QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

Economic Impact
and
Industrial Strategy Study

VOL II:

INDUSTRIAL STRATEGY

FINAL REPORT

prepared by the Consortium of

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EXECUTIVE SUMMARY

The objectives of this Industrial Strategy Study are to assess the potential industrial benefits from implementing the Quebec-Ontario High Speed Rail (HSR) project and to develop an industrial strategy that would maximize the attainment of these benefits.

Industrial benefits are defined as the direct employment, income and profits incurred through increased industrial activity. Industrial benefits would result from Canadian industry's participation in the project and in its further participation in U.S. and other potential international HSR projects. The Economic Impact Study, which includes an assessment of these and other direct effects as well as indirect and induced effects resulting from the project, is presented in a separate volume.

This study consists of an assessment of HSR technology requirements, including technology transfer; an assessment of Canadian industrial capabilities; an estimation of the Canadian content for the Q/O HSR project and the distribution of that content among Provinces. A market study of the U.S. and other international HSR projects and an evaluation of Canadian industry's likely share of these markets were also undertaken. An assessment of the South Korean and Spanish HSR projects and a review of Canadian industrial policy experience have also been provided for a better appreciation of the nature and magnitude of an HSR industrial strategy and in order to take advantage of this experience in devising a Canadian HSR industrial strategy.

Canadian Rail Industry Profile

Following years of rationalization and modernization, Canada has developed a strong and fully integrated, internationally competitive industry that supplies the North American conventional passenger rail and mass transit markets.

The Canadian industry includes engineering, manufacturing and assembly of rail cars and locomotives, vehicle components, power supply and distribution equipment, signalling equipment, communications equipment and rail and track equipment for urban mass transit, freight and passenger rail transportation.

Canadian industry is considered world class for state-of-the-art conventional rail technology. Canada also has some experience in designing and developing HSR technology. The Turbotrain, developed in Canada based on an American design, has reached speeds of 226 kph and the LRC train, which operates with the benefit of a tilting mechanism, was designed and developed to operate at speeds of 200 kph.

High Speed Rail Requirements

HSR is not a revolutionary technology. It is an amalgamation of state-of-the-art components and sub-systems (with a few specialised advanced components) which allows for the attainment of speeds considerably higher than conventional technology with safety and comfort.

Existing European or Japanese HSR systems will require modifications and some redesign upon their adoption in the Canadian or U.S. corridor projects as every new application requires a different set of technical and performance specifications. These new specifications are mainly required because of different safety standards, distinct geo-physical characteristics of each corridor and the continuing evolution of HSR technology capabilities.

Technology Transfer

The technology transfer process to achieve a high level of Canadian content for the Q/O project, is not considered difficult, costly or constraining.

Ownership of HSR technology is due to economics rather than to law. Few patents exist.

Technology transfer has various levels of complexity. In terms of the value of components and sub-assemblies it is estimated that;

» 70% to 75% does not require technology transfer or requires the simple transfer of engineering drawings;

» 10% to 15% requires technical assistance and perhaps license agreements, in addition to engineering drawings;

» 15% to 20% is considered "noble" and not likely to be transferred for strict economic and proprietary reasons.

There are no other non-negotiable constraints to technology transfer.

Since HSR technology is developed and sold as a system, effective control of the technology resides with the primes.

Research and Development

For the Quebec-Ontario HSR project, R & D is characterized both as the need to adapt HSR technology to North American standards and climatic conditions and on-going work to further develop the technology in terms of speed, comfort and cost-effectiveness.

The cost of adapting HSR technology to N.A. standards and climatic conditions is estimated at roughly $20 million (Cdn) to cover some 40 R&D projects.

Canadian Capability Relative to HSR

Canadian industry is definitely capable of undertaking the Quebec-Ontario HSR project.

It is estimated that 70% to 75% of components could presently be manufactured in Canada under present capabilities or with minimal assistance and some drawings.

Canadian companies, either alone or within a consortium, could take on the responsibilities of prime contractors for most sub-systems, including electrification, communications and signalling.

A survey was conducted with 40 firms manufacturing in Canada, representing all segments of the Canadian rail industry.

The survey results can be summarized as follows:

» all firms anticipate no technical or economic obstacles to participating in the project. All are qualified or in process of qualifying to ISO or equivalent standards;

» 26 firms have recent and relevant experience with technology transfer, 6 firms stated that no technology transfer is required;

» 20 firms are wholly owned Canadian, 20 are foreign owned subsidiaries;

» 21 firms have North-America-wide mandates for some HSR products, 33 firms export to the U.S.;

» all firms state that Canadian project component volumes would be sufficient to justify any required investment in training, tooling and machinery.

The Canadian HSR Project

With appropriate industrial strategy measures, and some technology transfer, Canadian firms could supply an estimated 85% of manufactured components for the Q/O HSR project with little or no cost premiums incurred.

The manufactured components (above the sub-grade) are estimated at around $2.9 billion (Cdn), for both technologies.

Distribution of Industrial Production of the Q/O HSR Project (for both Technologies)

	Foreign Imports	Canadian Content	Quebec	Ontario	Rest of Canada
Power Car	22%	78%	36%	42%	
Passenger Car	12%	88%	44%	44%	
Power Supply	14%	86%	43%	43%	
Power Distribution	10%	90%	45%	45%	
Signalling	30%	70%	26%	44%	
Communications	20%	80%	40%	40%	
Track & Equipment.	13%	87%	15%	47%	25%
Total Manuf. Compon.	**15%**	**85%**	**35%**	**45%**	**5%**

The distribution of the manufacturing activity would be in the order of 45% Ontario, 35% Quebec and 5% Rest of Canada, with the remaining 15% being imports.

The 15% foreign content results from the need to import "noble" components, technical assistance as well as some specialised sub-components and materials for component assembly.

The choice of technology has been found to be industrial benefit (IB) neutral relative to the Canadian content of the project as both representative technologies will require the same value of manufactured components and face the same Canadian sourcing options.

The stand alone HSR route options devised for the Q/O project would not have any affect on the findings or conclusion relevant to Canadian capability, Canadian content or distribution of manufacturing activity.

International Markets for HSR Component and Services

The total U.S. HSR market for components and services above the rail, is estimated at $7.6 billion over a 20 year period. Based on optimistic and pessimistic case estimates, the market size ranges between $5.2 billion and $10 billion (Cdn). The market for other international HSR projects is estimated at $6 billion or between $3.6 billion and $8.4 billion.

Estimated International HSR Market for Components and Services

($ Billion Cdn)	Optimistic	Realistic	Pessimistic
U.S. HSR Market	10.0	7.6	5.2
Other International HSR Markets	8.4	6.0	3.6
Total International HSR Markets	**18.4**	**13.6**	**8.8**

We have concluded that HSR projects in the U.S. will be implemented in an incremental manner due mainly to the high cost and limited financial resources available for HSR. The likely technology to be adopted in the U.S. will be the tilting technology, as it is more amenable to incrementality, shared track arrangements and to the geo-physical characteristics of most of the likely corridors.

North American and Global Trading Environments

Although Canadian industry has done well in the U.S. market, "Buy America" requirements continue to represent a significant obstacle to Canadian HSR exports. The mere presence of a Buy America requirement acts as an incentive for prime contractors of potential U.S. projects to consider only U.S. producers even where the Buy America requirements would permit purchases of non-U.S. goods.

Since NAFTA continues to exclude Buy America provisions, the possibility of Canada gaining preferential treatment under Buy America is unlikely.

Opportunities for Canadian exporters exist, however, through waivers to the Buy America requirements. After analysis of the Buy America act and its provisions, and after an evaluation of non-legislated local content rules, it is estimated that foreign firms would be eligible to compete for 50% of the U.S. market for components and services above the rail.

Also as part of NAFTA, both Via Rail Canada Inc. and Canadian National Railway Company have been listed and must comply with obligations on Government Procurement. They must follow strict procedures in awarding major contracts in excess of $250,000 ($8 million for construction contracts).

Relevant benefits to Canadian firms resulting from NAFTA include the elimination of tariffs which will still apply to imports from third countries and clarification on rules of origin resulting in greater certainty on their interpretation by U.S. customs and a reduction in incidents of arbitrary determinations. Relevant benefits resulting from GATT include the specific exemption of R&D and regional development subsidies from countervailing duties.

Potential Canadian Exports

Total Canadian Exports of HSR Components and Services (based on realistic market estimates)

Total for 20 Years	U.S.		Other Int'l		TOTAL	
Cdn Project Scenarios	**%**	**$ M Cdn**	**%**	**$ M Cdn**	**wgt. av.%**	**$ M Cdn**
With Cdn Proj & Tilt Tech. Adopted	8.5	640	3.7	220	**6.4**	**860**
With Cdn Proj & Non-Tilt Adopted	4.5	330	2.8	170	**3.7**	**500**
Without Cdn Proj	2.5	190	1.3	70	**1.9**	**260**
Max. Net Proj. Related Exports	**6.0**	**450**	**2.4**	**150**	**4.5**	**600**

Total exports of Canadian components and services, based on realistic case estimates for U.S. and other international markets, are $860 million if the Q/O project adopts tilting technology, $500 million if non-tilt technology is adopted and $260 million if there is no Canadian project. The realistic maximum net exports resulting from the project, which is the increment between no project and adopting tilt technology, is $600 million.

For the U.S., the main competing factors for achieving HSR market share are products designed for tilting technology and flexibility to conform to requirements dictated by incrementality.

Foreign HSR Industrial Strategy Design

The differences between the HSR industrial strategy objectives of the Spanish, South Korean and Canadian projects are as follows;

» In Spain, the main objective was to strengthen a weak domestic industry.

» In South Korea, it is to instate a rail component manufacturing industry with export potential and obtain high-tech spinoffs for other industry sectors.

» In Canada, it is to maximize the attainment of potential industrial benefits based on an industry that exists and that is relatively strong.

In Spain the project resulted in minimal cost in technology transfer as Spanish industry reached a level of quality comparable to the prime suppliers. The TALGO tilt technology, (designed in the U.S. but further developed and exploited in Spain), however was not adopted for their HSR project and has reduced their potential for penetrating the U.S. tilt market. Since the Spaniards did not incorporate a timely negotiating strategy to maximize industrial benefits, the domestic content was only roughly 55%, which is far below the maximum dictated by the capability of their industry.

In South Korea, the HSR project is expected to result in a 55% domestic content with long term industrial prospects. The establishment of an effective bidding and negotiations process, incorporating clear requirements for maximising industrial benefits, was successful in raising Korean industry's participation well above its present capabilities.

Lessons for Canada from these experiences would be to insure that an effective bidding and negotiation process be installed prior to initiating any element of the Quebec-Ontario project. A process that has clear industrial benefit objectives.

Canadian Policy and Strategy Experience Relative to Major Procurement Projects

Canada has acquired a great deal of experience in maximising industrial benefits of infrastructure and procurement projects.

Industrial and Regional Benefits (IRB) policies were successful in producing industrial benefits for Canada. For example, based on an internal Industry Canada evaluation of 25 major Crown projects valued at over $100 million each, it was estimated that there was a $1.16 return for every $1.00 spent on procurement for these projects.

Based on a Science Council of Canada survey in 1992 of sectoral technology strategy experience, the most successful R&D initiatives for producing industrial benefits are niche-engineering "innovation" or "breakthrough" strategies as opposed to "adopt & adapt" strategies. Although it would not be possible to use innovation or breakthrough strategies with respect to developing a new HSR technology, there are some R&D projects particularly with respect to developing distinct sub-system technologies where these strategies could yield long term benefits from participation in international projects.

A Proposed Canadian HSR Industrial Strategy

There is limited scope for developing an HSR industrial strategy in Canada as a Canadian industry already exists and possesses most of the required capabilities; technology transfer is non-constraining; and trade impediments affecting export market participation cannot be influenced by public policy.

Within this limited scope, seven strategic elements have been outlined that could maximize the attainment of potential industrial benefits resulting from the implementation of the Quebec-Ontario HSR project. The means of affecting the maximization of the potential benefits, which are implicitly incorporated into the strategic elements, include;

- maximising the Canadian content in terms of the manufactured components required to undertake the Q/O HSR project,

- maximising the Canadian export of HSR components and services to the U.S. and other international markets.

- maximising the Canadian participation in R&D expenditures related to the adaptation and ongoing development of the chosen technology.

Of the seven strategic elements provided, only the first element is technology specific. The other six elements are technology neutral and should be implemented regardless of which of the two technologies is adopted in the Q/O corridor.

1) Technology Choice

Considering our findings that the same industrial benefits will result from the construction and operation of the Canadian project using either technology and that exports will be maximized by adopting tilting technology, from a strictly industrial benefit perspective, tilting technology should be adopted in the Q/O corridor. This conclusion is not inconsistent with the findings of the economic impact study (volume I) if viewed with respect to the direct and indirect effects on the railway industry and its associated suppliers.

The overall economic impact results however suggest that adopting tilt technology could provide slightly less employment, income and GDP since it has been found that this technology would attract fewer riders and would require more public funding to operate. Based on the assumption that the project would be funded by public sector expenditure reallocation, relatively more negative economic impacts will occur from the implementation of tilting technology in other industrial sectors not related to the railway industry. It could be argued therefore that based on overall economic impact results emanating from this funding assumption, non-tilting technology should be favoured.

If the choice of technology however is based strictly on a criteria of maximized industrial activity within the Canadian railway sector and its associated suppliers, tilting technology should be adopted.

2) Timing of the Canadian Project

To insure that the potential export related benefits are maximised, the Canadian project should be undertaken immediately following the North-East corridor project and prior to the second U.S. project.

3) Competition

RFPs open to international tender should be prepared for all sub-systems, including infrastructure, rolling stock, electrification, signalling and communications.

In addition to required technical and performance specifications, guidelines for the attainment of industrial benefits should be included in the RFPs.

4) Formation of Canadian Primes

The development of Canadian primes in electrification, communications and signalling should be encouraged and supported to compete for all international projects including the Quebec-Ontario HSR project.

5) Negotiation of Industrial Benefit Agreements

Contract award should be based in significant part on the value of industrial benefits.

Each bid should be required to include an **Industrial Benefit Plan** that would outline the expected benefits and how they would be achieved. This plan should address Canadian content, technology transfer, Canadian participation in international projects, adaptive R&D and other project related and unrelated industrial benefits.

6) Government Support Programs

In order to enhance Canadian capabilities and reinforce the probability of attaining the industrial benefits specified in this study, a review of the pertinent public sector support programs should be made. Programs specifically related to industrial development, export promotion and R&D must be used were possible and necessary to strengthen Canadian capabilities in HSR.

7) R&D Strategy

Included as a supplemental strategic element, specific areas of R&D should be further investigated. These include the development of distinctive Canadian technology in HSR tilting, turbine locomotives, signalling and communications.

This strategic element should be implemented regardless of whether the Quebec-Ontario HSR project is undertaken.

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1.0 Introduction

1.1 Objectives and Structure of this Study

The Economic Impact & Industrial Strategy Study is separated into two volumes. Volume I deals specifically with the assessment of economic impacts resulting from the Quebec-Ontario High Speed Rail (HSR) project. Volume II deals with assessing the industrial benefits that will emanate from this project and determining a strategy in order to maximize the attainment of these benefits.

Industrial benefits are defined as the direct employment, income and profits incurred through increased industrial activity within the Canadian rail sector and its suppliers. Industrial benefits will result from the rail industry's participation in the project and in its further participation in U.S. and other potential international HSR projects. The study of economic impacts on the other hand include an assessment of the project's influence on employment and income levels but also on GDP, debt and balance of payments. The main difference is that it does not only consider the effects on the rail industry sector but on other industrial sectors of the economy as well, such as on industries that supply alternative modes of transportation or on industrial activity that would be displaced due to any change in the expenditure habits of governments, the private sector or households themselves brought about by the project.

Although each report is meant to be self contained, the information in the two reports are interlinked and required reading for a full appreciation of the economic influences and consequences of this project.

In keeping with the main objectives, the purpose of this final report on Industrial Strategy is to expose the research and analysis regarding the industrial benefit opportunities, constraints, and challenges of Canada's rail industry sector particularly with regard to;

1) HSR technology requirements and the need for technology transfer,

2) the R&D expenditures required to adapt the technology to North American standards, norms and climatic conditions,

3) the capability of Canadian industry to compete effectively in HSR,

4) the potential for the export of Canadian manufactured components and services internationally.

Based on the results of this research and analysis, the elements of a Canadian HSR industrial strategy have been outlined.

The structure of this final report reflects these main areas of consideration and is as follows:

In order to properly appreciate Canada's capabilities in rail technology development and industrial production, **section 2** provides a brief characterization of the evolution of the Canadian mass transit and passenger rail industry sectors as well as the general operating requirements of the markets for its products. .

Section 3 of this report outlines the technologies required for a High Speed Rail system, their differences with respect to conventional technology and the issues of technology ownership and transfer.

Section 4 identifies the R&D that will be required to adapt HSR technology to North American standards, norms and climatic conditions with an estimate of the costs associated with this R&D.

Section 5 describes in greater detail the Canadian capability to manufacture HSR componentry and to compete effectively in this industry. The results of interviews with selected firms are presented and the ability of Canadian industry to absorb as well as develop HSR technology is also addressed.

Section 6 provides a description of the Quebec-Ontario HSR project in terms of its requirement for manufactured componentry. An estimate of domestic content as well as a split between provinces of where this manufacturing activity will likely emanate is also presented.

Section 7 identifies the results of a market study to determine the potential size of the U.S. HSR market. A brief assessment of the potential size of other international markets is also addressed.

Section 8 provides an assessment of Canadian industry's potential share of U.S. and other international markets. This section also provides a description of the legal trading environment that could impact on potential Canadian exports.

Section 9 provides a brief review of the HSR projects initiated in Spain and South Korea and their approach to industrial strategy while **section 10** reviews Canadian policy experience relative to developing and implementing industrial strategy in other economic sectors.

In **section 11** a brief review of the relevant strategic issues, findings and conclusions as well as an outline of the required elements for an Canadian HSR industrial strategy is presented.

Section 12 is an addendum which briefly describes some opportunities arising from the recent Canadian participation in the development of a new HSR trainset to compete in international markets.

1.2 Information Sources

The research on which this study is based has spanned close to two years. Although information has been taken from certain parallel study reports for the Quebec-Ontario HSR project and feasibility studies related to other HSR projects, the bulk of the information in this report has been collected through an extensive interview process with representative primes and their associates, a representative sample of Canadian manufacturers and a variety of stakeholders from across North America, Europe and Asia. In all, close to 100 interviews were undertaken (not including project management, technical or steering committee meetings).

All assumptions used in the development of estimates are based on the information collected and on the professional experience of the members of this consortium. More than 15 consortium consulting staff members have provided direct input into this document.

Specific information sources relative to each section are as follows;

Sections 2 and 3 borrow mainly from our consortium's extensive knowledge and experience regarding the conventional rail sector.

Section 4 is based on our consortium member's experience, their participation in the (now defunct) Research Consortium on High Speed Rail as well as interviews with the directors of this organization.

Section 5 relies mainly on the interview of 40 manufacturing companies undertaken specifically for this project.

Section 6 is based on information provided by the interviewed manufacturers, from parallel study inputs and on information that was available internally to our consortium members and confirmed through discussions with the potential primes for the Canadian project.

Information on the U.S. HSR potential market and legislative environment detailed in **Section 7 and 8** was collected and confirmed through a variety of sources. Initial information was collected with the help the High Speed Rail and MAGLEV Association, through the offices of CANAC International Ltd. in New York and representatives of the Federal Railway Administration.

