments but could attract the younger and poorer members of the travelling public with some possible increase in the efficiency of vehicle use. Its impact, in practice, would probably be marginal, however, and no government intervention seems warranted. High speed rail plus a rented car available at the destination city is another approach to the concept of same-train auto-haul. Unless large subsidies were made available to cover the cost of the car rental, it is not really an innovation, since rental cars are widely available; the approach does not therefore seem to warrant additional consideration.

  The same-train auto-haul with reduced fares rates somewhat worse than STAH at economic fares, mainly because of the increased net operating cost (subsidy) involved. In view of the negligible impact of this approach on highway investments, a subsidy does not seem warranted from the public purse. In this as in other transportation modes, the principle of charging users as nearly as possible the true economic cost of the service provided would appear to be an excellent guideline to follow.

While a very different application, the large freight aircraft also scores 2. This is a very interesting concept for transport of bulk petroleum products from the Arctic Islands to markets in the south, and is now actively being investigated. Whether or not this approach will be adopted depends heavily upon the demand for natural gas and the consequent need to draw upon the Arctic archipelago sources. If the approach is adopted, it is quite possible that it would have application in Canada's Mid-North as a means of carrying ore from remote mineheads which is cheaper than building fixed roads or rail lines.

- STOL services rate next with a score of 1. Assuming second generation jet-STOL aircraft, such services could be quite attractive serving city pairs of up to 500 miles separation and providing feeder services from smaller centers to major cities. A number of much more definitive studies have been made on this approach indicating the need for substantial research and development investments in the development of a Canadian STOL aircraft.[10,11]

- within the large error ranges mentioned earlier, improved communications, tracked levitated system, reduced air fares, and STOL with reduced air fares are all rated as producing no improvement relative to conventional highways. The improved communications approach is most difficult to evaluate in the absence of any firm estimates of capital and operating costs, tariffs and subsidies, system use and probable impact on inter-city travel.

  A recent report prepared for the Department of Communications discusses alternative approaches and possible impacts in this area and identifies the more detailed data collection and analysis which must be carried out as a basis for policies and programs in this area.[12] The TLS approach rates considerably behind high speed rail, primarily because of its much higher capital cost, smaller compatibility with existing modes, and greater implementation risk. In view of this, and the other conclusions of the CTC Inter-city Passenger Transport Study referred to earlier, this approach is seen as relatively unattractive, particularly in view of the five to ten year time horizon for this study.

  The approach of reduced air fares on conventional air services was proposed as a possible means of diverting traffic from highways and thereby reducing highway investments. The negligible diversion impact of this and all other approaches essentially negates it as a viable alternative owing to the increased capital and operating costs which would result and the desirability of a pay-as-you-go basis for transportation services. The same arguments apply to the STOL with reduced fares approach.

- finally, the automated highway rates lowest with a score of -2. This is primarily because of its expected higher operating cost, negative environmental impact, greater implementation risk, and problems of vehicular compatibility during the many years of its implementation. The somewhat uncertain advantages of possibly increased capacity and greater safety do not seem to offset these disadvantages, and the long time horizon to produce an operational system makes it an unattractive candidate in terms of this study.

10 *Study of Regional Application of STOL*, Transportation Development Agency, Montreal, March 1972.

11 *Feasibility of STOL Aircraft Service in the Middle and Lower North Shore Region of Quebec*, Transportation Development Agency, Montreal, April 1972.

12 *Transportation and Communication as Instruments of National Policy*, op. cit.

PART 4
CONCLUSIONS

The major conclusions of this preliminary study can be summarized as follows:

1 None of the new technology/innovative management approaches evaluated is expected to have a noticeable impact on required inter-city highway investments for the Canadian Highway System during 1972-82 owing to the preponderance of relatively short trips on inter-city highways and the difficulty of developing an alternative mode which is attractive and flexible enough to divert these shorter trips. While they may be of national significance, the Canadian Highway System links were built mainly by the Provinces, in accordance with their constitutional mandate, primarily to serve these shorter trips. Therefore any consideration of new approaches which attempt to carry the longer trips at less cost must realize that *the incremental capital costs of serving additional intercity trips via highway are generally relatively small* since highways of relatively high capacity have already been built for other purposes. Obviously, this argument would not apply if a completely new highway link were being considered where one did not exist before, nor would it apply for sudden major increases in inter-city highway travel which might result from, say, the discontinuance of passenger rail services between Ottawa and Montreal. It *does* apply, however, where highways already exist and new modes such as HSR, TLS or STOL are being considered. New modes with relatively low capital cost per unit of capacity (such as HSR) will therefore tend to be more attractive than those of higher capital cost (such as TLS), and the benefits of any new mode will have to be substantial to offset the incremental cost advantage of the highway mode.