All information sessions concerning U.S. projects were attended at the HSR MAGLEV Association congress held in Toronto and informal discussions were held with each State representative responsible for HSR development during that conference. A series of meetings were held in Washington with executives of Amtrak, the Federal Railway Administration, the Directorate of Transportation of the General Accounting Office, The High Speed Rail and MAGLEV Association, and the Canadian Embassy. Telephone inquiries were also recently held regarding each U.S. HSR project described in our report. Recent discussions were also held with prominent U.S. transportation consultants and academics and a review of relevant U.S. feasibility studies was also recently undertaken.

Section 9 regarding the Spanish project is based mainly on interviews held in Spain with relevant stakeholders. Some published information was also consulted and discussions were held with Canadian embassy staff prior to our mission. Some informal meetings were also held in Canada with visiting Spanish stakeholders. Information regarding the Korean project was collected through published sources, from correspondence between the Korean High Speed Rail Authority and the Ontario Ministry of Transportation as well as discussions with officials of the department of External Affairs.

Section 10 was taken mainly from public sector interviews and a documentation review, the results of which were initially presented as part of our first interim report (February 1993).

Section 11 was based on the entirety of the information collected and analysis undertaken for this study while the assessment presented in **section 12** was based on the same information, assumptions and methodology used in sections 8 as well as on specific discussions with both Amtrak and Bombardier.

2.0 The Canadian Passenger Railway Industry

In order to properly appreciate Canada's capabilities regarding this area of economic activity, this section provides a brief description of the evolution and success of the Canadian mass transit and passenger rail industry as well as the general operating requirements of the markets for its products.

2.1 A Brief Historical Perspective

Initiation of railway operations in Canada triggered the birth of a Canadian railway industry. Early Canadian railways designed and built, sometimes with the aid of contractors, their own track and structures. The railways, in addition to maintaining and overhauling their motive power in their own shops, eventually designed and built their own locomotives and passenger coaches.

Founded in 1853, and in continuous operation since, the Pointe-Saint-Charles shop of the then Grand Trunk Railway designed and built, in 1859, what was then the largest locomotive in Canada, a 4-4-0 weighing 48 tons. In 1857, the Hamilton shops of the Grand Western Railway designed and built the first ever sleeping car on any railway in the world. Its design inspired the American Pullman company.

Early in the twentieth century, Montreal Locomotive Works (MLW) in Montreal and the Canadian Locomotive Company in Kingston were founded by local industrialists, to design and build steam locomotives for Canadian railways and eventually for export. Between the two World Wars, a new segment of the industry developed, the production of streetcars and inter-urban cars (often under license from American companies) for streetcar networks in major cities and regional rail lines.

After World War II, Canadian railways started to shift to diesel traction. MLW started manufacturing diesel-electric locomotives, Canadian Locomotive Company began diesel locomotive production and General Motors opened a plant in London to manufacture its diesel-electric locomotives in Canada.

In 1966, the Turbotrain, was built and further developed in Canada by MLW to a design by the American firm United Aircraft. It was placed in service by Canadian National between Montreal and Toronto and holds the Canadian railway speed record at 210 km/h. The train was acquired from Canadian National by VIA Rail upon its formation and was subsequently operated by VIA.

The Canadian railway industry consisted primarily of manufacturers of rolling stock (locomotives, passenger and freight cars, streetcars and commuter cars) and suppliers of rail and some ancillary equipment. The introduction of the subway in Toronto (1954) and the metro in Montreal (1966) provided great opportunities for diversification, as these transit systems required not only more sophisticated electrically-powered rolling stock, but also complex equipment for power supply, power distribution, signalling and traffic control.

The first 36 subway cars produced in Canada were designed and manufactured by MLW, and delivered to Toronto Transit Commission in 1962 and 1963.

In 1974, the Transportation Equipment Group of Bombardier was founded, its first order being the fabrication and assembly of 423 rubber-tired metro cars for Montreal.

In 1977 the Canadian LRC technology, which used a tilting (or banking) mechanism, was designed and built by a consortium of Canadian firms: MLW, Dofasco, and Alcan. It was introduced into commercial operation by VIA in 1981. Although designed to consistently operate at speeds slightly above 200 kph, it has never been required, until recently, to attain speeds superior to 160 kph. The LRC technology is presently owned by Bombardier.

As regional commuter rail services were renovated (Toronto, 1972, Montreal, 1984), a demand for specialized commuter cars was created. In 1986, Vancouver began rail transit service with its Skytrain, an innovative, fully-automated rail transit system designed and built in Canada by UTDC.

As a result of its progressive development and sophistication, the Canadian passenger railway industry has come to play an increasingly important role in the North American market.

2.2 Present Structure of the Industry

As defined here, the railway passenger industry is that which designs and/or manufactures rolling stock and fixed equipment for use on inter-urban rail services, commuter rail services, and rail transit systems such as metros and streetcars. For convenience in description, this industry may be subdivided as follows:

> **car builders**, who design and engineer passenger rail vehicles (except locomotives); fabricate and assemble their car body shell; select, install, and connect their major components and sub-assemblies; perform final assembly and testing of the complete vehicle; and provide after-sales service in conformity with contractual arrangements;

vehicle; and provide after-sales service in conformity with contractual arrangements;

locomotive builders, who do the same as car builders, but for locomotives; in the recent past, Canadian locomotive builders have been designing and building almost only diesel-electric locomotives;

vehicle component suppliers, who design, engineer and manufacture major components for cars and locomotives; components are most important in number and complexity in electrically-powered self-propelled passenger vehicles such as metro cars;

vehicle materials suppliers, who supply sheet and formed metal, plastics, glass, fasteners, wiring, piping, etc.;

power equipment suppliers, who design and manufacture electrical equipment for power supply and distribution; this applies only to electrically-powered systems;

communication equipment suppliers, who manufacture and supply traditional and fibre optic cables and transmission equipment as well as radio controllers, towers, antennas, etc.;

signalling equipment suppliers, who manufacture and supply electronic, electrical, and electro-mechanical equipment used for train protection and control: this includes track and wayside signalling equipment, equipment for train and route control; central control equipment as well as train control and dispatching software;

rail and track equipment suppliers, who manufacture and supply rails, ties, fasteners, turnouts, turnout motors, turnout snow blowers, etc.

A number of firms having manufacturing operations in Canada are presented below, grouped according to the above classification. A more complete list is presented in Appendix F.

2.3 Canadian Vehicle and Equipment Manufacturers

2.3.1 Car Builders

At present, as is the case in many industrialized countries, there is only one major Canadian car builder: Bombardier. This company, founded in 1942 in Valcourt (Quebec) to manufacture industrial (and eventually, recreational) vehicles, diversified into the railway industry and opened a car building plant in La Pocatiere (Quebec) in 1974. As of 1992, this plant had manufactured 2500 passenger railway vehicles for urban, regional, and inter-urban transport, nearly 80% of which were exported, almost exclusively to the US.

In 1991, Bombardier acquired UTDC, a company with headquarters and transit vehicle manufacturing facilities in Kingston (Ontario), which had earlier (1985) acquired a car building plant in Thunder Bay (Ontario). The Thunder Bay plant had been founded by Canadian Car and Foundry in 1947, then sold to British interests (Hawker Siddeley), from who it was acquired by UTDC.

2.3.2 Locomotive Builders

Following the recent closing of GE Locomotives in Montreal (Quebec), there is only one Canadian locomotive builder: General Motors of Canada Limited in London (Ontario) which manufactures diesel-electric locomotives.

General Motors of Canada Limited is a wholly-owned subsidiary of the U.S. General Motors Corporation. At present, due to the decreasing market for diesel-electric locomotives of the types designed by General Motors, the main U.S. locomotive plant in La Grange (Illinois) is in the process of being phased out. As was learned in the surveys conducted as part of the present study, the London plant is, as a result, taking over the worldwide mandate for final assembly, testing, and service of the locomotives previously built in La Grange.

2.3.3 Vehicle Component Suppliers

There is a large number of Canadian manufacturers that are active in the supply of vehicle components to the Canadian passenger railway industry. The majority of first-level (complete component) suppliers are identified in Table 2-1. Details on their products and other suppliers may be found in Appendix F.

Table 2-1
Canadian Railway Passenger Vehicle Component Manufacturers

Name	Component Manufactured	Location of Facility
Barnes Wallace Co. Ltd.	Coil Springs	Burlington (Ontario)
Canadian Steel Wheel	Wheelsets	Montreal (Quebec)
Dofasco	Gears	Hamilton (Ontario)
GSM Design	Interior Components	Saint-Laurent (Quebec)
Ingersoll Rand	Air Compressor	Kirkland (Quebec)
Knorr Brake Ltd.	Brake Components	Mississauga (Ontario)
Pirelli Cables Ltd.	Power Cables	Saint-Jean (Quebec)
Railtech Inc.	Interior Components	Baie D'Urfe (Quebec)
SAFT	Batteries	Scarborough (Ontario)
Vapor Canada Ltd.	Door operating systems HVAC components	Montreal (Quebec)
Westinghouse Canada	Braking Resistors	Hamilton (Ontario)

2.3.4 Suppliers of Materials for Vehicles

There is a large number of qualified Canadian manufacturers of sheet and formed metal (LAHT steel, stainless steel, aluminium), plastics, glass, fasteners, wiring, piping, who are currently supplying materials to the car builder and locomotive builders.

2.3.5 Suppliers of Power Equipment

Currently, there is a number of Canadian manufacturers that are active in providing power supply and distribution equipment to the Canadian passenger railway industry; the majority of the first-level (complete component) suppliers are identified in Table 2-2; details on their products and other suppliers may be found in Appendix F.

Table 2-2 Canadian Manufacturers of Railway Power Supply and Distribution Equipment		
Name	Component Manufactured	Location of Facility
ABB	High Voltage Breakers	Montreal (Quebec)
Glenayre Electronics	Systems Controls	North Vancouver (BC)
Insul-8	Third Rail Components	Saint-Jerome (Quebec)
Kearney Canada	Sub-station Equipment	Saint-Leonard (Quebec)
Ferranti Packard	Transformers	St-Catherine's (Ontario)
Markham Electric	Sub-station Design & Components	Markham (Ontario)
Siemens Electric	Power supply Components	Pointe-Claire (Quebec)

2.3.6 Suppliers of Signalling Equipment

Currently, there are several Canadian manufacturers that provide signalling equipment to the Canadian passenger railway industry; they are identified in Table 2-3; details on their products may be found in Appendix F.

Table 2-3 Canadian Manufacturers of Railway Signalling Equipment		
Name	Component Manufactured	Location of Facility
DSL Dynamic Sciences Ltd.	Wayside Interfaces	Saint-Laurent (Quebec)
General Railway Signal	Central Control Components Wayside Signal Components Switch Machines	Pointe-Claire (Quebec)
Glenayre Electronics	Signalling Components	North Vancouver (BC)
Motorola Communications	Central Control Components	North York (Ontario)
Safetran Corporation	Central Control Components Wayside Signal Components Switch Machines	Mississauga (Ontario)
SEL-Alcatel	Signalling Systems	Weston (Ontario)
Servo Corporation of America	Hot Box Detectors	Gloucester (Ontario)
Union Switch & Signal	Central Control Components Wayside Signal Components Switch Machines	Pointe-Claire (Quebec)
Vapor Canada Ltd.	Wayside Interfaces	Montreal (Quebec)

2.3.7 Suppliers of Communications Equipment

There is a number of Canadian companies, including Northern Telecom and SEL Alcatel, that design and manufacture communications equipment. Equipment designed for high performance and heavy duty service can be used in the passenger railway industry.

2.3.8 Suppliers of Rail and Track Equipment

A number of Canadian manufacturers that supply rail and other track equipment to the Canadian passenger railway industry. They are identified in Table 2-4. Details on their products may be found in Appendix F.

Table 2-4
Canadian Manufacturers of Rail and Track Equipment

Name	Component Manufactured	Location of Facility
Alfex	Rail Welding Materials	Saint-Jerome (Quebec)
Algoma Steel Corporation	Rail	Sault Sainte-Marie (Ontario)
Hovey Industries	Turnout Heaters and Blowers	Gloucester (Ontario)
Pandrol	Track Fastener Pads & Insulators	Gloucester (Ontario)
Sydney Steel Corporation	Rail	Sydney (NS)
Voest-Alpine Nortrak	Turnouts	Richmond (BC)

Naturally, manufacturers from the major industrial countries maintain sales offices or agencies in Canada and are in regular contact with Canadian manufacturers in all the above mentioned sectors to supply foreign-made components and sub-components to them.

2.4 The Demand for its Products

The Canadian passenger railway industry supplies its products and services essentially to the Canadian and U.S. markets. These markets consist of mainline passenger systems, such as;

- VIA Rail and Amtrak, who acquire inter-urban passenger cars (coaches mainly, but also sleeping, dining, and other specialized cars) and locomotives [primarily diesel-electric, as well as all-electric locomotives (not manufactured in Canada) are used between Washington and New Haven only]:

    - Amtrak owns over 1700 cars of various types and 20 Turbotrains;

    - VIA Rail owns over 650 cars of various types;

- regional rail authorities who operate the commuter rail services in 12 major metropolitan areas. They acquire commuter cars, diesel-electric locomotives, and electric multiple units where regional networks are electrified (Chicago, Montreal, New York, Philadelphia);

- urban transit authorities, in cities where urban rail transit systems are operated. They acquire:

    - electric multiple units for metro trains (in 15 cities where those are operated) and

    - streetcars (also known as Light Rail Vehicles) in 18 cities where these are operated.

Table 2-5 below summarizes the number of vehicles operated and on order for the various regional and urban rail transit systems in Canada and the U.S.A.

Table 2-5
Canadian and U.S. markets for passenger rail vehicles

	Urban Pop. (Mil.)	Street Cars LRT	Heavy Rail Transit	Commut. Rail Transit	Regional Pop. (Mil.)
Canada					
Population served by system	4,44				6,54
Number of systems		3	3	2	
Vehicles operated and on order		492	1,658	458	
U.S.A					
Population served by system	28,65				69,85
Number of systems		15	12	10	
Vehicles operated and on order		1,308	12,453	4,868	
Total for Canada and U.S.A.		1,800	14,111	5,326	

Source: Jane's Urban Transport Systems

Assuming a useful life of forty years for these vehicles (this allows for a major factory overhaul after 20 or 25 years of service), the annual demand for replacement vehicles amounts, on the average, to 45 Light Rail Vehicles, 350 metro vehicles, and 133 commuter rail cars, excluding locomotives used in commuter rail services.

2.5 Operation of the market

Typically in North America, orders for rolling stock and for other components for a rail system are given by its operator: the inter-urban railway operator (VIA Rail or Amtrak); the regional rail service operator (often in conjunction with the railway operating the commuter trains by contract); the urban rail transit system operator.

Normally a public call for tenders is issued, based on formal specifications and/or Terms of Reference. The order is awarded, in principle, to the supplier offering the lowest cost while respecting all requirements of the technical and performance specifications.

Suppliers responding to a public call for tenders for their equipment normally have a period of approximately three to six months to prepare their submittal.

During this period, the prime supplier (the car builders and locomotive builders in the case of complete vehicles) obtains technical and price proposals from all its component suppliers. The greatest proportion of negotiation between the prime supplier and its component suppliers takes place during this period.

There are two reasons for this:

- first, the prime supplier must commit itself to a price, vis-à-vis the client, and correspondingly expects the component suppliers to each commit themselves to their price;

- second, as part of the bid evaluation process, each proposal will be reviewed in detail from a technical standpoint by the client. Specific components must often be proposed by the prime to guarantee and demonstrate that system performance criteria are met.

As a result, selection of a prime supplier by the client may explicitly require the selection of some of the proposed components (especially if they are critical), for which no substitutes will henceforth be accepted.

The agreements between the prime supplier and the component suppliers that are part of its team in the bidding process are usually conditional. If the prime is retained, then the sub-contractor will supply its components at the already-agreed terms and conditions. If the prime is not retained, the conditional agreement is more or less automatically void. Also, a component supplier may offer its components to several prime suppliers.

3.0 High Speed Rail Requirements

This section outlines the technologies required for a High Speed Rail system, their differences with respect to conventional technology and the issues related to technology ownership and transfer.

The new high speed rail system considered for implementation in the Quebec-Ontario corridor is different, technically and in terms of performance, from conventional railway systems.

3.1 Technical Characteristics

Two technologies are being considered throughout the current studies:

- a so-called tilt technology, with a cruising speed of 200 to 250 km/h, to be operated primarily on existing rights-of-way, straightened locally where required. The example used in the studies for this type of technology is the Swedish X-2000.

- a so-called non-tilt technology, with a cruising speed of 300 km/h or over, to be operated primarily on new, straightened rights-of-way. The example used in the studies for this type of technology is the French TGV;

Trainsets would consist of dedicated bi-directional electric multiple units. The TGV unit would be made up of two power cars and eight intermediate trailer cars. The X-2000 unit would be made up of one power car and five trailer cars, the last one being equipped with a cab for push-pull operation.

Whatever the technology, power supplied to the trains would be single-phase alternating current at 25,000 V; this current would be supplied from a series of trackside power substations; these substations would be connected to the Hydro-Quebec and Ontario-Hydro high-voltage networks.

Whatever the technology, power distribution to the trains from the trackside substations would be from an overhead catenary, the current being collected by the train's power cars with a roof-mounted pantograph.

Considering the very high speeds and the need for a very high level of safety, the most modern signalling design and equipment must be used. New signalling, which can perform the functions of automatic collision protection, speed monitoring and control, train monitoring and route control, and others, must be installed on the full length of the line (1200 km). With very few exceptions, if any, grade crossings would be eliminated.

Communications equipment could be high-performance equipment designed for heavy duty service in any comparable application.

Whatever the technology, the system would be operated on new double track. This implies the supply, for the whole project, of approximately 1200 km of new double track. This track requires materials and construction methods that guarantee safety, comfort, reliability, and easy maintainability at high speed.

3.2 Performance Requirements

The different performance requirements stem from the very definition of High Speed Rail and the need to operate high speed passenger services (the cruising speed being 200, 250, or 300 km/h), regularly and frequently, under all weather conditions, and to do so while minimizing operating and maintenance costs.

These performance objectives, impose on all sub-systems, components, parts, and materials, requirements for reliability, maintainability and safety (RM&S) that are different than what Canadian industry has been called on to provide up to now. To achieve desired overall RM&S levels requires more innovative approaches and more stringent quality procedures in the design, engineering, and manufacturing of all HSR components.

3.3 System Requirements

3.3.1 Uniqueness of Each HSR Line

For suppliers of conventional inter-urban passenger rail transport vehicles and equipment, the situation is as if there was a single North American railway network: trainsets are designed to be operated on any line in the continental U.S. and Canada; similarly, fixed equipment could be installed anywhere. Another reason for compatibility of conventional interurban rail passenger equipment is the regulations and industry standards developed for safety. As a result, compatibility is a prime concern in investment decisions as product design can often be recuperated over longer production runs.

This is not necessarily the case in high speed rail, where every line could be considered a system in itself.

When high speed rail (Shinkansen) service was introduced in Japan in 1964, the first line, known as Tokaido (eventually, each new line was given its own name) was operated on standard gauge track (1435 mm), when most of the Japanese network was still on narrow gauge (1067 mm). Later, four other Shinkansen lines were placed in service, the maximum speed increasing from 220 to 240 km/h, each line having specific design criteria which had resulted both from the evolution of HSR capabilities and from the different geo-physical and market characteristics of each line. The high-speed trainsets of a given Shinkansen line are not normally operated on any other line of the high speed network, and can definitely not be operated on the remainder of the Japanese railway network.