2 The development and implementation of improved public transportation for inter-city travel in Canada will have to be justified on the grounds of improved levels of service and availability of alternative means of transportation for those without access to a private automobile, rather than as a means of significantly reducing highway expenditures. Bearing this in mind as well as aspects of public acceptance and environmental impact discussed earlier, the high-speed rail approach would appear to warrant further consideration in at least two Canadian Corridors (Quebec-Windsor and Calgary-Edmonton) and the same-train auto-haul approach could be demonstrated and tested in other corridors with sufficient capacity to determine the real demand for such service. STOL services could also be further tested and developed for Canadian application.

3 The difficulty of obtaining consistent and comprehensive data on inter-city transport volumes and system costs points up once again the need for improved data collection, demand modelling and economic studies on a continuing basis in Canada to provide the framework for developing transport policy and programs. For example, the selection of pairs of centres, between which person-miles or ton-miles of movement are large enough to be of national significance, would be possible based on more complete data.

4 In terms of goods transportation, it is expected that container unit trains will capture a greater share of long-haul general cargo transport during the next few

years; large freight aircraft are a very interesting possibility for the Mid-North and Arctic areas of Canada in terms of bulk commodities.

5 Meanwhile, in view of conclusions 1 and 2 above, it seems highly unlikely that new technology and/or innovative management approaches will have an impact upon the required investments in new and improved inter-city highways at the national level in Canada by 1980. Based on these findings, the most appropriate strategy appears to be to continue investing in improvements to the Canadian Highway System in order to serve observed and anticipated increases in traffic volumes on the highway system, while selectively considering other, public transportation improvements for the reasons stated in conclusion 2.

APPENDIX
NEW TECHNOLOGY AND/OR INNOVATIVE MANAGEMENT APPROACHES

SYSTEM 1 IMPROVED LONG DISTANCE COMMUNICATION

DESCRIPTION	The change in communication expected to have an impact on inter-city travel is the *videophone*. This comprises a CRT display unit in connection with a send/receive (telephone) unit.
OBJECTIVE	Besides improving person to person contact and the transmission of data, this system could reduce the need for inter-city travel.
CANADIAN APPLICABILITY	Because of the spatial arrangement of Canadian urban centres this development is quite applicable to all of Canada and is particularly pertinent to the high density transport corridors.
REQUIRED TECHNOLOGICAL DEVELOPMENT	Most of the major technological "bugs" have been ironed out of the system. Prototypes are presently in operation.
UNIT COSTS	Not available.
TIME HORIZON	1975 to 1980.
MANAGEMENT	The management structure presently exists for such a strategy.

SYSTEM 2 AUTOSHARING SERVICE

DESCRIPTION	This system would operate on a basis similar to a co-op demand-responsive transit system. The potential rider would contact a central depot to say that he is going from A to B on a specific date, and he either wishes a ride or is willing to carry a rider. Shared costs would be predetermined, the operating agency being paid a small sum by the rider or carrier.
OBJECTIVE	To increase the car occupancy rate for inter-city travel, thereby increasing the effective capacity of the roadway.
CANADIAN APPLICABILITY	Applicable to most of Canada with emphasis on the high density, heavily travelled corridors.
REQUIRED TECHNOLOGICAL DEVELOPMENT	No technological development is required to initiate this system.
UNIT COSTS	Unit costs per passenger mile could range from one to six cents.
TIME HORIZON	The system could be implemented within a few months.
MANAGEMENT	Ideally operated by private enterprise.