Similarly, on the French TGV network, each line is different. The first line, opened in 1981, was designed for operation at 270 km/h. The Atlantique line, opened in 1989, was designed for 300 km/h and different trainsets are operated. The North line, opened in 1994, is designed for 320 km/h operation and its trains are different again. While there is some compatibility (TGV trains can be operated on the medium-speed lines (160 km/h) of the French railway network), each high speed line is optimized for its own geographic and operating conditions and uses its own vehicles.

Thus, from an industrial standpoint, supplying equipment or components for a high speed rail line is much more like supplying equipment or components for a transit line than for conventional interurban transport: equipment for one high speed line is not expected to, and could probably not be used without modification on another line.

3.3.2 Interaction Between Sub-Systems

To achieve the desired levels of performance, cost, and RM&S, and thus optimize the system, a much higher degree of interaction between sub-systems (rolling stock, electrification, signalling, communications and track) is necessary for a high speed line than it is for conventional rail.

In conventional rail, this interaction is normally taken care of by design criteria that each sub-system imposes on some others: for instance, the infrastructure constraints (height and width of tunnels, for instance) are expressed by clearance diagrams, which are imposed on the design of rolling stock; for the car builder, the clearance diagram is given and not negotiable.

In high speed rail, to achieve the desired performance cost-effectively, the interaction between sub-systems must be taken into consideration even in design and engineering and there must often be some mutual adjustment: for instance, to achieve the necessary effectiveness in current collection at a given high speed, the catenary and pantograph must be designed and engineered in close coordination.

3.4 Technology Requirements

Based on the parallel studies, (and terms of reference of this study) the Canadian, Ontario, and Quebec governmental authorities have decided that the implementation of HSR in the Quebec-Windsor corridor inherently implies the need to adopt an existing HSR system. This was done in order to a) minimize risk and b) minimize development and manufacturing costs.

Indeed, given the large investment of resources required to develop a new HSR system, doing so for the Quebec-Windsor corridor, would be time-consuming and expensive. However it would be possible to consider updating the LRC tilt technology, which has been in commercial operation for the last fourteen years in Canada, to consistently operate at speeds that are comparable to other low range tilting HSR systems (180 kph - 200 kph).

3.4.1 Existing System and Component Suppliers

As a result of adopting an existing system, whatever it is, Canada will be faced with established technology suppliers, the most significant being the vehicle technology suppliers.

In the case of the two representative systems selected for study, the existing vehicle technology suppliers, who have designed and built trainsets currently in operation, would be:

- GEC Alsthom, who has supplied TGV trainsets to France and Spain;
- ABB, who has supplied X-2000 trainsets to Sweden.

In the process of developing and building these trainsets, these vehicle technology suppliers have established technical and commercial relationships with vehicle component suppliers.

Furthermore, there are also existing suppliers for all of the other sub-systems: the power supply and distribution sub-system, the signalling sub-system, the communications sub-system, the track sub-system. Again, each of these existing sub-system suppliers has established relationships with component suppliers.

3.4.2 The Requirement for Qualifying Designs and Products

To achieve the required performance, while meeting the target levels of efficiency and cost effectiveness, and applicable safety and other regulations, all components of existing HSR systems were qualified, through a series of appropriate tests, at significant steps in the design, engineering, and construction of the existing systems.

As a result, when implementing a project, any existing HSR system will be required to meet the performance and technical specification that will be particular to the project.

3.4.3 Ownership of Technology

It is sometimes mentioned that companies that have already participated in a HSR project *own the technology* of the sub-system or component that they have supplied.

This does not always imply that, as in intellectual property, these companies have patented that sub-system or component and have thus obtained formal rights to its technology, and that any interested party could obtain access to it simply by paying the applicable patent rights to the appropriate Patents owners.

Often, in most cases, the sub-system or component has not been patented, as the degree of technological (or other) innovation in it did not justify the granting of a formal patent.

In fact, the ownership of that technology, although quite real, is informal rather than formal, and is due to economics rather than to law.

As these companies have invested significant time and funds in the development of the necessary technology and in the qualification of their component or sub-assembly for HSR, they have placed themselves in a privileged position so that, for another HSR application, other suppliers could not easily develop a substitute product, qualify it, and still offer it at a price that is competitive with the existing product.

For the entrant HSR supplier obtaining, through negotiation and technology transfer, access to the technology of an existing component or assembly, is in some cases more cost-effective than developing a new product or even proceeding through a qualification process.

3.5 The Technology Transfer Process and its Constraints

As relevant and significant as may be the capabilities of Canadian industry in the field of railway passenger transport equipment, strictly speaking, no Canadian manufacturer has yet been involved directly in the production of equipment to the high speed requirements of the systems being evaluated under the terms of reference of the current studies.

Although Canadian manufacturers do work to the same quality standards as the European builders work to, they do not necessarily possess, at present, the full range of technology (engineering and industrial know-how, manufacturing equipment, qualified manpower etc.) required. Technology transfer appears to provide some means for rapidly accessing the necessary technology level. However, based on the definition of technology transfer, for most Canadian component manufacturers (up to 73%) this transfer could consist of a minimal level of technical assistance and the acquisition of necessary drawings and tolerance specifications from the prime sub-system suppliers.

3.5.1 Commercial Control over Existing HSR Systems

In the case of the TGV, the system designer was French Railways, SNCF. The TGV trainsets were developed, engineered, and built by GEC-Alsthom under the guidance of SNCF. Numerous materials and component suppliers developed and qualified their products for the TGV. SNCF designed the power supply, power distribution, signalling, and communications sub-systems, for which equipment was developed and qualified by industrial manufacturers. Other railway suppliers developed and qualified specialty products such as rail fasteners, high-speed turnouts, etc. The infrastructure for the new lines was designed by consulting engineers under SNCF guidance and built by construction companies.

In the case of the X-2000, the system designer was Swedish Railways, SJ. The X-2000 trainsets were developed, engineered, and built by ABB; numerous materials and component suppliers developed and qualified their products for the X-2000. SJ designed the power supply, power distribution, signalling, and communications sub-systems, for which equipment was developed and qualified by industrial manufacturers. Other railway suppliers also developed and qualified specialty products.

3.5.2 Existing Technology Transfer Agreements

The only known agreement involving representative technologies is the one between GEC-Alsthom and Bombardier. The objective of this agreement is the joint marketing and production of the TGV in North America (Canada, U.S. and Mexico) for North American markets. A clause of this agreement requires that the responsibilities and revenues be split equally between the two partners.

As for the X-2000, there is no known technology transfer agreement or corporate commitment whereby a given proportion of the X-2000 for a Canadian application would be manufactured in Canada, although one may surmise that, given that ABB already operates manufacturing facilities in Canada, a proportion of the manufacturing would be allocated to those facilities.

As far as is known, there are no other existing technology agreements, although, in the survey of Canadian Manufacturer (see section 5), some firms suggested that they might currently be active in that area, without being very specific.

Finally, as confirmed by the surveys, our understanding is that there are no other constraints or institutional limits to technology transfer.

3.5.3 The Need to Involve Canadian Suppliers

If a system is implemented in the Quebec-Ontario corridor, its major sub-systems could, in concept, be ordered directly from the existing technology suppliers, and this could possibly result in the lowest financial cost for acquiring these sub-systems.

But, as the industrial benefits to Canada of such an approach would be minimal, the proposed approach, and indeed the reason for the present study, is instead to maximize Canadian content through the active participation of Canadian suppliers.

Canadian suppliers can only participate if they can guarantee that their products will contribute to meeting the performance requirements outlined previously. Their products must be qualified.

If an existing HSR system were implemented in Canada exactly as it was last built by its existing suppliers, then all its components would be considered as qualified. Any proposed substitute component would have to be qualified also, by passing with success all the necessary tests.

However since all existing HSR system are expected to be implemented instead with some modifications or redesign to meet new technical or performance specification, all components involved in or potentially affected by these modifications would have to undergo a new qualification process, to demonstrate that they meet the modified requirements. Opportunities for the qualification of Canadian manufactured components will exist with the introduction and impact that each modification has on the existing system.

In some cases, qualification might be relatively easy. In other cases, where the required performance is significantly in excess of that currently required for conventional rail, the qualification process might be quite involved and expensive.

In those cases, obtaining the technology from a European supplier might be the preferred alternative, as it would save time and costs. Indeed, in some cases, technology transfer may well be the only means for a Canadian supplier to qualify for HSR in a reasonable amount of time, with a reasonable investment.

3.5.4 The Object of Technology Transfer

Strictly speaking, technology transfer should be required for every single component of the system that is specifically designed for high speed.

This should not be construed to imply that technology transfer is a major hurdle for each and every of these components. Indeed, in some cases, the difference between current Canadian products and corresponding products for HSR is not major, resulting in a straightforward transfer of drawings by the prime. In other cases, the difference is much greater, making the technology transfer more difficult and mostly, more costly. For illustration purposes, tables 3-1 and 3-2 highlight some of the difficulties for a HSR locomotive and a trailer car by assigning a difficulty index to each major component or sub-assembly.

These indices were assigned to each component based on detailed discussions with the technology owners and detailed information on potential Canadian counterparts based on the results of the survey. They reflect both the technical and commercial constraints to technology transfer, although, as already stated, these difficulties are more of a commercial than technical nature. They result from the investments in engineering, manpower and methods development, and qualification, made by the technology developers or component suppliers for the initial HSR systems.

There is rather little however in high speed technology that, with time and investment, that Canadian manufacturers could not master.

Table 3-1
Technology Transfer Difficulty Index for Locomotive Components

	X2000 Techn.	TGV Techn.
Components		
Truck Frame	2	3
Wheel sets	2	2
Truck Assembly	1	1
Pantograph	2	3
Main Transformer	2	2
Power Conditioning	2	2
Gears	2	2
Traction Motors	2	3
Control Electronics	3	3
Brakes	1	1
Brake Control	2	2
Air Compressor	1	1
Primary Suspension	2	2
Secondary Suspension	3	3
Traction Link Assembly	1	2
PCU for Auxiliaries	1	1
Engineering & PM	2	1
Materials & Supplies	1	1
Carbody Fab. & Assembly	1	1
Vehicle Assembly & Test	2	2

In the tables 3-1 and 3-2, the difficulty indices imply the following meaning;

3: Transfer is very difficult

It is estimated that between 10% and 20% of the value of components are included in this category. These components are sometimes referred to as being **noble** or **proprietary** and would not make any economic sense to try and transfer their technology. This category could be defined as follows;

> - there is a significant difference in technology levels between the technology supplier and a potential Canadian counterpart; the supplier has made substantial investments to develop the technology; the market for this component is very limited in relation to the required investment; the opportunities for joint ventures on this specific component (or related business) appear very limited.

2: Transfer presents some difficulty

This category represents between 10% and 20% of the value of components. The technology can be transferred but with some cost and effort. It can be defined as follows;

> - there is a difference in technology levels between the technology supplier and potential Canadian counterpart; the supplier has made considerable investments to develop the technology; the market is not large in relation to the required investment; there appears to be opportunities for joint ventures on this specific component (or related business).

1: Transfer presents only minor difficulties

This category represent the majority of HSR components, between 70% and 75% of the systems or sub-systems value. The transfer of the technology in these categories could require only drawings, tolerance specifications or at most some training and supervision. This category could be defined as follows;

> - there is no notable difference in technology levels between the technology supplier and Canadian manufacturers; the supplier has already recovered a substantial proportion of the investments made to develop the technology; the market is sufficient to justify required investment (if any).

Table 3-2
Technology Transfer Difficulty for Trailer Car Components

Components	X2000 techn.	TGV techn.
Truck Frame	3	3
Wheel sets	2	2
Truck Assembly	1	1
Brakes	2	2
Brake Control	2	2
Air Compressor	1	1
Primary Suspension	1	1
Secondary Suspension	2	1
Inter-car Sub-Assembly	1	2
Seats	1	2
Windows	1	1
Door Operators	1	1
HVAC	1	1
Lighting	1	1
Toilet systems	1	1
Batteries	1	1
Flooring & Carpeting	1	1
Inside walls	1	1
Engineering & PM	2	1
Materials & Supplies	1	1
Carbody Fab. & Assembly	2	1
Vehicle Interior Finish	1	1
Vehicle Assembly & Test	2	1
Trainset Assembly & Test	2	1

Although there would be a cost associated with technology transfer, specifically for level 3 and 2 difficulty, this cost cannot be quantified. The cost for technology transfer would in part be negotiated and the agreed value would result from a variety of factors. Given the nature of the exact agreement; these factors include:

- the importance of the investment (in engineering, machines, manpower, etc.) made by the technology developer;

- the extent to which that investment has been (or is likely to be) recovered by the technology developer, in the HSR or a related market;

- the difference in levels of technology between the technology owner and a potential Canadian counterpart;

- the corresponding requirements for a Canadian counterpart to invest in manufacturing equipment, training, qualifying, etc.

- the load factors and backlogs of the supplier's and counterpart's engineering services and manufacturing facility;

- the past, present, and future opportunities for joint ventures between the supplier's and counterpart, in the HSR and/or other fields;

- other potential uses for the technology to be acquired through transfer; other advantages from acquiring the technology.

3.5.6 The Process and Challenges of Technology Transfer

Technology transfer, as described for level 2 and 3 of difficulty, would take place in the context of a commercial agreement whereby;

- based on a lump sum payment and/or royalties and/or other considerations, a European company, having already designed and/or supplied qualified sub-assemblies or components to an existing HSR systems will provide, to a recipient Canadian company: engineering drawings documentation, and specifications; tooling and manufacturing assistance; on site training by specialists, etc.;

This will enable the Canadian company to produce sub-assemblies or components that would be in full conformity with the Quebec-Ontario HSR project specifications, and would thus be qualified to be incorporated into the manufacture of the system.

It should be stressed that technology transfer is not an all-or-nothing proposition. The fact that there exists a valid technology transfer agreement does not imply that the Canadian counterpart will manufacture 100% of the component, sub-assembly or material covered by the transfer agreement.

But it should not be overlooked that technology transfer, particularly for level 3 of difficulty, pose some challenges. Some of these are:

- to maintain a commercial competitive advantage, the technology developer may refuse altogether to transfer the technology;

- the technology may be so complex that its transfer to a less sophisticated recipient would entail too many risks of degrading performance;

- the costs involved (such as for acquiring manufacturing equipment and/or developing technical resources) may be so great as to make technology transfer uneconomical to the recipient firm.

3.5.7 Expected Strategies of Technology Suppliers

In developing an HSR industrial strategy for Canada, it appears useful to identify the strategic considerations available to European (or other) holders of HSR technology when they look at the North American market:

- the U.S. market appears to be much larger than the Canadian market, and thus is the primary commercial target;

- ideally, the HSR supplier would prefer to supply everything from its home base, but this is not possible if the Buy America Act applies in the U.S. and they must compete for the Canadian project on the basis of providing industrial benefits;

- when concluding agreements, the HSR supplier would try to do so on a project by project basis to maintain as much flexibility as possible for future projects;

- it is important to have its technology be the first to be used in a North American (especially U.S.) HSR applications: this may be called the *Showcase Effect*.

4.0 Research and Development

For this HSR project, R & D can be characterized as:

- the need to adapt HSR technology to North American standards and climatic conditions;

- on-going work to further develop the technology in terms of speed, safety, comfort and cost-effectiveness.

The mandate of this study is to evaluate the industrial benefits related to adaptive R&D for the Quebec-Ontario HSR project.

4.1 Adaptive R&D Projects and Costs

Based on information provided by the parallel studies and this consortium's expertise and experience, an estimated 40 R&D projects have been identified that would be required in order to adapt an HSR system to the standards, norms and climatic conditions found in the Quebec-Ontario corridor. A complete listing of these R&D projects is presented as part of appendix E. These projects provide an indication of the variety of unknowns that must be explored and some of the specific detail that must be undertaken at the outset of the Q/O HSR project.

In order to determine the total cost of this adaptive R&D, 23 of the identified projects were estimated in detail. This detailing of their cost breakdown is provided in Appendix E. These 23 projects are considered representative of the magnitude of the R&D work that would be required. Based on the detailed cost breakdown of these projects, a total adaptive R&D cost estimate has been derived by taking an average cost per project in terms of manpower and materials, adding some lab costs and specialised equipment purchases.

As can be seen in table 4-1 below, total adaptive R&D cost has been estimated at roughly $19.7 million (Cdn) of which $13.1 million are labour costs. These R&D expenditures would be added to construction and operating costs estimated in the parallel study reports and would be shared by both the project manager and the primes responsible for each sub-system. Borrowing from the Canadian content analysis (see section 6), it is assumed that 95% of the labour costs and 85% of the material costs would be domestic.

Table 4-1
Cost of Adaptive R & D Projects

Sub-Systems	Senior	Total	Project Cost
	Personnel		
	(Person Days)		
ROLLING STOCK	2,091	4,799	5,820,000
ELECTRIFICATION	1,627	3,068	3,515,000
TRACK AND ROADBED	1,113	2,326	2,322,000
SIGNALLING & COMMUNICATION	308	719	747,000
BRIDGES & STRUCTURES	425	881	725,000
TOTAL LABOUR COSTS	5,564	11,793	13,129,000
TOTAL MATERIALS			6,564,000
TOTAL ADAPTIVE R&D COSTS			19,693,000

5.0 Assessment of Canadian Capabilities Relative to HSR

The objective of this section is to present the results of the analysis performed to determine whether Canadian industry has the capabilities for actively participating in the Canadian HSR project.

This section describes in greater detail the Canadian capability to manufacture the required componentry and compete effectively in this industry. The results of our interviews with selected firms are presented and the ability of Canadian industry to absorb (as well as develop) HSR technology is also addressed.

5.1 Participants in the Design and Construction of a HSR System in Canada

Table 5-1 presents a typical distribution of responsibility for designing and building an HSR system. These tables are based on what has happened in other countries in the case of new HSR lines. It is also representative of current practice in North America and would reflect what would be the case for a Canadian HSR project.

Table 5-1 identifies four major groups of actors in implementing an HSR project. These are:

<u>The System Client</u>

In conventional rail, the system client would normally be the railway or project manager acquiring the rolling stock.

In the case of HSR, the client might be a consortium of railways, a group of governmental agencies, or a mixed group of government agencies and railways. Whatever its composition, the system client would be responsible for designing the system and for formulating performance specifications, standards and criteria for all sub-systems.

The system client would be responsible for specifying the requirements for adapting the chosen foreign HSR technology to Canadian climatic and operating conditions;

Consulting Engineers

In conventional rail, engineering is most often the responsibility of the railways' engineering departments.

In an HSR project, considering the amount of engineering to be done in a relatively short amount of time, Canadian consulting engineers would also be involved in the project.

Construction Companies

In conventional rail, infrastructure and track construction are generally contracted out by the railways, as they are not regular on-going activities and the railways do not maintain construction staffs.

In the case of HSR, most of the work would also be done by construction companies, except perhaps some very specialized work, such as track laying, which would probably be done by the railways using specialized equipment that they own.

Industrial Manufacturers

In HSR, equipment is to be industrially manufactured by specialized firms.

This is also the case in conventional rail, today, as railways do not manufacture their own equipment as they did in the past.

Table 5-1
Distribution of Responsibility for HSR Design and Construction

Sub-system	Component	Responsibility
System Design		
System Design		System Client
Electrical and Mechanical Sub-Systems		
Vehicle		Industrial Manufacturers
Power Supply and Distribution	Sub-System Design	Consulting Engineers
	Power Supply Equipment	Industrial Manufacturer
	Power Distribution Equipment	Industrial Manufacturer
	Catenary and Sub-station Construction	Construction Company
Signalling	Sub-System Design	Consulting Engineers
	Track Signalling Equipment	Industrial Manufacturer
	Central Signalling Equipment	Industrial Manufacturer
	Construction of Track Signalling	Construction Company
Communications	Communications Equipment	Industrial Manufacturer
Infrastructure		
Track	Track Design	Consulting Engineers
	Roadbed and Track Foundation	Construction Company
	Rail	Industrial Manufacturer
	Concrete Ties	Industrial Manufacturer
	Elastic Fasteners	Industrial Manufacturer
	Switches and Other Track Equipment	Industrial Manufacturer
	Track Laying	Existing Railway
Bridges and Structures	Structural Design	Consulting Engineers
	Construction	Construction Company
	Mass-Produced Components (i.e. Beams)	Industrial Manufacturer
Yards and Shops	Sub-System Design	Consulting Engineers
	Equipment	Specialized Manufacturer
	Construction	Construction Company
Stations	Sub-System Design	Consulting Engineers and Planners
	Construction	Construction Company

5.2 Capabilities of Consulting Engineers and Construction Companies

There is generally little doubt that Canadian consulting engineers and the engineering departments of Canadian railways have the necessary capabilities for taking responsibility for the activities for which they have been identified in Table 5-1; for some very specific aspects, they would solicit the technical assistance of railways experienced in HSR.

There is generally little doubt that Canadian construction companies have the capabilities for taking responsibility for the activities for which they have been identified in Table 5-1; again, for some very specific tasks, they would solicit the technical assistance of foreign construction companies or consultants experienced in HSR.

5.3 Manufacturing Firms: Results of Survey

Generally speaking, it can be assumed that Canadian industrial manufacturers in the passenger railway industry, and possibly in other high-technology industries also, have the capabilities for assuming responsibility for the activities for which they have been identified in Table 5-1.

However, as these manufacturers are not currently supplying products for HSR, the question may be raised as to whether these manufacturers would experience any difficulty in manufacturing qualified HSR components and sub-systems.

To answer this question, and other questions relevant to their industrial capabilities, a survey of representative manufacturing firms was conducted as part of the present study. Firms were considered as representative if they were currently active in the passenger railway industry and supplying high-level components manufactured in Canada. It was attempted also to have firms involved in every sub-system, and to seek a balanced geographic distribution of manufacturing facilities. The sample chosen was also deemed representative in terms of production capacity.

In conformity with the survey plan, the firms interviewed cover the full range of responsibilities outlined in Table 5-1; they include: an active car builder and a prospective car builder; a locomotive builder; many suppliers of vehicle components and materials; several firms producing power supply equipment; power distribution equipment; signalling equipment; communication equipment; rail and track equipment. A list is provided in Table 5-2

Most firms contacted were interested in participating in the interview and were very cooperative, with the exception of a small number of firms which might be considering participation in the Canadian HSR projects with firms other than those offering the two systems being studied.

Of the firms for which an interview was completed relevant to the following issues;

- 14 are independent Canadian corporations of various sizes; 6 are subsidiaries of larger Canadian corporations or holdings; 10 are subsidiaries of U.S. corporations; 10 are subsidiaries of European companies.

- 33 are already active in the Canadian railway industry, supplying their materials, components, or sub-systems to the Canadian railways or to Canadian rail transit authorities directly or (in the case of vehicle component manufacturers) through the car builder or locomotive builders. The products supplied are manufactured in these firms' Canadian facilities; the Canadian content of these products varies from 50% to 100%, the typical range being 70% to 80%.

- 25 are already active in the passenger railway industry in the U.S.A., supplying their materials, components, or sub-systems to American railways or to American regional and urban rail transit authorities: directly or (in the case of vehicle component manufacturers) through the car builder or a locomotive builder active in the U.S. The products exported are also manufactured in these firms' Canadian facilities; the Canadian content of these export products is generally 20% to 30% lower than when the same products are supplied to the Canadian market.

- 21 firms have North American mandates for some HSR products but most firms perceive the Buy America Act (BAA) as well as the Women's Business Enterprise (WBE) and Disadvantaged Business Enterprise (DBE) acts as obstacles to penetrating the U.S. market;

- 26 firms have recent and relevant experience with technology transfer, 6 firms stated that no technology transfer is required;

- 18 firms currently maintain business relationships with suppliers to current HSR projects. Of the remaining, 8 invested resources in market research, search for alliances or undertook or plan relevant R&D;

Table 5-2
List of Manufacturing Firms Interviewed

Sub-System	Manufacturer	Location of Facility
Car Builders	Bombardier	La Pocatière (Quebec) Thunder Bay, Kingston (Ontario)
	AMF	Montreal (Quebec)
Locomotive Builders	GE Locomotives	Montreal (Quebec)
	General Motors	London (Ontario)
Vehicle Components	Vapor Canada	Montreal (Quebec)
	Canada Alloy Castings	Kitchener (Ontario)
	Unigear Industries	Baie d'Urfe (Quebec)
	Railtech Inc.	Baie d'Urfe (Quebec)
	Field Aviation	Mississauga (Ontario)
	Atlas Alloys	Pointe Claire (Quebec)
	Ingersoll Rand	Kirkland (Quebec)
	Goodfellow	Delson (Quebec)
	Quebec Gear Works	Saint-Laurent (Quebec)
	Westinghouse Canada	Burlington (Ontario)
	Protectolite	Don Mills (Ontario)
	Forges CSW	Montreal (Quebec)
	WABCO Canada	Hamilton (Ontario)
	Bach-Simpson	London (Ontario)
	Fibrex	Terrebonne (Quebec)
	Pan-Acc Transit Equipment	Dorval (Quebec)
	National Electrical Carbon Canada	Mississauga (Ontario)
	Groupe Multina	Drummondville (Quebec)
Power Supply & Distribution	Ferranti Packard	St. Catherines (Ontario)
	ABB	Varennes (Quebec) Guelph (Ontario)
	Kearney National	Saint-Leonard (Quebec)
	Insul-8	Saint-Jerome (Quebec)
	Markham Electric	Markham (Ontario)
	Siemens Electric	Pointe-Claire (Quebec)
	Cegelec	Laprairie (Quebec)
	Alcatel Canada Wire	Dorval (Quebec)
	GEC Alsthom Energie	Laprairie (Quebec)
Signalling & Communications	Signarail	Brossard (Quebec)
	Phillips Cables	Brockville (Ontario)
	Motorola	Dorval (Quebec)
	Northern Telecom	Lachine (Quebec)

Track Equipment	Alfex	Saint-Jerome (Quebec)
	Algoma Steel Corporation	Sault Sainte-Marie (Ontario)
	Pandrol Canada	Anjou (Quebec)
	Hovey Industries	Gloucester (Ontario)
Others	Dominion Bridge	Montreal (Quebec)

All of the firms interviewed have qualified or are in the process of qualifying themselves to the prevailing standards where they operate, be they AAR, CSA, ISO 9002, ISO 9003, etc.

The firms interviewed are prepared to consider technology transfer and envision no major technical problems. The firms also report that there are no institutional constraints to technology transfer. None of these firms is now, due to its corporate status, in a position that would prevent it from entering into a technology transfer agreement with a technology supplier of the two systems under study.

As for commercial constraints to technology transfer, these firms are aware that its financial and commercial conditions will result from firm-to-firm negotiations, and that the outcome of these negotiations will be influenced by prevailing market and economic conditions (the cost benefit factor relating to make or buy in Canada), as well as any institutional (such as local content requirements) and other constraints. Consequently, it is difficult and somewhat unrealistic on their part to try and evaluate the future commercial costs of technology transfer, at this point.

All of these firms have indicated that their existing manufacturing facilities have sufficient capacity to handle their participation in the Canadian HSR project. They have also mentioned that their manpower possesses the necessary skills and that significant training or re-training would not be necessary.

Depending on the material, component, or sub-system, there might be some investments required for production initiation, such as for tooling (particularly for moulded or cast parts), reaching 20 million dollars in the case of a rail manufacturer. From their preliminary market analysis and/or the information supplied to them in the interview, the firms report that any required investments would be commensurate with the expected volume of components and corresponding revenues from their participation in the HSR project.

Although these impressions were provided to us on the basis of the Quebec-Windsor corridor being implemented, and an initial estimate for the supply of 30 trainsets, different project routing scenarios, such as a Montreal-Toronto stand alone, would have no affect on our survey results or conclusions. In fact, the number of trainsets estimated for the Montreal-Toronto scenario will require up to 37 trainsets which would only reinforce the findings of our survey.

5.4 Manufacturing Challenges & Opportunities

This section addresses, in more detail, the manufacturing challenges posed by HSR and indicates the capability of Canadian industry for responding to those challenges.

5.4.1 Vehicles

Table 5-3 presents a typical distribution of responsibility for designing and building vehicles for a HSR system. The distribution of responsibility for a Canadian HSR would be similar.

Table 5-3
Distribution of Responsibility for Designing and Building HSR Vehicles

Sub-sub-System	Component	Responsibility
Vehicle Engineering	Systems Engineering	Car Builder
	Manufacturing Engineering Design Qualification	Trailer Cars by Car Builder, Power Cars by Locomotive Builder
Car Body Shell	Structural Engineering Parts Fabrication Shell Assembly	Trailer Cars by Car Builder, Power Cars by Locomotive Builder
Truck or Bogie	Structural Engineering and Frame Construction	Truck Builder or Car Builder
	Truck-Mounted Components	Component Suppliers
	Testing and Final Assembly	Truck Builder or Car Builder
Major Components	Design and Engineering	Component Suppliers
	Integration to Vehicle	Trailer Cars by Car Builder, Power Cars by Locomotive Builder
	Production	Component Suppliers
Power Cars	Final Assembly Vehicle Testing	Locomotive Builder
Trailer Cars	Final Assembly Vehicle Testing	Car Builder
Assembled Train	Final Assembly Unit Testing	Car Builder

Assuming access to the design, and possibly (but not necessarily) assistance in a small number of highly specialized areas, the Canadian car builder could assume the responsibilities identified for it in Table 5-3.

As for locomotive builders, they would also need to have access to the appropriate designs. Furthermore, they might need somewhat more technical assistance, especially in engineering and testing, as they have not recently produced any all-electric locomotives, nor locomotives of such power and performance as would be required.

As for component suppliers, as far as is known, no Canadian firm is currently supplying components for any HSR system. Consequently, any Canadian firm interested in supplying its products to the Canadian HSR would need to qualify all of them, to ensure the necessary performance and RM&S levels.

Canadian component suppliers could probably do this more cost-effectively by offering already-qualified products for which they would have obtained the technology from existing foreign HSR component suppliers.

This does not imply that some Canadian component manufacturers might not be capable of designing, developing, and qualifying their own products and offering them at a lower price. This occurred recently when Pocatech of La Pocatière (Quebec) and Tech Rep Industries of Saint-Laurent (Quebec) developed, for the high-technology metro train being supplied by Bombardier to the New York MTA, a door operating system and controls for an on-board monitoring system, respectively, that equalled or surpassed the performance of those of established manufacturers in addition to being cost-competitive.

5.4.2 Power Supply and Distribution Equipment

Although different in their design, power supply sub-stations for an electrified railway, even high speed, use a substantial proportion of components that are also used in conventional sub-stations that are the nodes of electricity transport and distribution networks.

Consequently, some of the power supply equipment manufacturers identified in section 2.3.5 and Appendix F could, from a technical standpoint, engineer and manufacture power supply equipment for a Canadian HSR, based on specific sub-station design by Canadian consulting engineers. The power supply system made up of these components would have to be qualified for HSR by demonstrating that it can supply current to the catenary at the required electrical and performance standards.

As for power distribution equipment, a catenary for an electrified railway uses a large number of components (such as wires, insulators, poles, etc.) similar in concept to those that are currently used in the overhead lines of electricity distribution networks.

Consequently, the identified Canadian power distribution equipment manufacturers could, from a technical standpoint, manufacture the necessary power distribution equipment for HSR. The power distribution system made up of these components would have to be qualified for HSR by demonstrating that it can supply current to the trains at the required electrical and performance standards.

Canadian industry has taken responsibility and supplied componentry for two of the three railway electrification projects in North America in the last 20 years (Tumbler Ridge and Deux-Montagnes). Although not specifically for high speed systems this experience, along with Canada's expertise in the design and manufacture of high voltage transmission and supply equipment, should provide some advantage to Canadian suppliers and manufacturers.

5.4.3 Signalling Equipment

Signalling equipment may pose some specific technical and commercial challenges:

- first, although the equipment to be provided is complex, due to the numerous functions of this required sub-system, equipment for HSR would be closer, in design and concept, to that of a transit system than to that of a conventional railway. Due to its operating conditions (exposed to the weather, spread over long distances), that equipment would also have to possess some of the sturdiness of conventional railway signalling equipment,

- second, the existing Canadian manufacturing capability is limited, due to the small number of fully-signalled transit systems in Canada. This has not provided sufficient financial incentives to develop Canadian capabilities for the design, engineering, and complete manufacturing of that type of equipment, but only for limited assembly,

- third, the Canadian industry is dominated by foreign multinationals.

To take a more active role in the production of equipment for HSR (than for conventional railway or transit equipment) Canadian suppliers of railway signalling equipment would probably need a greater degree of technical assistance or (R&D) than is the case for other sub-systems.

Opportunities for Canadian manufacturing in this area might also be available especially if North American railway communications norms and standards are to be developed for North American under ATCS (Automatic Train Control Systems) [although their is still some controversy regarding ATCS's adoption as a standard]. A distinctive technology that would satisfy these norms and standards and which could meet various HSR performance specifications set for each project, would be well positioned to compete for North American HSR projects.

5.4.4 Communications Equipment

Communications equipment for HSR does not differ significantly from specialized heavy-duty communications equipment already produced by several Canadian firms. This sub-system would present no technical capability problem.

5.4.5 Track and Track Equipment

As concluded in the parallel study reports, whatever the technology, the system would be operated on new track consisting of long welded rail, attached to concrete ties with elastic fasteners. This track requires materials and construction methods that guarantee safety, comfort, reliability, and easy maintainability under high speed operation. The precision of manufacture and installation currently exceeds Canadian practice.

As a result, laying track for HSR requires changes in construction methods, but does not cause a major problem for the supply of rail. Current Canadian suppliers of rail and rail equipment (such as rail welding supplies) could adapt their operations to the specific technical requirements of rail for high speed.

Concrete ties are not being manufactured currently in Canada for lack of demand, but this is not a major technical problem, as a manufacturing plant was operated recently in Western Canada for a major construction project.

As for elastic fasteners, some components have been manufactured in Canada in the past, but never the complete fastener. From a technical standpoint, the same manufacturers, given access to design and some production equipment, would be capable of producing the complete fastener.

Similarly, the high-speed turnouts necessary for HSR were never required in Canada: the necessary capability does not exist. But, from a technical standpoint, existing Canadian manufacturers of conventional turnouts, given access to design and some production equipment, would be capable of producing high-speed turnouts.

5.5 Design and Engineering Challenges and Opportunities

In most cases, the greatest technical challenges to Canadian industry would be probably related to designing and engineering the equipment, consisting of:

- systems design, to ensure the proper interface of the equipment with others as needed; this may include safety, reliability, and maintainability analysis and studies;

- conceptual and detailed design, if new equipment is being designed (alternatively, design could be obtained through technology transfer, but would have to be mastered and possibly adapted);

- detailed engineering (including prototype construction if required);

- design qualification and testing, to demonstrate that the proposed design meets the applicable requirements;

- manufacturing engineering and process design, to ensure that the part or component will be produced cost-effectively in full conformity with the design;

- quality assurance and control, to ensure that every part or component is indeed built according to design and thus meets all the applicable specifications.

Canadian manufacturers already in the passenger railway industry are used to these procedures and requirements; so are manufacturers now operating in similarly demanding industries (such as aircraft construction).

Smaller manufacturers are usually not faced with such requirements and, consequently, do not possess the design and engineering resources to face them.

5.6 Development of Canadian Primes

In order to take on prime responsibility for a sub-system for a HSR project, certain criteria is required, including having sufficient assets on which an insurance bond can be obtained, sufficient related experience and expertise etc..

It would be possible to have a Canadian company, consortium or alliance that would meet these criteria and take prime responsibility for the Canadian project with respect to each of the following sub-systems;

Signalling

Although Canadian industry is dominated by foreign multinationals in this sector, some Canadian companies, such as Glenayre Electronics in British Colombia in alliance with other companies, as well as some foreign companies with world product mandates, would have the experience and technical capabilities to take on the responsibility of a prime for this sub-system. Canada has already achieved some recognition as a leader in automatic signalling and control systems and has had export success. The SEL-Alcatel system developed for the Vancouver Skytrain for example has been exported to the U.S., England, Turkey and Malaysia.

Canada also possesses many advanced capabilities with respect to technologies, such as long range sensing and satellite technology, which could be used (amalgamated) in the development of a new advanced HSR signalling technology. A technology that could conform to North American standards as well as satisfy performance and safety specification for an HSR system as a whole. A sub-system such as this could be commercially implemented, proven and controlled by a Canadian signalling Prime.

Although there are certain hurdles to commercially developing, implementing and operating a state-of-the-art HSR signalling sub-system that would utilize satellite and long range sensing technologies, the potential gains in industrial benefits would justify attempting to overcome these hurdles.

Electrification

A Canadian prime consisting of an alliance or consortium of consulting engineering companies and electrical system designers could effectively compete to undertake the Canadian project. Based on the experience of the recent Deux Montagnes and New Haven electrification projects, some foreign expertise relative to catenary design or to insure an effective interface with the pantograph could be required. This could either be done with inclusion into the consortium or by a consulting contract.

Communications

Canadian companies such as Northern Telecom or a Canadian based foreign multinational who could acquire a world product mandate for HSR communication systems, could be awarded prime responsibility for the Canadian project with respect to this sub-system. As with signalling, it would be possible to develop, for the Q/O HSR project, an HSR communications technology that would be distinctively Canadian while at the same time would conform to North American standards and protocol as well as satisfying performance specifications.

Track & Infrastructure

As previously stated, Canadian construction and consulting engineers have the required capabilities and experience to take on the prime responsibility for all infrastructure construction for the Quebec-Ontario HSR project.

Each of the primes for signalling, electrification and communications could, once having gained experience with the Canadian project, conceivably compete in the U.S. and other foreign markets. This will be discussed in more detail as part of the market study in Section 8 of this report.

6.0 The Canadian HSR Project

This section provides a description of the Quebec-Ontario HSR project relative to its requirements for manufactured componentry, the domestic content of this componentry as well as a split between provinces of where this Canadian domestic manufacturing activity will likely emanate.

6.1 Canadian Content and Distribution Between Provinces

As is evident from the discussion in section 5.0 above, there is a capability in Canada to supply components and sub-assemblies for the Quebec-Ontario HSR project. It has also been determined that Canadian companies or consortiums could take prime responsibility for the supply and construction of most sub-systems.

To date we have identified over 250 companies in Canada that could manufacture components, supply materials and assemble and construct sub-systems. A complete list is contained in Appendix F.

The tables provided below reflects our assessment of the Canadian content relative to manufactured componentry (above the rail bed) and the expected distribution of this industrial production between Quebec, Ontario and the Rest of Canada (ROC). This is done for both representative technologies including 200 km tilting technology or the 300 km-plus non-tilting technology.