SYSTEM 3 HIGHWAY TOLLS

DESCRIPTION	Tolls could be applied to all travel on specific highway links. The amount of toll could be varied according to time of day and/or vehicle class.
OBJECTIVE	The objective of this concept would be to encourage off-peak use of the highway mode and possibly to increase highway transportation revenues.
CANADIAN APPLICABILITY	Although the toll concept does not enjoy widespread application in Canada (with the exception of some toll roads in Quebec), it is conceivable that various medium to high density highways, such as Highway 401 in Ontario, could become toll roads.
REQUIRED TECHNOLOGICAL DEVELOPMENT	No technological development is needed to implement this idea.
UNIT COSTS	The major capital cost of the toll concept is related to toll stations. This cost is expected to range between $10-$50,000 per mile.
TIME HORIZON	Allowing for detailed studies of the concept and the construction of toll stations, this concept could be operational in 1975.
MANAGEMENT	No management structure presently exists for such a national scheme. To successfully implement the scheme would require the creation of such a structure. Alternatively, a significant increase in gasoline tax could be applied without the above-mentioned capital expenditures, but would not be selective in acting to smooth peak period traffic volumes.

SYSTEM 4 AUTOMATED HIGHWAY

DESCRIPTION	Depending on the system, sub-surface wires (on the roadway) are energized by roadside transmitters and sensed by vehicular sensors or the transmitters are vehicular borne. Transmitters react with the sub-surface wiring system to control steering and speed.
OBJECTIVE	By automating vehicular control, three objectives may be attained: 1) Significant decreases in accident rate and fatalities 2) Increases in system capacity 3) Decreases in trip time.
CANADIAN APPLICABILITY	Applicable to relatively high density corridors, examples being Toronto-Montreal, Edmonton-Calgary.
REQUIRED TECHNOLOGICAL DEVELOPMENT	Implementation depends on successful R & D efforts including: 1) Vehicular detection technology 2) Economical, fail-safe electronic controls 3) Extensive lab and field tests.
UNIT COSTS	Approximately $3 million/mile for a two-lane automated highway.
TIME HORIZON	1990.
MANAGEMENT	A management structure to control this system does not presently exist. Many sophisticated management tolls would need to be develop and exploited in order to successfully implement and operate an automated highway system.

SYSTEM 5 BUS OR TRUCK TRAINS

DESCRIPTION	This system involves the combining of individual bus or truck units in an articulated fashion.
OBJECTIVE	The objective is to increase the capacity of the vehicle thereby increasing the capacity of the mode and decreasing labour costs per unit.
CANADIAN APPLICABILITY	This system would be economically justified only in high density corridors. In low to medium density corridors, present bus and truck sizes are adequate, relative to existing and anticipated demands.
REQUIRED TECHNOLOGICAL DEVELOPMENT	Little R & D is required for safe (and failsafe) vehicle articulation at high speeds.
UNIT COSTS	Up to 30% reduction in costs per seat-mile and per ton-mile.
TIME HORIZON	1974 to 1975.
MANAGEMENT	The management machinery for this concept already exists.

SYSTEM 6 HIGH SPEED RAIL (HSR)

DESCRIPTION

The problem of increasing train speeds is related to problems of increasing train power to weight ratios, suspension and adhesion capabilities, flattening vertical and horizontal track curvature, etc.

OBJECTIVE

The object is to increase train operating speed (while utilizing as much as possible the existing fixed plant) thereby increasing the railway's share of inter-city traffic and minimizing expenditures.

CANADIAN APPLICABILITY

Increasing train speeds is certainly applicable to all inter-city passenger movements; but the effect of train speeds on modal splits is most likely to be felt in the high density corridors.

REQUIRED TECHNOLOGICAL DEVELOPMENT

The operational TurboTrain (CN), the SNCF and the Japanese Tokaido line are indications of the technological feasibility of the concept. The LRC train now being developed by MLC-Worthington is expected to be operational soon.