As can be seen from tables 6-1, the percentage of Canadian content is anticipated to be 85% for both the 200 Kph and 300 Kph systems from the manufacture of componentry for the construction and operation of the Quebec-Ontario HSR project. These percentages reflect what is considered to be the expected Canadian participation in the project after an effective competitive and negotiating strategy has been implemented. A more detailed breakdown of this assessment is presented in table 6-2 and 6-3.

As reflected in the tables, and in the methodology description prepared below, the Canadian content percentages were calculated based on the known foreign content of each component, assembly or sub-assembly. An initial Canadian content of 73% was derived based on present Canadian manufacturing capacities and experience. This was considered a base case to which our assessment of Canadian HSR capabilities as well as our assessment of technology transfer opportunities, was added.

Table 6-1
Distribution of Industrial Production of the Q/O HSR Project

	Foreign Imports	Canadian Content	Quebec	Ontario	ROC
Power Car	22%	78%	36%	42%	
Trailer Car	12%	88%	44%	44%	
Power Supply	14%	86%	43%	43%	
Power Distribution	10%	90%	45%	45%	
Signalling	30%	70%	26%	44%	
Communications	20%	80%	40%	.40%	
Track & Equipment.	13%	87%	15%	47%	25%
Total Manuf. Compon.	**15%**	**85%**	**35%**	**45%**	**5%**

For purposes of interpretation (and to be consistent with the language used in section 3) the 73% base figure could be viewed as componentry technology that is easily transferred or does not require any transfer (difficulty level 1). The difference between the base case percentage and the expected 85% (roughly 12%) could be viewed as the technology that can be transferred with some difficulty (difficulty level 2). The remaining percentage (roughly 15%) of foreign content can be viewed as noble and proprietary components (difficulty level 3) which would likely not be transferred.

The costs associated with increasing the Canadian content above the base case of 73% to reach 85% cannot be estimated for the same reasons outlined in section 3.5.4. However, these costs should be minimal as it is anticipated that with a proper competitive environment, and depending on the timing of the project, the affected primes, manufacturers and suppliers, will be prepared to absorb most of these costs. As revealed in our industry survey, most firms considered these costs to be commensurate with expected returns on this and other projects.

After using the same methodology to derive the domestic Canadian content for both representative technologies, it was discovered that they both provided roughly the same percentages. This is understandable if it is considered that no matter which prime gets the contract, it will face the same options and choices regarding Canadian production establishments, including the choice of power car and trailer car assembler. It should also be considered that once an industrial sector acquires the capabilities that Canada has attained, assessment of domestic content becomes more a function of understanding and measuring the constraints as opposed to the opportunities; constraints which are faced equally by both of the technology representatives.

As discussed in the first interim report, it must be considered that some cost premiums could result due to imperfect competition in this Canadian economic sector. Certain cost premiums could also result if some of the major manufacturers or assemblers were operating at full capacity at the time the production orders were given. Again we expect that there will be no (or at most minimal) cost increases resulting from either of these situations if the primes are allowed to maintain some flexibility with respect to choosing component manufacturers. Also Canadian firms that were surveyed have indicated that they have the production capacity to take on this project without requiring any major investment.

In terms of the distribution of the expected domestic production (industrial benefits) between provinces, it has been estimated that, for both representative technologies, roughly 35% will be produced in Quebec, 45% in Ontario and 5% in the Rest of Canada (ROC); with the remaining 15% being produced abroad.

Although this Canadian Content and distribution analysis was based initially on entire Quebec-Windsor corridor project, the results would not change based on different project route scenarios, such as a Montreal-Toronto or Quebec-Toronto route.

It must be remembered that these Canadian content figures deal exclusively with manufactured components above the rail bed, which represent about 30% of the total construction phase value of the project.

6.2 Methodology and Assumptions

The methodology and assumptions on which the Canadian content and provincial distribution percentages were developed, are as follows;

> The total value for trailers cars, power cars, power supply, power distribution, signalling, communications, track and track equipment is based on data from parallel studies. The percentages used to determine the component cost breakdown, which in turn was utilised in determining the value of Canadian content and its provincial distribution, were developed internally based on previous studies and discussions with vehicle and major component manufacturers.

Canadian Content

1. Canadian content percentages of components were taken primarily from information provided directly from the manufacturers. If, for the same component, stated Canadian content percentages differed between manufacturers, the more conservative of the figures was adopted.

2. The content of some components, which are not presently manufactured in Canada for the conventional rail industry, were estimated based on Canada's overall capabilities and expertise in those particular areas. Examples would include Canada's expertise in the Signalling and Communications sectors, where, based on the case of the Vancouver Skytrain, a high percentage of Canadian content has been assumed. The advanced states of the Canadian telecommunication and electronics industries have also allowed us to assume high levels of Canadian content for components related to these sectors. Provisions have been made however for the need to import some specialised sub-componentry.

3. Seldom was it estimated that Canadian content would be 100%. In many instances it was assumed that at least 5% foreign content would be required in the form of technical assistance.

4. Components with 100% foreign content, are those which have been identified by the prime contractors as being "noble" components which cannot be transferred because of contractual or economic reasons.

Quebec/Ontario Split

5. The Quebec/Ontario distributions of the Canadian content is based primarily on the presence of manufacturing facilities located in each province.

6. Where only one qualified manufacturer was identified in Quebec or Ontario, 100% of the attributed Canadian production was assumed to take place in that province.

7. Where a qualified manufacturer is located in both Ontario and Quebec, the distribution was split evenly between provinces (such as with Bombardier who has a car building plant in Thunder Bay and La Pocatiere).

8. If no qualified manufacturers are located in Ontario or Quebec then production was attributed to the rest of Canada when qualified manufacturers could be identified.

9. Where many competitors exist in Quebec and Ontario, the distribution between these two provinces was estimated based strictly on competitive forces. ("C" in the table denotes competition). It is assumed that this distribution would result in even split between the two provinces.

TABLE 6-2: Distribution of Industrial Production of a High Speed Rail Project

Case: Quebc-Windsor, 200 kph System via Dorval

	Component Index %	Component Costs $(M)	Canadian Cont. %	Canadian Cont. $(M)	Foreign Cont. %	Foreign Cont. $(M)	# of CDN. companies Que	Ont	ROC	Quebec Cont. % Cdn. Cont.	Quebec Cont. $(M)	Ontario Cont. % Cdn. Cont.	Ontario Cont. $(M)	Rest of Cdn % Cdn. Cont.	Rest of Cdn $(M)
POWER CAR		**397.0**													
truck frame	7%	27.8	100%	27.8	0%	0.0	1	1		50%	13.9	50%	13.9		
wheelsets	3%	11.9	75%	8.9	25%	3.0	1	0		100%	8.9	0%	0.0		
truck assembly	4%	15.9	100%	15.9	0%	0.0	1	1		50%	7.9	50%	7.9		
pantograph	5%	19.9	80%	15.9	20%	4.0	0	1		0%	0.0	100%	15.9		
main transformer	6%	23.8	85%	20.2	15%	3.6	0	1		0%	0.0	100%	20.2		
power conditioning	10%	39.7	50%	19.9	50%	19.9	1	0		100%	19.9	0%	0.0		
gears	2%	7.9	75%	6.0	25%	2.0	3	0		100%	6.0	0%	0.0		
traction motors	8%	31.8	70%	22.2	30%	9.5	0	1		0%	0.0	100%	22.2		
control electronics	7%	27.8	50%	13.9	50%	13.9	C	C		50%	6.9	50%	6.9		
brakes	1%	4.0	70%	2.8	30%	1.2	0	1		0%	0.0	100%	2.8		
brake control	2%	7.9	70%	5.6	30%	2.4	0	1		0%	0.0	100%	5.6		
air compressor	1%	4.0	100%	4.0	0%	0.0	1	0		100%	4.0	0%	0.0		
primary suspension	3%	11.9	70%	8.3	30%	3.6	0	1		0%	0.0	100%	8.3		
secondary suspension	3%	11.9	75%	8.9	25%	3.0	0	1		0%	0.0	100%	8.9		
Inter-car subassembly	2%	7.9	100%	7.9	0%	0.0	1	1		50%	4.0	50%	4.0		
PCU for auxiliaires	8%	31.8	80%	25.4	20%	6.4	1	0		100%	25.4	0%	0.0		
engineering & PM	6%	23.8	80%	19.1	20%	4.8	1	1		50%	9.5	50%	9.5		
materials and supplies	4%	15.9	95%	15.1	5%	0.8	1	1		50%	7.5	50%	7.5		
carbody fabrication & asse	6%	23.8	80%	19.1	20%	4.8	0	1		50%	9.5	50%	9.5		
vehicle assembly & testing	12%	47.6	90%	42.9	10%	4.8	0	1		50%	21.4	50%	21.4		
	100%		**78%**	**309.7**	**22%**	**87.3**				**36%**	**144.9**	**42%**	**164.8**		
TRAILER CAR		**926.0**													
truck frame	4%	37.0	100%	37.0	0%	0.0	1	1		50%	18.5	50%	18.5		
wheelsets	3%	27.8	75%	20.8	25%	6.9	1	0		100%	20.8	0%	0.0		
truck assembly	4%	37.0	100%	37.0	0%	0.0	1	1		50%	18.5	50%	18.5		
brakes	1%	9.3	70%	6.5	30%	2.8	0	1		0%	0.0	100%	6.5		
brake control	2%	18.5	70%	13.0	30%	5.6	0	1		0%	0.0	100%	13.0		
air compressor	1%	9.3	100%	9.3	0%	0.0	1	0		100%	9.3	0%	0.0		
primary suspension	1%	9.3	70%	6.5	30%	2.8	1	1		50%	3.2	50%	3.2		
secondary suspension	2%	18.5	50%	9.3	50%	9.3	1	1		50%	4.6	50%	4.6		
interior car sub-assembly	9%	83.3	75%	62.5	25%	20.8	1	1		50%	31.3	50%	31.3		
seats	3%	27.8	90%	25.0	10%	2.8	C	C		50%	12.5	50%	12.5		
windows	2%	18.5	90%	16.7	10%	1.9	C	C		50%	8.3	50%	8.3		
door operators	5%	46.3	80%	37.0	20%	9.3	1	1		50%	18.5	50%	18.5		
hvac	8%	74.1	100%	74.1	0%	0.0	1	1		50%	37.0	50%	37.0		
ligjting	3%	27.8	100%	27.8	0%	0.0	C	C		50%	13.9	50%	13.9		
toilets	2%	18.5	100%	18.5	0%	0.0	C	C		50%	9.3	50%	9.3		
batteries	1%	9.3	100%	9.3	0%	0.0	1	1		50%	4.6	50%	4.6		
flooring & carpeting	1%	9.3	100%	9.3	0%	0.0	C	C		50%	4.6	50%	4.6		
inside walls etc.	2%	18.5	100%	18.5	0%	0.0	C	C		50%	9.3	50%	9.3		
engineering & PM	10%	92.6	90%	83.3	10%	9.3	1	1		50%	41.7	50%	41.7		
materials & supplies	6%	55.6	90%	50.0	10%	5.6	1	1		50%	25.0	50%	25.0		
carbody fabrication & asse	8%	74.1	80%	59.3	20%	14.8	1	1		50%	29.6	50%	29.6		
vehicle interior finishing	6%	55.6	100%	55.6	0%	0.0	1	1		50%	27.8	50%	27.8		
vehicle assembly & testing	8%	74.1	90%	66.7	10%	7.4	1	1		50%	33.3	50%	33.3		
trainset assembly & testing	8%	74.1	90%	66.7	10%	7.4	1	1		50%	33.3	50%	33.3		
	100%		**89%**	**819.5**	**11%**	**106.5**				**45%**	**415.1**	**44%**	**404.4**		
TOTAL ROLLING STOCK		**1,323.0**	**85%**	**1,129.2**	**15%**	**193.8**				**42%**	**560.0**	**43%**	**569.2**		
POWER SUPPLY		**237.0**													
transformers	40%	94.8	90%	85.3	10%	9.5	1	1		50%	42.7	50%	42.7		
switchgear	40%	94.8	80%	75.8	20%	19.0	1	1		50%	37.9	50%	37.9		
sub-station	20%	47.4	85%	40.3	15%	7.1	C	C		50%	20.1	50%	20.1		
	100%		**85%**	**201.5**	**15%**	**35.6**				**43%**	**100.7**	**43%**	**100.7**		
POWER DISTRIBUTION		**277.0**													
structural materials	40%	110.8	95%	105.3	5%	5.5	C	C		50%	52.6	50%	52.6		
hardware	15%	41.6	95%	39.5	5%	2.1	C	C		50%	19.7	50%	19.7		
insulators	5%	13.9	5%	0.7	95%	13.2	0	0	1	0%	0.0	0%	0.0	100%	0.7
wires & cables	40%	110.8	95%	105.3	5%	5.5	C	C		50%	52.6	50%	52.6		
	100%		**90%**	**250.7**	**10%**	**26.3**				**45%**	**125.0**	**45%**	**125.0**	**0%**	**0.7**
TOTAL ELECTRIFIC.		**514.0**	**88%**	**452.1**	**12%**	**61.9**				**44%**	**225.7**	**44%**	**225.7**	**0%**	**0.7**
SIGNALING		**262.0**													
trackside systems	25%	65.5	70%	45.9	30%	19.7	0	1		0%	0.0	100%	45.9		
central control	50%	131.0	70%	91.7	30%	39.3	C	C		50%	45.9	50%	45.9		
trackside parts	25%	65.5	70%	45.9	30%	19.7	C	C		50%	22.9	50%	22.9		
	100%		**70%**	**183.4**	**30%**	**78.6**				**26%**	**68.8**	**44%**	**114.6**		
COMMUNICATION		**203.0**													
equipment	**100%**	**203.0**	**80%**	**162.4**	**20%**	**40.6**	**C**	**C**		**40%**	**65.0**	**40%**	**65.0**		
TRACK & TRACK EQUIP.		**634.0**													
Rail	50%	317.0	95%	301.2	5%	15.9	0	2	1	0%	0.0	67%	200.8	33%	100.4
Ties	12%	76.1	95%	72.3	5%	3.8	C	C		50%	36.1	50%	36.1		
Fasteners	13%	82.4	75%	61.8	25%	20.6	1	0		100%	61.8	0%	0.0		
Track Equipment	25%	158.5	75%	118.9	25%	39.6	0	1	1	0%	0.0	50%	59.4	50%	59.4
	100%		**87%**	**554.1**	**13%**	**79.9**				**15%**	**98.0**	**47%**	**296.3**	**25%**	**159.8**
TOTAL INDUSTRIAL PROD.		**2,936.0**	**85%**	**2,481.2**	**15%**	**454.8**				**35%**	**1,017.4**	**44%**	**1,270.8**	**6%**	**160.5**

Table 6-3 : Distribution of Industrial Production of a High Speed Rail Project

Case: Quebc-Windsor, 300 kph System via Mirabel

	Component Index %	Component Costs $(M)	Canadian Cont %	Canadian Cont $(M)	Foreign Cont. %	Foreign Cont. $(M)	# of CDN. companies Que	Ont	ROC	Quebec Cont. % Cdn. Cont.	Quebec Cont. $(M)	Ontario Cont. % Cdn. Cont.	Ontario Cont. $(M)	Rest of Cdn % Cdn. Cont.	Rest of Cdn $(M)
POWER CAR		516.0													
truck frame	7%	36.1	100%	36.1	0%	0.0	1	1		50%	18.1	50%	18.1		
wheelsets	3%	15.5	75%	11.6	25%	3.9	1	0		100%	11.6	0%	0.0		
truck assembly	4%	20.6	100%	20.6	0%	0.0	1	1		50%	10.3	50%	10.3		
pantograph	5%	25.8	80%	20.6	20%	5.2	0	1		0%	0.0	100%	20.6		
main transformer	6%	31.0	85%	26.3	15%	4.6	0	1		0%	0.0	100%	26.3		
power conditioning	10%	51.6	50%	25.8	50%	25.8	1	0		100%	25.8	0%	0.0		
gears	2%	10.3	75%	7.7	25%	2.6	3	0		100%	7.7	0%	0.0		
traction motors	8%	41.3	70%	28.9	30%	12.4	0	1		0%	0.0	100%	28.9		
control electronics	7%	36.1	50%	18.1	50%	18.1	C	C		50%	9.0	50%	9.0		
brakes	1%	5.2	70%	3.6	30%	1.5	0	1		0%	0.0	100%	3.6		
brake control	2%	10.3	70%	7.2	30%	3.1	0	1		0%	0.0	100%	7.2		
air compressor	1%	5.2	100%	5.2	0%	0.0	1	0		100%	5.2	0%	0.0		
primary suspension	3%	15.5	70%	10.8	30%	4.6	0	1		0%	0.0	100%	10.8		
secondary suspension	3%	15.5	75%	11.6	25%	3.9	0	1		0%	0.0	100%	11.6		
Inter-car subassembly	2%	10.3	100%	10.3	0%	0.0	1	1		50%	5.2	50%	5.2		
PCU for auxiliaires	8%	41.3	80%	33.0	20%	8.3	1	0		100%	33.0	0%	0.0		
engineering & PM	6%	31.0	80%	24.8	20%	6.2	1	1		50%	12.4	50%	12.4		
materials and supplies	4%	20.6	95%	19.6	5%	1.0	1	1		50%	9.8	50%	9.8		
carbody fabrication & ass.	6%	31.0	80%	24.8	20%	6.2	0	1		50%	12.4	50%	12.4		
vehicle assembly & testing	12%	61.9	90%	55.7	10%	6.2	0	1		50%	27.9	50%	27.9		
	100%		78%	402.5	22%	113.5				36%	188.3	42%	214.1		
TRAILER CAR		774.0													
truck frame	3%	23.2	100%	23.2	0%	0.0	1	1		50%	11.6	50%	11.6		
wheelsets	2%	15.5	75%	11.6	25%	3.9	1	0		100%	11.6	0%	0.0		
truck assembly	2%	15.5	100%	15.5	0%	0.0	1	1		50%	7.7	50%	7.7		
brakes	1%	7.7	70%	5.4	30%	2.3	0	1		0%	0.0	100%	5.4		
brake control	3%	23.2	70%	16.3	30%	7.0	0	1		0%	0.0	100%	16.3		
air compressor	1%	7.7	100%	7.7	0%	0.0	1	0		100%	7.7	0%	0.0		
primary suspension	2%	15.5	70%	10.8	30%	4.6	1	1		50%	5.4	50%	5.4		
secondary suspension	3%	23.2	50%	11.6	50%	11.6	1	1		50%	5.8	50%	5.8		
interior car sub-ass.	7%	54.2	75%	40.6	25%	13.5	1	1		50%	20.3	50%	20.3		
seats	4%	31.0	90%	27.9	10%	3.1	C	C		50%	13.9	50%	13.9		
windows	2%	15.5	90%	13.9	10%	1.5	C	C		50%	7.0	50%	7.0		
door operators	5%	38.7	80%	31.0	20%	7.7	1	1		50%	15.5	50%	15.5		
hvac	10%	77.4	100%	77.4	0%	0.0	1	1		50%	38.7	50%	38.7		
ligjting	3%	23.2	100%	23.2	0%	0.0	C	C		50%	11.6	50%	11.6		
toilets	2%	15.5	100%	15.5	0%	0.0	C	C		50%	7.7	50%	7.7		
batteries	1%	7.7	100%	7.7	0%	0.0	1	1		50%	3.9	50%	3.9		
flooring & carpeting	1%	7.7	100%	7.7	0%	0.0	C	C		50%	3.9	50%	3.9		
inside walls etc.	2%	15.5	100%	15.5	0%	0.0	C	C		50%	7.7	50%	7.7		
engineering & PM	10%	77.4	90%	69.7	10%	7.7	1	1		50%	34.8	50%	34.8		
materials & supplies	6%	46.4	90%	41.8	10%	4.6	1	1		50%	20.9	50%	20.9		
carbody fabrication & ass.	8%	61.9	80%	49.5	20%	12.4	1	1		50%	24.8	50%	24.8		
vehicle interior finishing	6%	46.4	100%	46.4	0%	0.0	1	1		50%	23.2	50%	23.2		
vehicle assembly & testing	8%	61.9	90%	55.7	10%	6.2	1	1		50%	27.9	50%	27.9		
trainset assembly & testin	8%	61.9	90%	55.7	10%	6.2	1	1		50%	27.9	50%	27.9		
	100%		88%	681.5	12%	92.5				44%	339.6	44%	341.9		
TOTAL ROLLING STOCK		1,290.0	84%	1,084.0	16%	206.0				41%	527.9	43%	556.1		
POWER SUPPLY		202.0													
transformers	40%	80.8	90%	72.7	10%	8.1	1	1		50%	36.4	50%	36.4		
switchgear	40%	80.8	80%	64.6	20%	16.2	1	1		50%	32.3	50%	32.3		
sub-station	20%	40.4	85%	34.3	15%	6.1	C	C		50%	17.2	50%	17.2		
	100%		85%	171.7	15%	30.3				43%	85.9	43%	85.9		
POWER DISTRIBUTION		236.0													
structural materials	40%	94.4	95%	89.7	5%	4.7	C	C		50%	44.8	50%	44.8		
hardware	15%	35.4	95%	33.6	5%	1.8	C	C		50%	16.8	50%	16.8		
insulators	5%	11.8	5%	0.6	95%	11.2	0	0	1	0%	0.0	0%	0.0	100%	0.6
wires & cables	40%	94.4	95%	89.7	5%	4.7	C	C		50%	44.8	50%	44.8		
	100%		90%	213.6	10%	22.4				45%	106.5	45%	106.5	0%	0.6
TOTAL ELECTRIFICAT.		438.0	88%	385.3	12%	52.7				44%	192.3	44%	192.3	0%	0.6
SIGNALING		278.0													
trackside systems	25%	69.5	70%	48.7	30%	20.9	0	1		0%	0.0	100%	48.7		
central control	50%	139.0	70%	97.3	30%	41.7	C	C		50%	48.7	50%	48.7		
trackside parts	25%	69.5	70%	48.7	30%	20.9	C	C		50%	24.3	50%	24.3		
	100%		70%	194.6	30%	83.4				26%	73.0	44%	121.6		
COMMUNICATION		272.0													
equipment	100%	272.0	80%	217.6	20%	54.4	C	C		40%	87.0	40%	87.0		
TRACK & TRACK EQUIP.		617.0													
Rail	50%	308.5	95%	293.1	5%	15.4	0	2	1	0%	0.0	67%	195.4	33%	97.7
Ties	12%	74.0	95%	70.3	5%	3.7	C	C		50%	35.2	50%	35.2		
Fasteners	13%	80.2	75%	60.2	25%	20.1	1	0		100%	60.2	0%	0.0		
Track Equipment	25%	154.3	75%	115.7	25%	38.6	0	1	1	0%	0.0	50%	57.8	50%	57.8
	100%		87%	539.3	13%	77.7				15%	95.3	47%	288.4	25%	155.5
TOTAL INDUST. PROD.		2,895.0	84%	2,420.7	16%	474.3				35%	975.6	43%	1,245.5	6%	156.1

7.0 International Markets

This section identifies the results of a market study to determine the potential size of U.S. HSR market as well as an outlook on other international markets.

7.1 HSR Development in the U.S.

High Speed Rail in the US has been under study since 1972, however over the last few years increasing public interest has been focussing on evaluating HSR as a means of satisfying short-term inter-urban transportation requirements.

In December 1991, the Intermodal Surface Transportation Efficiency Act (ISTEA) was passed by congress. This was the first piece of legislation to consider High Speed Rail development and requires that projects be evaluated by the Federal Railway Administration for their potential to reach high speed designation.

To date, seventeen State governments have formed High Speed Rail commissions or agencies within their Departments of Transportation, devoted to the assessment and development of high speed rail in their States and to initiate requests for Federal funding of HSR initiatives.

In 1992 the Federal Railway Administration (FRA) requested information on potential High Speed Rail corridors (with speeds originally anticipated to reach over 150 mph (240 kph)) from all State departments of transportation. Fourteen project descriptions were sent to the FRA (the exact number of projects varies depending on how a corridor is defined).

To date only 7 of the 14 projects have received official Federal HSR designation, these are California, Texas, Florida, Empire, North-East, Illinois-Missouri and Illinois-Michigan corridors.

Of the 14 identified projects, 8 have received the benefits of a full feasibility study and only one, the North-East corridor project has received an established timeframe of implementation.

The Federal High Speed Rail Development Act, which is expected to soon be passed into law in the U.S., will provide between $165 and $185 million (U.S.) over three years on a matching program with the State governments for HSR. These funds are to be shared among the designated corridors for the rehabilitation of existing infrastructure. Originally $1.3 billion (U.S.) in funding for HSR was requested under this act.

7.1.1 General Issues Regarding the Likelihood of U.S. Project Implementation

Funding of U.S. HSR

Unlike highway and airport infrastructure projects, rail development in the U.S. must be funded either through existing rail operation revenues or by special State and Federal budgetary allotments. There are no special trust accounts in which a dedicated portion of taxes collected are deposited (such as highway and airport trust accounts). Hence rail infrastructure development must compete with all other expenditure request, including all social program requests such as health-care, education and crime prevention.

Federal funding made available to HSR includes;

- funding under ISTEA, which was the first legislation which affected (although indirectly) HSR. Under ISTEA there were provisions which allowed for the appropriation of $110 million for steel wheel projects. This included $35 million under section 1010 for the upgrade of grade crossings, $50 million for Demonstration Effects of the technology, and $25 million for R&D. These funds are being spread over the period ending in 1997 when the act expires.

- $1.2 billion which has been allotted by Congress out of general budgetary expenditures specifically for the development of the North East corridor project.

- $187 million (U.S.) under the HSR Development Act, (still to be signed by the President) is to be used for HSR infrastructure development. This money is to be spread over three years and is likely to be the only new Federal money made available to HSR till 1998. As the funds available under ISTEA, this money will only be for projects with existing rail infrastructure and which have been officially designated as HSR corridors.

These levels of Federal funding for HSR are by no means significant. If this money was to be matched on a dollar for dollar basis by State governments (which is what is proposed), funding would be insufficient to complete even one HSR project. In all likelihood the money available through the HSR development act will be dedicated to closing level crossing and building grade separations and other track infrastructure upgrades in preparation of HSR.

Private sector financing of HSR has to-date not been forthcoming and shows signs of extreme hesitance. This was evidenced by the inability of the Texas project to find sufficient private money for its HSR project. According to New York investment banking sources, private funding of HSR will be difficult to raise without State or Federal guarantees. State guarantees or direct participation in HSR projects has been prohibited in some States (such as Texas) by their legislatures. One sign of hope however has come from a recent decision by the Senate to provide HSR rail projects with the same tax-exempt bond status under the Federal tax code that airport and seaport projects enjoy.

Incrementality

There is increasing evidence to suggest that the implementation of HSR in the US will proceed in an incremental fashion, or phased approach as it is sometimes referred to.

Incrementality (based on a definition provided by most State representatives for HSR) is where projects would space out investment to gradually repair and replace existing rail infrastructure and rolling stock. Under incrementality train speeds would gradually increase from a minimum 90 mph (145 kph) (which most corridors attain presently as a maximum speed, although some corridors will require some investment in infrastructure improvement to even reach this initial top speed) to the maximum top speeds expected from the HSR technology that they purchase.

Incrementality will not reduce the total requirements for HSR equipment and componentry but only affect the timing of their purchase. It is probable that HSR rolling stock (at least passenger cars) signalling and even communication equipment will be an initial purchase for most projects aspiring to reach HSR status. The purchase of electrification components will be held off until the final ascendence to "high speed" (unless a turbine diesel locomotive technology can be developed to reach comparable high speeds and can demonstrate its ability to do so cost-effectively).

The rationale for concluding that U.S. HSR projects will adopt an incremental approach is based mainly on the following;

1) the high cost and limited available resources for implementing HSR projects,

2) grass root opposition to changes along existing rail lines or to the creation of new rights-of-way,

3) the time required to develop an 'American' very high speed rail (VHSR) magnetic levitation (MAGLEV) technology,

4) the political process and structure in the U.S.

1) The incremental approach will mainly result due to the high cost of overhauling the rail system or building a new system in order to immediately attain a high speed system. Based on existing data this cost is estimated to be between $7 and $12 billion (U.S.) per project. These expenditures have become increasingly difficult to justify in the U.S., particularly under a climate of budgetary restriction and because Federal participation in HSR must come out of general budgetary expenditures. Without a special 'trust' tax dedicated to rail projects and having to compete with a variety of social programs under general budgetary expenditures, the marginal prospects for sufficient Federal participation in U.S. HSR will encourage the tendency towards incrementality.

Also, much of the cost for improvements along existing infrastructure will have to come from operating revenues. It is unlikely that existing rail operators will forego revenues for the three or four years required to install new HSR infrastructure. An incremental approach would allow for some revenue streams to be maintained.

2) Compounding the slow movement of HSR development in the US is the overwhelming local citizen and grass root opposition to any and all changes proposed to construct or overhaul the rail line. Based on the experiences of Amtrak with the development of the North East Corridor project, practically every attempt so far to close grade crossings or acquire rights-of-way have been met with local and quite vocal opposition from a large number of individuals with a vested interest in the status quo. Opposition on the grounds of environmental impacts is also expected to make the implementation of HSR a slow and long term process in the U.S.

3) American politicians are reluctant to spend large sums of public money on foreign technology. The incremental approach to HSR will allow an 'American' Very High Speed Rail (VHSR) technology to be developed which will be commercially viable (see section 7.3.1 below for a discussion of MAGLEV technology).

4) Incrementality will allow U.S. authorities to derive the maximum amount of visibility as each stage of infrastructure improvement can be heralded and publicized as an accomplishment in improving inter-urban transportation.

Alternative Transportation

Also of concern is that the viability of certain HSR projects is becoming increasingly suspect due to the threat of increased competition from "low fare" airlines. The occurrence of these no frills, low fare, frequent departure flights are increasingly expanding in the US. They now service most major markets and plan to expand into the others soon. For example, South-West airlines, operating between Dallas and Houston, offers one way fares at $64 (U.S.) (with lower fare of $39 requiring 21 days advanced notice) which presents strong competitive challenge to HSR which expects to offer fares in the $60 to $80 range. Similar low fares are offered in other corridors by South-West such as St-Louis to Detroit ($69), L.A. to Los Vegas ($62). By consistently operating at a profit in these and other major markets, these airlines are impacting on the competitive viability of HSR in the U.S.

Sharing of Existing Right-of-Way

U.S. freight operators own or control most of the existing rights-of-way in the U.S. The issue of sharing these rights-of-way has been a major stumbling block with respect to the development of HSR in the U.S. With the consolidation of U.S. railway networks in recent years, most of the freight (and profits) have been rerouted to the main lines that are being coveted for potential HSR projects.

Shared track arrangements are considered likely in most corridors as the costs associated with track and signalling improvements could be shared with the freight companies, hence reducing HSR project risk and exposure as well as providing some incentive to freight operators to make certain operating concessions.

7.2 Most Likely U.S. HSR Projects

After extensive consultation and analysis, it is estimated that only 6 of the 14 potential projects identified will be implemented over the next 20 year period, which is the established time frame of this study.

Of these 14, one project (North-East Corridor) is presently being initiated and 7 projects are judged to be under serious consideration based on a number of preparedness factors. These factors range from being in the process of undertaking feasibility studies (such as in the California corridor) to having tested HSR trainsets and having received State funding to initiate track realignment (such as in the North-West corridor).

Other than the North-East corridor the projects under serious consideration include;

Chicago- St-Louis	(Illinois-Missouri corridor),
Chicago - Detroit	(Illinois-Michigan corridor),
Portland-Seattle-Vancouver	(North-West corridor)
Cleveland-Columbus-Cincinnati	(Ohio corridor).
L.A. - San Francisco	(California corridor),
Miami - Orlando	(Florida corridor)
New-York - Albany - Buffalo	(Empire corridor)

The general preparedness factors on which an assessment of the likelihood of implementation of these individual projects is based, have been summarized below. As a prior note, the Texas project is the only Federally designated corridor to not appear in the above list of serious projects since it has recently failed in raising sufficient private sector participation to implement its proposed HSR project and because the Texas government passed legislation which precludes any State money to be implicated in such projects.

Washington-New York-Boston (North East Corridor)

This corridor extends from Washington through New York and onto Boston. The cost of upgrading it for HSR is estimated at $1.2 billion (although more than $2 billion has been spent to date in preparation for HSR). Funding for this project has been appropriated from the General Fund of the Treasury to be used over a 5 year period. These funds are expected to cover infrastructure modifications, including electrification, and acquisition of new equipment. New equipment is estimated at $450 million for 26 trainsets to provide hourly service between Washington and Boston. The forecasted in-service date for the Washington-New York HSR link is 1997.

Bids for the electrification of the portion of the line between New-Haven and Boston which is the only portion to date non-electrified, are presently being evaluated. It is estimated that this will cost about $204 million. Amtrak has tested both the tilting X-2000 trainset and non-tilting ICE technologies between New-York and Washington. Three companies have been qualified for supplying trainsets by Amtrak for this project including ABB with the X-2000, a GEC Alsthom/Bombardier hybrid tilt system (which will be referred to as the Franco-Canadian Tilt technology), and the Siemens/Fiat hybrid tilt system (the term hybrid referring to the combination of tilting and non-tilting systems). It is conceded that the extent of the curvature in the corridor and the high cost involved in expropriation for track straightening, is what provided a marked advantage for the tilt technology to be required in this corridor.

Chicago-Detroit - (Illinois-Michigan Corridor)

Following a request from the Michigan Department of Transportation, the FRA has officially designated this corridor as High Speed. Through joint efforts by Michigan DOT, Conrail and Amtrak, more than $13.5 million has already been invested in infrastructure improvements along this corridor.

A feasibility study for what is referred to as the Illinois - Michigan project, recommended the use of existing track to attain a top speed of 110 mph (175 kph). Although a 1991 Ridership study concluded that revenues would be insufficient to fund full conversion to HSR it is expected that the incremental approach to achieve HSR through gradual track upgrade could be implemented to reduce elapsed time in this corridor to three and a half hours.

The cost of upgrade has been estimated at between $500 and $700 million, not including rolling stock, to achieve the expected top speed of 110 to 125 mph (175 to 200 kph). In order to achieve higher speeds of 150 mph (240 kph) they would either electrify or await the development of non-electric power cars that could attain these speeds.

Chicago-St-Louis - (Illinois - Missouri Corridor)

Following the official designation of this corridor by the FRA, the State of Illinois is presently examining a number of options for incremental improvements to the existing rail lines between Chicago and St-Louis.

A 1994 feasibility study determined that there would be sufficient ridership to justify expenditures to achieve speeds of 140 mph (225 kph). Presently, the maximum speed on this corridor is 79 mph (127 kph). An incremental approach is recommended with an initial expenditure of about $400 million to purchase rolling stock and a further $300 million needed for further track improvements, grade separations etc., in order to achieve a maximum speed of 140 mph (225 kph) (not including the cost of electrification).

L.A.-San Francisco - (California Corridor)

Numerous studies have been conducted in the past several years on a few potential projects within California and California-Nevada corridors. In February of 1993, the California Department of Transport commissioned preliminary engineering and other feasibility work to be done for the L.A.-San Francisco project. In total $3 million (U.S.) will be spent on studies, with the ridership and economic impact studies yet to be initiated. The population centres affected by this project would be L.A., Bakersfield, Fresno, San Jose and San Francisco.

Plans have been prepared to further expand HSR service north to Oakland, Sacramento and Reno, Nevada but implementation of this service is expected to be much more long term.

The L.A.- San Diego line was upgraded in recent years with the benefit of $80 million (U.S.) provided under ISTEA. There are no plans to purchase HSR Rolling Stock for this corridor project.

Portland- Seattle- Vancouver (North-West Corridor)

The findings of a 1992 High Speed Ground Transportation Feasibility Study for this corridor put the cost of achieving speeds of up to 185 mph (300 kph) at between $9 and $12 billion (U.S.) and for a MAGLEV system that would achieve speeds of 300 mph (540 kph) at between $12 and $16 billion. It was recommended however that a phased approach be implemented where top speed would be increased gradually to 150 mph (240 kph) by the year 2020. Over the past 6 months a Talgo passive tilt train was leased and tested in this corridor. No noticeable decreases in trip time have been recorded although much track rehabilitation and realignment work will be required in order to achieve any increase in average and top speeds in this corridor.

Although it is the only likely project not to have received Federal HSR designation status, due mainly to the mountainous and winding nature of existing right-of-way, the apparent dedication of the State of Washington Senate and Department of Transport officials have provided it with enough planning and funding impetus to be included here. State funding for the project has amounted to $70 million from the 1994 budget for infrastructure development with ostensibly the same amounts expected in 1995.

Tampa-Orlando-Miami (Florida Corridor)

The Tampa-Orlando link would be the first phase of this corridor which is also expected to be extended eventually to Miami.

The Department of Transportation has been promised by the State as much as $70 million a year as of 1997 to develop their HSR system. It is anticipated that private funding will be forthcoming to implement the system. RFPs are expected to be sent out in the new year for a consortium to supply equipment, build and manage the project and the operations. Based on the straightness of existing right-of-way, a non-tilting TGV type technology could possibly be adopted in this corridor.

Cleveland-Columbus-Cincinnati (OHIO Corridor)

Also referred to as the 3-C corridor, this project is expected to develop an HSR system through incrementality. The OHIO State DOT plan to follow a schedule of gradually improving track, signalling, communication systems based on current shared track arrangements, purchasing rolling stock and eventually electrifying (or high speed turbine locomotives). The expected maximum top speed in this corridor is 125 to 150 mph (200 to 240 kph).

New York-Albany-Buffalo (Empire Corridor)

The New York State DOT, the State Thruway Authority, the New York State Energy and Development Authority (NYSERDA) as well as the Governor's office have all been involved in evaluating this project. The stated preference for this corridor is a MAGLEV project which would reach top speeds of around 300 mph (480 kph) and which is estimated to cost around $20 billion (U.S.), or $45 million a mile. Grumman Corp. has been awarded a contract (along with others from New York's military industry sector) to design a MAGLEV system for a test track at Stewart International Airport.

In anticipation for the commercialisation of MAGLEV, the State's plan includes a HSR steel wheel project with an initial upgrade of existing right-of-way in order to allow trains to reach speeds of up to 125 mph (200 kph) by the end of the decade. This would trim the one way trip time from eight to under six hours. An initial $ 1 billion (U.S.) proposal (for both Federal and State funding) would cover infrastructure, track and signalling improvements while Amtrak would purchase tilt technology rolling stock using existing operating revenues. The plan identifies turbine engines as a possible substitute for electrification in order to eventually meet the speed target of 125 mph (200 kph).

7.3 Likely Technology Choice in the U.S.

For the 6 projects identified as making up the U.S. market it is believed that the tilting technology will be the technology of choice in each case. This assumption has been justified based on the following arguments;

- tilt technology is more amenable to the concept of incrementality,

- present curvature of the track and the cost of straightening (to accommodate non-tilt), including expropriation costs, being extremely high,

- inability to cross or upgrade existing track in areas that are considered heritage or historic sites, wetlands and wildlife habitat etc.