UNIT COSTS

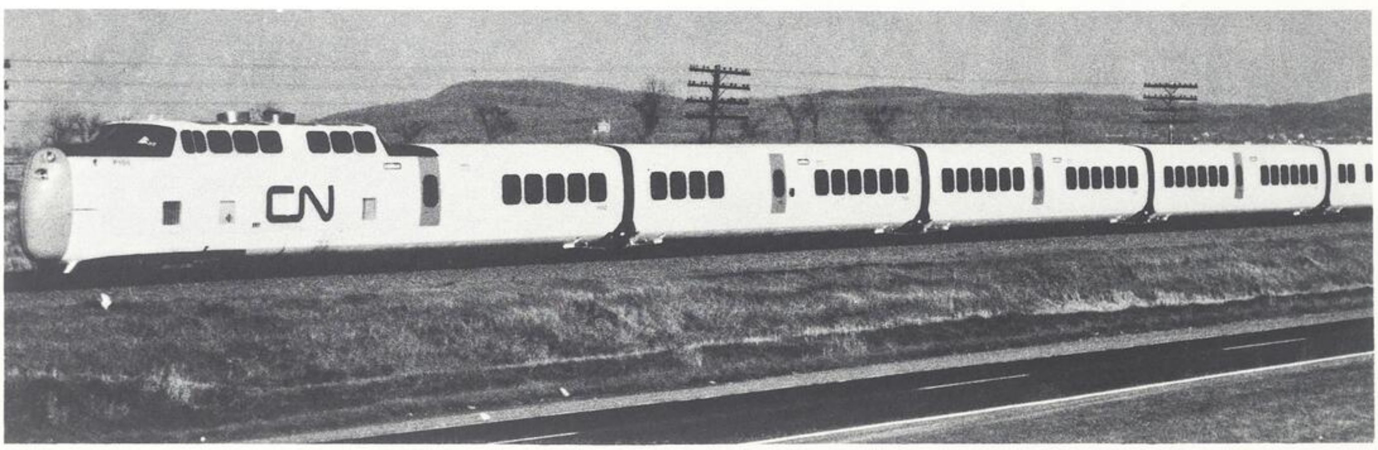
Labour and capital rolling stock costs may be reduced per seat-mile in proportion to speed increases: 2-5 cents person/mile, covered by revenues.

TIME HORIZON

Vehicle production and track renovations are the major constraints on implementation. The system could be operational anywhere between 1974 and 1980.

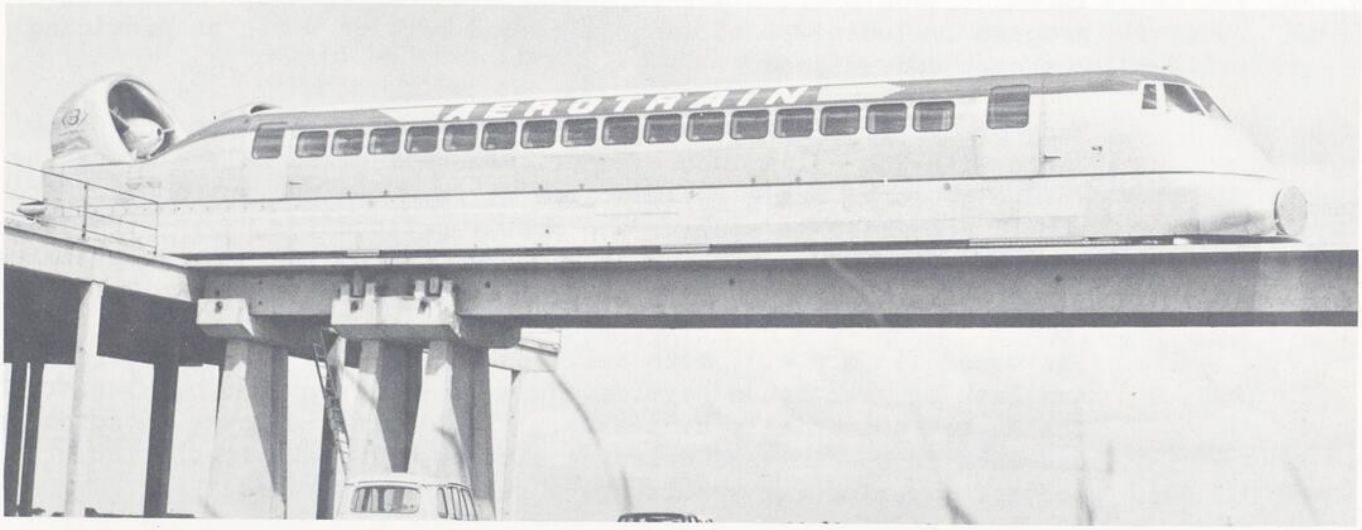
MANAGEMENT

The management tools and structures required for this system are in existence.