- tilt technology is much more amenable to existing track and Federal funding is available mainly for improvements to existing infrastructure,

- tilt technology would be preferred under shared track arrangements as freight trains are detrimental to the higher embankments (or super elevations) required for non-tilting trains.

These arguments were imparted mainly during discussions with representatives of State HSR authorities and Department of Transport officials. Every one of these interviews revealed a stated preference for adopting tilt technology (as well as adopting an incremental approach).

Also important with respect to the choice of technology is that there is a possibility that Amtrak would be given operating control of most U.S. HSR projects. If so, there will be a strong incentive (in terms of operating efficiency and overall cost effectiveness) for the standardization of equipment to be used in those corridors.

Since Amtrak has a stated interest in tilting technology for the North-East corridor, the technology of choice for the other corridors for which it would have operating control would also be tilting technology. Amtrak has stated an interest in supplying all the corridors under its control with a "hybrid" tilting technology which could be powered by turbo diesel locomotives that could consistently reach commercial speeds of 125 mph to 150 mph (200 - 240 kph). An RFP to conduct R&D for developing a dual powered (fossil and electric) HSR turbo locomotive was issued by Amtrak in 1991, however the technical specifications proved to be too stringent for any company to attempt.

It could be argued that it is possible that one or even two potential projects purchase non-tilt technology. Depending on the distance between cities (and the corresponding need for higher speeds) and the level of urban development (sometimes allowing for the straightening of track and the purchase of rights-of-way at a reasonable price), a 185 mph (300 kph) technology, such as TGV technology, could be adopted.

However, it is more likely that if the expenditures are justified for a 300 kph project then they would be justified for a very high speed rail (VHSR) project using MAGLEV.

7.3.1 MAGLEV Technology

Magnetic Levitation, or MAGLEV, technology is being promoted in the U.S. in tandem with that of HSR (Steel Wheel HSR). It is hoped that MAGLEV could be relied on to absorb some of the increasingly idle defense contract industry. It is also hoped that MAGLEV's promotion would become the basis on which a future U.S. leadership in VHSR technology is developed. Although this technology does present potential competition for steel wheel HSR, it is generally conceded that MAGLEV technology is about twenty years away from commercial viability.

MAGLEV is considered as yet too expensive and unproven to compete with readily available steel wheel HSR technology. For example, Florida State has approved construction of a 250 mph (400 kph) transrapid MAGLEV prototype line between Orlando International Airport and a new complex near Disney World. This 13 mile (21 km) project has a budget of $624 million ($97 million Federal money and $527 private) resulting in a cost of $40 million per mile ($30 million per km). Although the cost per mile is expected to decrease with larger projects, the cost of $45 million per mile estimated for the Empire corridor, does not bear this out. In the North West corridor, a MAGLEV alternative was estimated to cost between $36.3 and $48.3 million (U.S.) per mile as opposed to $27 million (U.S.) for the steel wheel on steel rail alternative. The consultant who authored that study however recommended that is was not advisable to adopt MAGLEV as the marginal ridership gains of the MAGLEV option did not justify the increased cost and increased technological risk at this time.

7.4 Estimated U.S. Market Size

As can be seen from table 7-1 on the following page, the total value of the manufactured components above the rail, including rolling stock, power supply and distribution, communications and signalling equipment, is estimated at $5.5 billion (Cdn).

The markets for services (that would be open to foreign competition) including installation services for signalling, communication electrification as well as some project and construction management as well as some services in engineering and design, is estimated at roughly $2.1 billion (Cdn) dollars.

The total market for components and services in the U.S. is $7.6 billion (Cdn).

Table 7-1
Estimated U.S. HSR Market
Manufactured Components & Services Above the Rail
Realistic Case Estimates

Corridors Cities Linked (U.S. '000)	Cost of Rolling Stock	Power Supply & Distribution	Communi-cations Equipment	Signalling Equipment	Total Component Costs	Eng.,Design, Proj. & Cons. Management	Installation Services	Total Exportable Services	Total MKT Components & Services
NORTH WEST									
Port.-Sea.-Van.	346,088	157,331	44,886	80,154	**628,459**	152,980	100,016	**252,995**	**881,454**
CALIFORNIA									
L.A.-San Frans.	787,380	186,853	53,309	95,195	**1,122,737**	260,719	118,783	**379,503**	**1,502,240**
OHIO									
Cin.-Col.-Clev.	108,829	126,126	35,984	64,256	**335,195**	87,229	80,179	**167,407**	**502,603**
ILLINOIS-MICHIGAN									
Chic.-Det.	358,258	130,797	37,316	66,636	**593,008**	141,993	83,148	**225,141**	**818,149**
ILLINOIS-MISSOURI									
Chic.-St-Lou.	126,178	130,797	37,316	66,636	**360,928**	93,256	83,148	**176,404**	**537,332**
EMPIRE									
N.Y.- Alb.-Buf.	667,595	216,283	61,705	110,188	**1,055,771**	250,585	137,492	**388,077**	**1,443,848**
FLORIDA									
Mia.-Orl.-Tam.	259,566	140,140	39,982	71,396	**511,084**	126,036	89,088	**215,124**	**726,208**
Average For 7 Projects	379,128	155,475	44,357	79,209	**658,169**	158,971	98,836	257,807	915,976
Total for 4 Tilting proj.	**1,516,511**	**621,901**	**177,427**	**316,835**	2,632,675	**635,884**	**395,345**	1,031,229	3,663,905
Total for 1 Non-Tilt proj.	**414,099**	**155,475**	**44,357**	**96,635**	710,566	**158,971**	**98,836**	257,807	915,976
NORTH EAST									
Wash-N.Y.-Bos.	**468,661**	**156,000**	**60,906**	**108,760**	794,327	**191,032**	**115,351**	306,383	1,100,710
TOTALS	2,399,272	933,377	282,690	522,229	4,137,568	985,888	609,532	1,595,420	5,680,591
(per year)	119,964	46,669	14,134	26,111	206,878	49,294	30,477	79,771	286,649
TOTAL (Cdn $ '000)	3,191,032	1,241,391	375,978	694,565	5,502,965	1,311,231	810,678	2,121,908	7,624,874
(per year)	159,552	62,070	18,799	34,728	275,148	65,562	40,534	106,095	381,244

7.4.1 Methodology and Assumptions

After a lengthy assessment of the U.S. market for HSR, it is judged that within a twenty year period it is likely that six HSR project will be implemented. To date only one HSR project has been initiated in the U.S. To determine the requirement for manufactured components and services for the other five project was calculated based on an average of the most serious projects (outlined above) and added to the costs of the North-East project.

Trainset requirements for some projects were estimated using information taken from recent feasibility studies for some U.S. projects as well as from the Q/O HSR parallel studies. These estimates are presented in table 7-2 on the following page. From the given and estimated number of trainsets and individual corridor lengths, the cost of the manufactured components and services above the rail were estimated for each project using the cost per kilometre and cost per trainset figures provided for the Canadian project.

The main assumptions used in estimating the U.S. market included the following;

<u>Estimated Trainsets</u>

1. The number of trainsets for the North-East, North-West, Illinois-Missouri and Florida corridors were taken from recent feasibility studies.

2. The number of trainsets required for the four other corridor projects were estimated by extrapolating from data of the four available U.S. project feasibility studies as well as parallel studies for the Quebec-Ontario HSR project.

3. Data from the Montreal-Ottawa-Toronto (MOT) stand alone project was used relative to ridership, route length, average haul length, passenger kilometres and number of trainsets, as this segment is more comparable to the U.S. corridors.

4. From the available data, an <u>average passenger kilometres per trainset</u> was derived. This average was used as an index in order to estimate the number of trainsets required in the other corridors. By using this index, the varied operating environments and operating assumptions of the four projects are implicitly captured, including assumptions regarding operating frequencies, station turn around times etc...

5. The number of spare trainsets required as well as trainsets required to satisfy future passenger demand were calculated separately and were based on averages taken from available data.

Table 7-2
Established & Estimated Trainset Requirements for U.S. HSR Projects

Corridors Cities Linked	Annual Passengers ('000)	Route Length (klm)	Avg. Haul Length (klm)	Avg. Haul Length (%)	Passenger Kilometers ('000)	Passenger Klm per Trainset ('000)	Number of Trainsets Required	Spare Trainsets Required	Future Trainsets Required	Total Trainsets Required
QUEBEC-ONTARIO Mont.-Ott.-Tor.	5,600	610	363	60%	2,032,800	75,289	27	9	6	**42**
NORTH EAST Wash.-N.Y.-Bost.	4,000	735	368	50%	1,470,626	66,847	22	4	5	**31**
NORTH WEST Port.-Sea.-Van.	5,116	542	271	50%	1,386,209	86,638	16	3	3	**23**
FLORIDA Miami-Orl.-Tamp	4,800	483	241	50%	1,158,480	96,540	12	2	3	**17**
ILLINOIS-MISSOURI Chicago-St-Louis	1,113	451	293	65%	325,929	65,186	5	2	1	**8**
Total / Weighted Avg.	20,629	2,820	1,536	54%	6,374,044	77,732	82			
OHIO Cin.-Col.-Clev.	1,832	434	217	50%	397,994		5	1	1	**7**
CALIFORNIA L.A.-San Fran.	7,351	644	386	60%	2,838,697		37	7	8	**52**
ILLINOIS-MICHIGAN Chicago-Detroit	4,778	451	270	60%	1,291,607		17	3	4	**24**
EMPIRE N.Y.- Alb. - Buff.	5,385	745	447	60%	2,406,843		31	6	7	**44**

6. Annual ridership figures for the corridors, where this data was not available, were estimated based on an average penetration rate taken from the affected corridor populations of the four projects for which data was available.

Project Costs

7. The project costs used for the purpose of estimating this segment of the market included only those judged available to foreign competition under the Buy America Act, namely rolling stock, power supply and distribution, communications and signalling.

8. The cost per trainset utilised was $14.65 million (U.S.), which is the base price provided to CIGGT by ABB Canada for one power car and five trailer cars. This price includes a supplement of 2.5% for spare parts. (Based on information available from other sources, this should be considered a conservative cost.)

9. The cost of power supply and distribution, communications and signalling equipment was based on the cost per kilometre breakdown taken from the Q\O HSR project (Quebec City to Windsor segment) and translated into U.S. dollars based on a 75 cent Canadian dollar. After subtracting for contingencies and professional services, 65% of the remaining cost was taken as componentry and twenty three 23% percent as installation.

10. The size of the market for project and construction management as well as for design and engineering services was estimated at being worth 21% of total of components plus installation costs.

11. Costs related to the purchase of spare parts and materials due related to maintenance were included for each year over 20 years of operation. These costs are based on the Q/O parallel study findings at 0.32% per year.

7.5 Estimated Market Size of Other International HSR Projects

Although we did not undertake a full market study of other international projects as we did in assessing the U.S. market size, we did undertake a review of the potential opportunities.

The main potential for initiating HSR projects, other then in North America and Europe, will be in the newly industrialised countries (NIC's) of East Asia and China. Projects are in the discussion phases in some of these countries and corridors could be anticipated within the next twenty years. Example of the most likely projects could include the corridors between, Shanghai and Beijing, Quan-zhou and Hong Kong (Kowloon), Singapore and Kuala Lumpur, Djakarta and Bandung, as well as a project in Taiwan linking Taipei and Tai-nan. Projects in Australia have been under study and some projects have also been discussed in Latin America, most likely in Brazil and Mexico. A project linking the Gulf State cities of Riyadh and Bahrain with Kuwait city has also been discussed.

Although it is likely that most remaining European and Scandinavia projects will be opened primarily to European and Scandinavian competition, there will be some opportunities for foreign manufacturers to supply certain sub-systems and components.

It is unlikely that any Eastern European or former Soviet States will initiate HSR projects within the next twenty years as they will be concentrating their efforts and resources on economic reforms.

Although insufficient information is available to determine which projects will be undertaken and what the requirements for components and services will be for those that will be undertaken, it is assumed that the size of the market will be equivalent to 5 projects over the next 20 years (3 being tilt and 2 being non-tilt).

By using the average project cost estimates from the U.S. market study, a realistic market size for other international HSR projects is anticipated to be roughly $ 6 billion (Cdn).

A breakdown by sub-system and services for these markets is presented in table 7-3 on the following page.

Table 7–3
Estimated International HSR Market (excluding U.S.)
Manufactured Components & Services Above the Rail
Realistic Case Estimates

Total Other International Markets (U.S. $ '000)	Cost of Rolling Stock	Power Supply & Distribution	Communi-cations Equipment	Signalling Equipment	Total Component Costs	Eng.,Design, Proj. & Cons. Management	Installation Services	Total Exportable Services	Total MKT Components & Services
Total for 3 Tilting proj.	1,033,601	466,426	133,071	237,626	1,870,724	455,119	296,509	751,628	2,622,352
Total for 2 Non-Tilt proj.	752,628	310,951	88,714	193,269	1,345,562	303,413	197,673	501,085	1,748,235
TOTALS	1,786,229	777,377	221,784	430,895	3,216,285	758,532	494,182	1,252,713	4,370,586
(per year)	89,311	38,869	11,089	21,545	160,814	37,927	24,709	62,636	223,450
TOTAL (Cdn $ '000)	2,381,639	1,036,502	295,712	574,527	4,288,381	1,011,375	658,909	1,670,284	5,958,665
(per year)	119,082	51,825	14,786	28,726	214,419	50,569	32,945	83,514	297,933

7.6 Optimistic and Pessimistic Case Estimates

The numbers presented to date are considered "realistic" case estimates. "Optimistic" and "pessimistic" case have been developed and are presented in Appendix D.

The optimistic estimates consider the possibility of 8 U.S. projects being implemented over the next twenty year period while the pessimistic estimates allows for only four 4 projects to be implemented.

For the other international HSR projects, the optimistic case is for 7 projects while the pessimistic case estimates consider 3 projects.

The total international market size for HSR components and services open to international competition, under optimistic, realistic and pessimistic case estimates, are presented in table 7-4 below.

Table 7-4
Estimated International HSR Market for Components and Services

($ Million Cdn)	Optimistic	Realistic	Pessimistic
U.S. HSR Market	9,990	7,625	5,190
Other International HSR Markets	8,355	5,960	3,560
Total International HSR Markets	**18,345**	**13,585**	**8,750**

8.0 Canadian Penetration of International Markets

In this section we assess the opportunities and constraints that will affect the ability of Canadian manufacturers to penetrate U.S. and other international markets. An examination of the legal elements of the global and regional trading environments (under GATT, FTA and NAFTA) which could impact on Canadian HSR trade has also been included.

The potential Canadian shares of the U.S. and other international HSR markets, based on various Quebec-Ontario HSR project scenarios, are provided at the end of this section.

8.1 The Global Trading Environment

In this section we provide a summary of the research and analysis prepared by our consortium's legal staff. A more indepth evaluation of recent changes to the various international legal trade instruments, and their overall potential impact on Canadian exports, has been provided as part of Appendix A.

8.1.1 GATT and its Codes

From the perspective of the proposed Q/O HSR project, the promise of greater access to the U.S. Federally funded purchases in transportation has, unfortunately not materialized and is, in our opinion, unlikely to materialize.

The GATT as originally negotiated, specifically excluded government procurement from the national treatment standard (GATT III(8)). During the Tokyo Round, a Code on Government Procurement was negotiated but the United States excluded from the Code, purchases by the Department of Transport, AMTRAK and Conrail. As a result, government funded purchases in these areas are largely immune to GATT discipline.

In virtually all negotiations since, U.S. negotiators have steadfastly refused to bargain away that core government procurement function.

The new GATT Procurement Agreement (signed on April 15, 1994 but which can have continued negotiation of improvements until its implementation January 1, 1996), will give Canadian companies enhanced access to U.S. government procurement contracts, although the existing situation with respect to Federally funded transportation contracts is not expected to change.

This procurement agreement is unique among GATT instruments in that it provides that commitments are made on the basis of mutual reciprocity and not on the basis of a most favoured nation obligation. As a result, Canada is still obliged to negotiate commitments with the major trading partners on a bilateral basis and cannot rely on commitments made by its partners to other countries.

The United States and the European Union (E.U.) have already completed their bilateral agreement respecting government procurement. During the U.S./E.U. negotiations, it became clear that U.S. negotiators were prepared to discuss (and perhaps even make commitments on) Federally funded purchases in transportation in the event that the E.U. was prepared to make appropriate concessions. Despite the fact that European Commission officials granted access to the E.U. telecommunications market, a U.S. offer on Federally funded transportation payments did not materialize.

Canada has yet to formulate its offer to the U.S. therefore the coverage of a U.S./Canada agreement is still open. However, given the inability of the E.U. to obtain access to the Federally funded transportation market, it appears highly unlikely that Canada would be successful in that area.

Another relevant element is that the Uruguay Round Agreement on Subsidies and Countervailing Measures seeks to address the uncertainty caused by the lack of agreement on what was countervailable. For the first time in such an agreement, there is a definition of subsidy. In addition, certain types of subsidies will be exempt from countervailing duties provided they are granted and administered in a manner consistent with the Agreement (e.g. subsidies for regional development, the environment and R & D). The new Code will inject more discipline and certainty into the system giving greater assurances to governments seeking to grant aid to industry.

8.2 Canadian Trading Opportunities and Constraints in the U.S.

Canada's trade relations with the United States, governed by regional instruments such as NAFTA and FTA, offer benefits in excess of those set out in the GATT. While the impact of NAFTA and FTA on Canadian HSR trade with the U.S. are discussed here, a more general discussion of these legal instruments, and of recent changes to U.S. trade policy, are presented as part of Appendix A.

8.2.1 Canada - U.S. Trade Relations

Canada has always prided itself on its close relationship with the United States. However, as the recent experiences with steel, beer, pork and lumber and other products seem to show, that close relationship with the United States may be more wishful thinking than reality. Time and again, when the Canada/United States relationship is tested against domestic American interests, the relationship is sacrificed.

As a result, Canada should not look for any special treatment or concessions without being able to demonstrate to the U.S. authorities a clear benefit for the United States. In particular, the possibility of gaining preferential treatment in Buy America projects does not appear to be a reasonable one. Clearly, if such a preference was to be had, it would have been available, at a price, in the FTA or NAFTA negotiations.

8.2.2 The Impact of Buy America

For Federally funded rail projects, Buy America requirements represent the most significant obstacle to Canadian exports. However, as many Canadian companies have shown, there are opportunities for Canadian suppliers who understand how to work within Buy America restrictions.

The details on the operation of Buy America are set out in Appendix B. In this section we will only summarize certain provisions and discuss their impact on Canadian export opportunities.

The core Buy America provision requires that steel, iron and manufactured products used in a grantee project are produced in the United States. Until 1984, cement was included in the Buy America restriction, now non-U.S. cement may be used. It should be noted, however, that pre-cast cement modules would be considered a manufactured product subject to the restrictions.

Canadian companies have been successful in supplying value added steel products to grantee projects by importing U.S. steel and performing additional processes in that steel in Canada for eventual supply to the project.

The major opportunities for Canadian exporters of manufactured products to the U.S. for use in grantee projects is found in the waivers to the Buy America requirements. Waivers from the Buy America requirements are permitted on the basis of four categories, namely;

- public interest,

- non-availability,

- price differential,

- rolling stock and related equipment.

The public interest waiver allows the use of non-U.S. manufactured products when it is determined that such use would be in the U.S. public interest. The non-availability waiver provides for the use of non-U.S. manufactured products when there are no available U.S. manufactured products. The price differential waiver permits the use of non-U.S. products when the cost of using a U.S. product would increase the cost of the contract between the grantee and the supplier of that product by more than 25%.