SYSTEM 7 TRACKED LEVITATED SYSTEM (TLS)

DESCRIPTION	Within this system high speed vehicles are *supported* and guided by cushions of air or magnetic suspension and operated on a fixed guideway. Propulsion is achieved by air thrust (the Bertin Aerotrain) or by Linear Induction Motors (LIM).
OBJECTIVE	To increase train speed beyond the capabilities of the steel wheel on steel track, thereby placing the mode in more direct (speed) competition with air travel for trips up to 500-1000 miles in length.
CANADIAN APPLICABILITY	Because of the heavy investment in new track and relatively expensive power units, this system tends to be feasible only in high density corridors.
REQUIRED TECHNOLOGICAL DEVELOPMENT	The Bertin I-80 is presently operational. Research and development on LIM, vehicle suspension systems, etc. for the second generation TLS are presently in progress.
UNIT COSTS	Possibly 5-10 cents/person/mile, covered by revenue.
TIME HORIZON	The progress in R & D for the second generation TLS indicates that the system could be available in the 1980-1990 period.
MANAGEMENT	Dependent on the economic viability of a TLS system, the public carriers presently enjoy a management structure capable of managing such a system, assuming public capital funds were available.



SYSTEM 8 SAME-TRAIN AUTO-HAUL (STAH)

DESCRIPTION

This system employs conventional rail facilities but special cars are used to transport the autos belonging to passengers. The autos are transported on the same train as the passengers but in a different car.

OBJECTIVE

The objective is to increase the railway's share of inter-city traffic by providing riders with a personal baggage "container" (their automobile) en route, flexible use of auto or train travel for various parts of the trip, and use of their auto at the destination(s). Particularly applicable to the long distance pleasure travel market.

CANADIAN APPLICABILITY

The system should be applicable to any part of Canada, particularly in the Trans-Canada Corridor.

REQUIRED TECHNOLOGICAL DEVELOPMENT

The technological components required for the full scale implementation of this system presently exists; successful operations exist in Europe, Great Britain and the United States, the latter provided commercially by Auto-Train Corporation.

EVALUATION

This concept has been successfully employed in the U.S. under the name "Auto-Train" through the use of a special consist, non-stop service from Washington, D.C. to Sanford, Fla. A previous attempt of this concept by C & O failed in the U.S. although "auto-trains" are popular in Europe. The key factors which help to spell success for Auto-Train are: a large potential market with year-round travel patterns to Florida; a non-stop, conveniently scheduled service, exclusively oriented to vacation travellers' needs; a price designed to attract interest from a broad market segment; a comprehensive marketing program including promotion, sales and service aimed at providing customer convenience.

Many of the ingredients mentioned above are absent from the CN's "Auto-With-You" plan, whose experience will presumably dictate the future of large scale applications of this concept in Canada. The market potential is smaller and poorly defined for "Auto-With-You" although undoubtedly it should include much of the same geographical market (N.E. United States) as Auto-Train.

The speed (45 m.p.h.), auto delivery schedule (4 hrs. before departure), and lack of year round service (June 23 - September 6 only) restrict the market potentially available. The limited capacity (6 autos/day) and lack of specialized customer service will make it difficult to project experimental results to a full scale service.

The limited marketing effort made to support the abbreviated service will not attract customers from the full potential market available. The price (return) is approximately equivalent to the cost of air fare plus car rental for two weeks and 1000 miles, or about double the cost of driving. These relationships are similar to those for the Auto-Train price structure; however, the actual magnitude of cost differences for driving versus Auto-With-You are more significant for the longer Toronto-Edmonton distance, with a total difference estimated at $400. per round trip. CN's promotional support of Auto-With-You has been restricted to brochures, limited newspaper advertising and press-conferences. The sales effort seems to be limited to distributing necessary information to Passenger Sales Offices, who are connected by wire to the Toronto coordinating office.

Services at terminals are organized more for railway convenience than for customers and no special on-train services exist for customers other than normal CN passenger services. In view of these differences between application of the concept by CN and the Auto-Train implementation, together with the reluctance of CP to commit itself before CN, it appears doubtful that the STAH concept will make a significant contribution to Canadian inter-city highway transportation, and if it does, the effect will be felt only on the CN/CP main lines from Toronto and/or Montreal to Winnipeg, Edmonton, Calgary, Vancouver and Halifax.

UNIT COSTS — 5-7 cents per person-mile for a family of four (including automobile), covered by revenue.

TIME HORIZON — Initiated in Canada during the summer of 1972 by the CN, on a trial basis between Toronto and Edmonton. Full scale operation is possible for summer of 1973, limited to one train/day between Toronto-Edmonton with year-round, system-wide service potentially feasible by 1974. CP participation possible by 1974, although likely restricted to Montreal/Toronto to Calgary. By 1975, the maximum service likely to be offered on a year round basis is probably about three car carriers on each of CP and CN's daily trains to Calgary and Edmonton. This would be effectively a total capacity of only 50 automobiles/day/direction, or two (2) autos/hr.

MANAGEMENT — Considerable effort would be required to provide an adequate marketing team to initiate the full-scale, system-wide marketing effort required to successfully launch a specialized train concept of the same nature as Auto-Train.

CAPITAL COSTS

Experimental — The Auto-With-You trial currently being run by CNR requires only bi-level enclosed car carriers (valued at $25,000 each) plus a minimal investment in loading/unloading facilities in Toronto and Edmonton. The bi-level cars are becoming surplus in normal auto service through conversion to tri-levels. A number of the CN carriers have already been sold to Auto-Train.

Further enlargement of the tag-along approach for auto carriers on existing passenger trains should cost only $25,000 per auto carrier. This approach has a limited capacity because of power limitations of the passenger trains.

Special Consist Trains (limited schedule and routes)

If trains of similiar consist to Auto-Train are initiated, the capital cost should be in the order of $2 - 3 million per train, including auto carriers, coaches, sleepers, buffet-movie, night club car, generator car and two locomotives. Costs would depend on the car mix required in the consist, the degree to which old equipment is refurbished, and how much equipment is transferred from other service. The cash outlay could be minimized through the use of leasing. One train per day on both the Toronto-Edmonton and the Montreal-Calgary runs would require a total of 10 train sets (including one spare for each line) for a total cost of $20 - 30 million.

This service could fit into existing schedules and readily make the trip under two days in both cases, even with allowance for stops in Winnipeg. The insertion of these relatively fast schedule trains (45-55 mph average) will undoubtedly cause some scheduling problems for freight traffic; however, no additions to track capacity should be necessary. Increasing the schedule to two or more trains per day on each line would probably cause sufficient congestion to necessitate improvement to the track and/or signalling facilities.

Special Consist Trains (frequent, system wide service)

The introduction of the auto-train concept between all major city pairs in Canada (Halifax-Montreal-Toronto-Winnipeg-Edmonton-Calgary-Vancouver) with daily service between all cities will increase train set and cost requirement by about 50%. Increase of Canada wide frequency to twice per day would increase equipment costs to about $50 million, with right-of-way improvement of another $50 - 100 million required for double tracking and/or signalling to maintain capacity for other traffic through busy sections in peak periods.

SYSTEM 9 HSR AND RENTED AUTO AT DESTINATION

DESCRIPTION	This concept couples the high speed rail (120-160 m.p.h.) with the provision of rented autos at the trip ends. A reduced auto rental cost could be a part of the trip package.
OBJECTIVE	The objective is to increase the railway share of inter-city traffic by providing a high speed inter-city link in conjunction with a reduced cost for intra-city movement at the destination(s).
CANADIAN APPLICABILITY	Although the concept is applicable to all inter-city passenger movement, effects on the modal split are most likely to be felt in the high density corridors.
REQUIRED TECHNOLOGICAL DEVELOPMENT	The concept is presently technologically feasible.
UNIT COSTS	As for System 6. plus car rental price.
TIME HORIZON	Vehicle production and track renovations are the major constraints on implementation. The system could be operational between 1974 and 1980.
MANAGEMENT	The management tools and structures required for this system are in existence.

SYSTEM 10 STAH AND REDUCED FARES

DESCRIPTION	In addition to transporting passengers with their autos (in different cars) a reduction in fare is suggested by this concept.
OBJECTIVE	The objective is to increase significantly the railway's share of inter-city traffic.
CANADIAN APPLICABILITY	The system should be applicable to any part of Canada, in particular the Trans-Canada Corridors.
REQUIRED TECHNOLOGICAL DEVELOPMENT	The technological tools required for the full scale implementation of this system presently exist.
UNIT COSTS	Deficit of, say, 4 cents per person-mile.
TIME HORIZON	The STAH aspect of this concept is to be initiated in Summer, 1972 on a trial basis. Full scale operation for the entire concept is possible for 1973-75. (See System 8).
MANAGEMENT	The management to initiate and operate this system presently exists.

SYSTEM 11 CONTAINER UNIT TRAINS

DESCRIPTION	This concept applies to goods movements which are to be performed by rail, the goods being packaged in standard containers and transported via rail car.
OBJECTIVE	To decrease truck traffic on the National Highway System.
CANADIAN APPLICABILITY	Presently used in Canada. Significant potential for expansion in all major transportation corridors in Canada.
REQUIRED TECHNOLOGICAl DEVELOPMENT	Available.
UNIT COSTS	1-2 cents per ton-mile.
TIME HORIZON	Presently available.
MANAGEMENT	The management for marketing and operating this concept presently exists.

SYSTEM 12 REDUCED AIR FARES

DESCRIPTION	This strategy involves reducing CTOL air fares.
OBJECTIVE	The objective of this strategy is to increase the air carriers' share of the inter-city travel market, thereby reducing highway traffic volumes.
CANADIAN APPLICABILITY	Applicable to transportation corridors (anywhere in Canada) where the trade-offs between highway construction and air transport subsidies favour the air transport subsidies.
REQUIRED TECHNOLOGICAL DEVELOPMENT	CTOL technology presently available.
UNIT COSTS	Deficit of, say, 3 cents per person-mile.
TIME HORIZON	The time horizon ranges from 1972 to 1980.
MANAGEMENT	The management structure and tools needed for this strategy are presently available; public subsidies would be required.

SYSTEM 13 STOL SERVICE

DESCRIPTION	The strategy would be based on the provision of service via short take off and landing aircraft operating directly from centre to centre between urban areas and from smaller centres to major airports.
OBJECTIVE	To increase the air carrier share of the market by reducing inter-city trip times.
REQUIRED TECHNOLOGICAL DEVELOPMENT	Development and testing is required for 1st generation (DHC7) and 2nd generation (jet-STOL) aircraft and systems.
UNIT COSTS	3-6 cents per person-mile.
TIME HORIZON	1st generation 1975-1976 2nd generation 1980-1985
MANAGEMENT	The management structure presently exists for such a strategy.

SYSTEM 14 STOL AND REDUCED FARES

DESCRIPTION	The strategy combines the provision of short take off and landing craft with overall reductions in air fares (subsidized).
OBJECTIVE	To significantly increase the air carriers' share of the inter-city passenger market by reducing inter-city trip times and costs.
CANADIAN APPLICABILITY	The strategy is applicable to all inter-city transport. STOL to be used predominately for short trips and CTOL for longer trips.
REQUIRED TECHNOLOGICAL DEVELOPMENT	As for System 13.
UNIT COSTS	Deficit of, say, 3 cents per person-mile.
TIME HORIZON	1st generation 1975-1976 2nd generation 1980-1985
MANAGEMENT	The management structure presently exists for such a strategy.

SYSTEM 15 LARGE FREIGHT AIRCRAFT

DESCRIPTION These are craft capable of pay loads 10 times that of conventional aircraft (1000 tons).

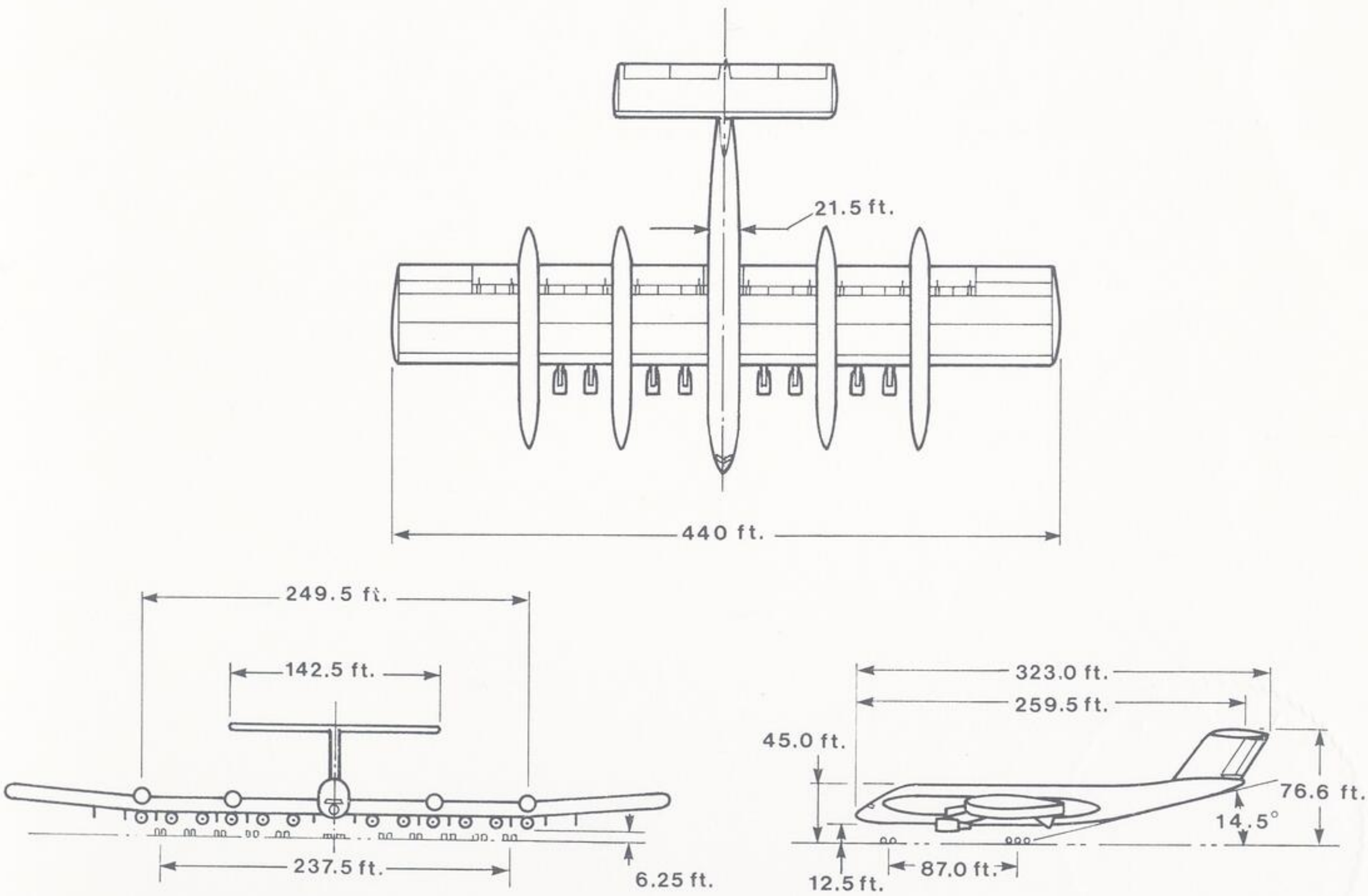
OBJECTIVE To reduce investment in resource-oriented highways for Mid-Canada.

REQUIRED TECHNOLOGICAL DEVELOPMENT Extensive.

UNIT COSTS Unknown; each aircraft would have an estimated cost of $100 million; estimates have been given of 1.5 - 2 cents/ton-mile for ore carriage.

TIME HORIZON 1980 to 1985.

MANAGEMENT Management approach would have to be developed.



PRINTED IN CANADA