The **rolling stock waiver** is the most often used waiver and permits the purchase of any rolling stock and related equipment (including train control, communication, signalling and traction power equipment) providing the cost of U.S. origin components is more than 60% of the cost of all of the components and final assembly takes place in the United States. A manufactured product that does not fall within any of the four categories would not be subject to the waiver and the full Buy America requirement would apply.

As the rolling stock waiver permits the use of up to 40% by cost of non-U.S. components, there is an opportunity for non-U.S. suppliers to provide up to 40% of the component requirements of a particular purchase. In theory, the 40% non-U.S. components could be made up of 100% non-U.S. materials.

At the level of sub-components and sub-sub-components, there is a further opportunity for the supply of non-U.S. goods and materials.

A component will be considered to be a U.S. origin component providing at least 50% by cost of its sub-components are U.S. origin and the component is manufactured in the United States. Thus, in the manufacture of any component, there is a possibility for non-U.S. sub-components suppliers to supply up to 50% by cost of the sub-component without effecting the U.S. origin of the component.

A sub-component will be considered a U.S. origin sub-component if it is manufactured in the United States; there is no requirement for domestic content by value in the origin determination of sub-components. Thus, non-U.S. suppliers of sub-subcomponents could theoretically provide even more than 50% by cost of the sub-subcomponents used in the manufacture of a sub-component and, providing the sub-component is manufactured in the United States, the sub-component will qualify as a U.S. sub-component.

As a result, in terms of the theoretical ability of non-U.S. suppliers to provide goods for use in the grantee project, those suppliers could provide;

- up to 40% by cost of all of the components used in the end product;

- up to 50% of the sub-components by cost used in the manufacture of components provided the component is manufactured in the United States;

- an unlimited number of the sub-sub-components used in the manufacture of sub-components provided the sub-components are manufactured in the United States.

While the opportunities to supply goods in contracts governed by Buy America requirements are evident, the most serious hurdle for Canadian suppliers, and in particular, small and medium size suppliers, is the ability to overcome both their own lack of knowledge of the procedures and opportunities and the lack of knowledge on the part of U.S. purchasers. In many instances, the mere presence of a Buy America requirement acts as an overwhelming incentive to consider only U.S. producers even where the Buy America requirements would permit purchases of non-U.S. goods.

8.2.3 The impact of NAFTA

Form the perspective of this study, the most glaring failure of the NAFTA is the continued exclusion of the Buy America provisions from the agreement. We understand that Canadian negotiators made serious efforts to gain some Canadian advantage in the Buy America policy but the policy was viewed as one of the non-negotiable elements of the Canada-United States trading environment.

While Canadian negotiators failed to have U.S. Federally funded transportation projects included in the NAFTA procurement obligations, Canada agreed to have both ***Via Rail Canada Inc. (Via) and Canadian National Railway Company (C.N.)*** comply with the obligations contained in Chapter 10 of NAFTA on Government Procurement. Thus, for any contract for goods and services where Via or C.N. is the contracting party and where the value of the contract is greater than $250,000 ($8 million for construction contracts), both companies would have to follow the strict requirements of the NAFTA in awarding the contract. Those requirements cover publication of tender information, fair qualification of suppliers, time limits for the bids, etc. NAFTA does not allow a covered procuring agency to favour domestic companies or even to favour bids with higher local content. Thus, if any contract to provide goods and services in respect of the Q/O HSR project was to be given by either C.N. or Via, NAFTA's procurement rules would apply unless the monetary threshold was not reached.

To the extent that Canadian goods can overcome the restrictions under Buy America policy, the NAFTA will give the suppliers of those goods an advantage in the American market vis-a-vis third party suppliers. The ongoing tariff reductions negotiated in the FTA, which are continued in NAFTA will give Canadian suppliers an increasing, albeit modest, cost advantage over third country supplies. As a result, U.S. purchasers looking for non-U.S. suppliers are facing a growing incentive to source from Canada rather than from third countries.

We have outlined in Appendix C, the tariff rates applicable to a variety of components and sub-components of a typical high speed train project to show a comparison of the Canadian tariff facing NAFTA qualifying goods and the MFN tariff, the tariff facing most third country suppliers. It will be noted that Canadian suppliers of NAFTA origin goods have a tariff advantage which increases as we approach the end of the NAFTA tariff phase-out period.

By 1998, the tariff on all NAFTA qualifying goods will be zero and the MFN rate will remain the same, unless tariff reductions are negotiated under GATT and that benefit is eroded as U.S. MFN tariff rates are reduced.

It is important to bear in mind that the U.S. tariff applies only to NAFTA qualifying goods. While goods may be produced in Canada, if the Canadian manufacturers use third country materials to produce those goods they may not always qualify for NAFTA treatment.

Given the significant tariff reductions already seen under the FTA, the tariff reductions contained in NAFTA will not significantly increase business opportunities for Canadian suppliers of NAFTA originating goods. The NAFTA benefits that Canadian manufacturers enjoy over third country suppliers of goods to the United States are diluted slightly by the inclusion of Mexico in the trade agreement, however, the Mexican tariff reductions will be phased in over time and Canadian manufacturers will continue to enjoy some benefit even in respect of Mexican producers for some time to come. With respect to HSR, it is assumed that, other than Bombardier's Mexican subsidiary, its industry is not likely to play a significant role in the short to medium term. Bombardier, however, will be given the option of using its subsidiary to supply part of the U.S. market.

The most significant benefit that has arisen out of NAFTA from the Canadian point of view will be the revisions to the Rules of Origin which will reduce the incidents of arbitrary administrative determinations by U.S. customs that Canadian produced goods do not qualify for preferential treatment. The greater certainty in Rules of Origin found in the NAFTA will accrue to the benefit of Canadian manufacturers.

8.3 The U.S. Competitive Environment for HSR Production

The U.S. Rail Manufacturing Industry has undergone a rationalization over the past 5 years. Foreign competition, mainly emanating from Japanese, European and Canadian manufacturers, have either bought out U.S. manufacturers or established new U.S. based facilities.

The main competition will come from the U.S. defense and aerospace industries. With declining defense budgets these companies are desperately searching for new markets to service with their highly technical skills and expertise. In 1992 in California, in a bid for the supply of 87 light rail cars for Los Angeles County Transportation Commission, four bidding teams combining traditional railcar builders with aerospace/defense contractors, had responded. Companies such as Grumman Corporation and Martin-Marietta have spent substantial resources on developing MAGLEV prototypes and technologies.

As can be deduced from the list of U.S. manufacturers provided in Appendix G, essentially the same capabilities exist in the U.S. for HSR as exists presently in Canada. Without the benefit of an extensive search, over 150 manufacturers have been identified that already supply the conventional rail markets. However simply because there exists competition for various componentry, does not mean that there are not opportunities for Canadian manufacturers.

Participation in HSR in the U.S. is also a function of being cost competitive, being part of the winning bid and competing effectively to be included in the bidding process, exploiting the waivers from Buy America requirements and acquiring Prime control over component sourcing.

8.4 Potential Canadian Share of the US Market

Since the U.S. market for HSR components is predominantly based on the adoption of tilting technology, the implementation of a Canadian HSR project and its adoption of a particular technology will have some effect on the potential Canadian share of the U.S. markets.

By using the methodology and assumptions described below, and based on the various technology choice options open relative to the Canadian project, it is estimated that the maximum net Canadian share of the U.S. HSR market is roughly 6 %, or $455 million (Cdn) using the realistic U.S. market size estimates.

The maximum net share is the difference between what would accrue to Canadian industry if the Q/O HSR project adopted the technology that provided the most exports and the exports that will accrue to Canadian industry regardless of whether the Canadian project was implemented.

The various market share estimates and export volumes relative to the optimistic and pessimistic U.S. market estimates are presented in table 8-2 and 8-3, while a breakdown by sub-system and services based on realistic estimates is presented in table 8-1.

Table 8-1
Estimated Canadian Share of U.S. HSR Market
Manufactured Components & Services Above the Rail
Realistic Case Estimates
(Cdn $ '000)

Potential Canadian Share by HSR Sector

Potential Canadian Share by Scenario		Rolling Stock	Power Supply & Distrib.	Communi-cations Equip.	Signal. Equip.	Total Compon.	Eng. &, Project Managem.	Installation Services	Total Services	Total MKT Compon. & Services
With Cdn Proj.– Tilt Tech. Adopted	8.53%	225,925	122,401	37,071	68,484	**453,882**	111,848	79,933	**191,781**	**645,662**
With Cdn Proj.– Non-Tilt Tech. Adopt.	4.46%	133,066	58,594	17,746	32,783	**242,189**	58,481	33,805	**92,286**	**334,475**
Without Cdn Project	2.50%	79,776	31,035	9,399	17,364	**137,574**	32,781	20,267	**53,048**	**190,622**
Max. Net Cdn Proj. Related Exp. To U.S.	6.03%	146,149	91,366	27,672	51,120	**316,308**	79,067	59,666	**138,733**	**455,041**
Each Year Over 20 Years										
With Cdn Proj.– Tilt Tech. Adopted	8.53%	11,296	6,120	1,854	3,424	**22,694**	5,592	3,997	**9,589**	**32,283**
With Cdn Proj.– Non-Tilt Tech. Adopt.	4.46%	6,653	2,930	887	1,639	**12,109**	2,924	1,690	**4,614**	**16,724**
Without Cdn Project	2.50%	3,989	1,552	470	868	**6,879**	1,639	1,013	**2,652**	**9,531**
Max. Net Cdn Proj. Related Exp. To U.S.	6.03%	7,307	4,568	1,384	2,556	**15,815**	3,953	2,983	**6,937**	**22,752**

Table 8-2
Estimated Canadian Exports of HSR Components and Services to U.S. Markets

Total for 20 Years	Mkt Share	Optimistic	Realistic	Pessimistic
Cdn Project Scenarios		**($ Million Cdn)**		
With Cdn Proj & Tilt Tech. Adopted	8.5%	850	645	440
With Cdn Proj & Non-Tilt Adopted	4.4%	440	335	230
Without Cdn Proj	2.5%	250	190	130
Max. Net Proj. Related Exports	**6.0%**	**600**	**455**	310

Table 8-3
Yearly Estimates of Canadian Exports of HSR Components and Services to U.S.

Cdn Project Scenarios	Mkt Share	Optimistic	Realistic	Pessimistic
Each Yr for 20 Yrs		**($ Million Cdn)**		
With Cdn Proj & Tilt Tech. Adopted	8.5%	42	32	22
With Cdn Proj & Non-Tilt Adopted	4.4%	22	17	11
Without Cdn Proj	2.5%	12	10	6
Max. Net Proj. Related Exports	**6.0%**	**30**	**22**	16

8.4.1 Methodology and Assumptions

In determining the potential Canadian market share, a methodology which incorporated the research and analysis undertaken for this study was adopted. It is essentially a process of breaking down the market in terms of the percentage open to foreign competition, then breaking that down further by areas of control over sourcing. Through a process of eliminating the areas where Canada could not participate, a reasonable share of the remaining areas was estimated for Canadian industry based on the following considerations;

- the workings and structure of HSR markets,

- the nature and extent of international competitive forces,

- the timing of the Canadian project,

- established and anticipated Canadian HSR capabilities,

- implementation of a Canadian HSR strategy.

Chart 8-1 is provided on the following page in order to more easily trace the methodology in determining the Canadian share to the U.S. HSR markets.

The methodology and assumptions used to estimate the Canadian potential share of the U.S. HSR markets are as follows;

<u>Foreign Content Allowance</u>

1 The share of manufactured components and services closed to foreign imports is based on our interpretation of the Buy America Act and on our understanding of non-legislated domestic content requirements.

2. All projects will have received some U.S. Federal funding and hence come under the Buy America Act. In attempting to satisfy the non-legislated (80%) domestic content requirement, the primes will follow the specification of the B.A.A., outlined below.

3. The rationale used to determine the allowable non-U.S. content was as follows:

- up to 20% of components above the rail may be supplied by non-US industry except for final assembly.

- of the remaining 80%, up to 50% of the sub or sub-sub-assemblies or materials may be supplied by non-U.S. industry provided assembly is done in the U.S. If it is assumed that the component assembly costs are 25% of the value, then the estimated content available to foreign manufacturers under the sub-assembly exemption would be 30 percent and calculated as follows;

$$(80\% - (80\% \times 25\%)) \times 50\% = 30\%$$

- The total potential value of the manufactured components that can be sourced outside of the U.S. is then 50 percent (i.e. 20% plus 30%). This will at times be referred to as the **Foreign Content Allowance or FCA.**

Control & Distribution of Foreign Content Allowance

4. Primes responsible for rolling stock, electrification, signalling and communications, will control the sourcing for the entire Foreign Content Allowance.

5. European primes will compete in all four sub-systems. U.S. and Canadian primes will compete in all sub-systems except for rolling stock.

6. Of the Total Market;

- 15% relative to rolling stock and 20% for the other three sub-systems, is considered **Noble & Proprietary Componentry** and uneconomic to produce elsewhere than with primary component suppliers.

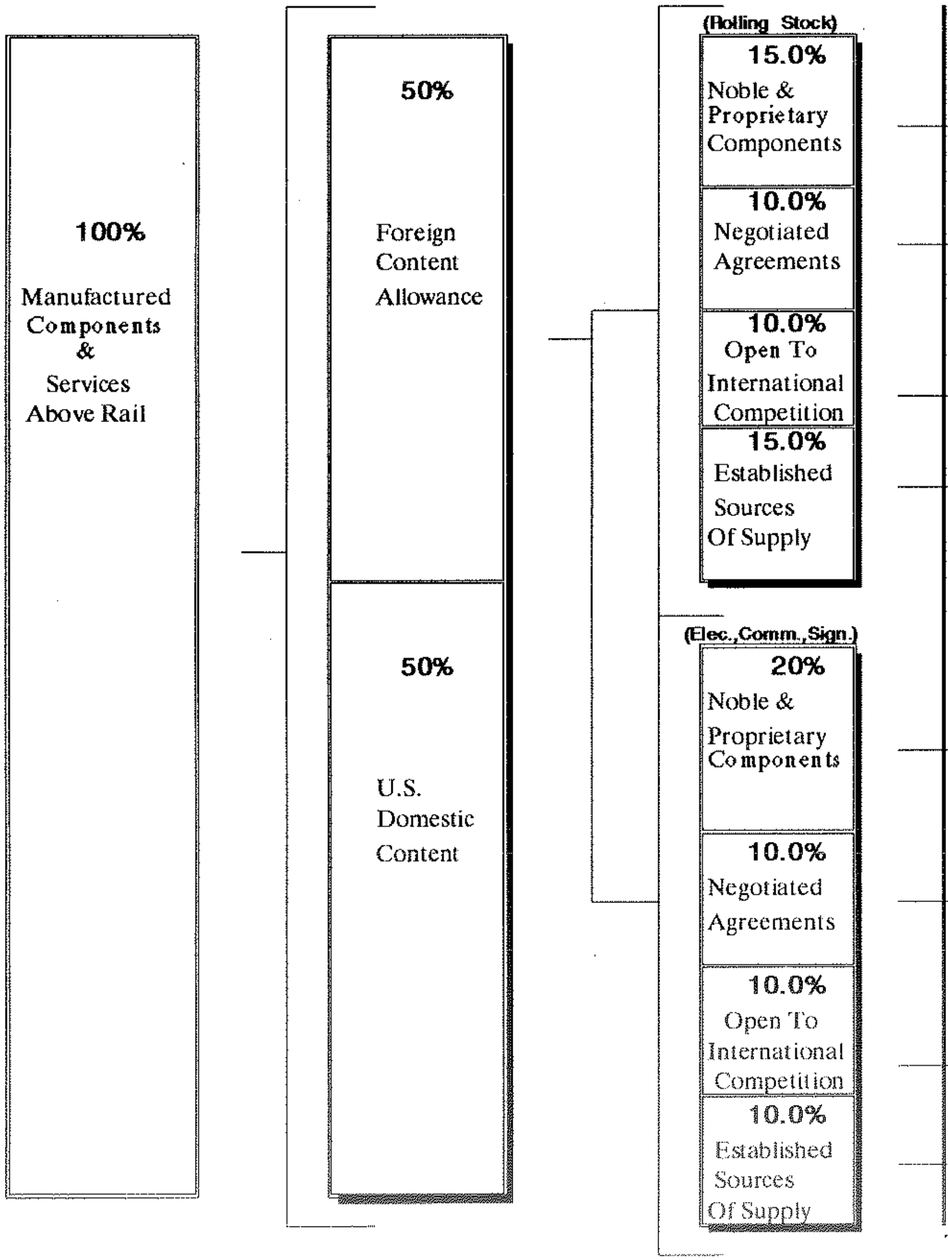
- 10% will be set aside by the primes for **Negotiated Market Participation Agreements**, which are previous obligations to past customers or anticipated obligations to future customers,

- 10% will be **Open To International Competition** as the primes will wish to minimise their costs in order to fulfil their bid price, broaden their potential supplier base and insure that their established sources of supply remain motivated to supply at competitive prices,

- the remainder, (15% for Rolling Stock and 10% for the others) will be supplied by the prime's **Established Sources of Supply** as they will wish to minimise their risk and exposure relative to adopting new sources of supply.

U.S. HSR MARKET FOR COMPONENTS & SERVICES ABOVE THE RAIL

CANADIAN SHARE OF U.S. HSR MARKET FOR COMPONENTS & SERVICES ABOVE THE RAIL



	With Cdn Project Tilt Tech. Adopt	With Cdn Project Non-Tilt Adopt	Without a Cdn Project
(Rolling Stock) Noble & Proprietary Components			
(Rolling Stock) Negotiated Agreements	2.08%	0.42%	
(Rolling Stock) Open To International Competition	5.00%	3.75%	2.50%
(Rolling Stock) Established Sources Of Supply			
Total Rolling Stock	7.08%	4.17%	2.50%
(Elec.,Comm.,Sign.) Noble & Proprietary Components	2.78%	0.56%	
(Elec.,Comm.,Sign.) Negotiated Agreements	0.69%	0.14%	
(Elec.,Comm.,Sign.) Open To International Competition	5.00%	3.75%	2.50%
(Elec.,Comm.,Sign.) Established Sources Of Supply	1.39%	0.28%	
Tot. Elec. Comm. Sign.	9.86%	4.72%	2.50%

Potential Canadian Share of the Foreign Content Allowance

7. Canadian industry's share is assumed to be the following;

- of the portion relegated to **Noble & Proprietary Components**, 3.33% of the FCA controlled by the electrification, communication and signalling primes could be captured assuming that Canadian primes for these sub-systems obtain each one project. (As can be seen in chart 8-1 the distribution of this percentage is 5/6 for the tilt and 1/6 for the non-tilt adoption scenario, resulting in a 2.78% and .56% split).

- to be assured a portion of the **Negotiated Market Participation Agreements** is a function of the Canadian operator's negotiated strategy. Successful negotiations could result in obtaining up to 2.5% relative to rolling stock and .83% for the other sub-systems. This would result from negotiating a 5% share in all the winning prime's U.S. projects. Again this is assuming that the winning rolling stock prime participates in three of the six projects and the others participate in one project each. (Again the distribution of these percentages is 5/6 for the tilt scenario and 1/6 for the non-tilt adoption scenario).

- based on the past competitive position of Canadian firms in related industries, Canadian participation in the portion **Open to International Competition** is assumed to be one quarter (2.5%) if no Canadian project is undertaken. If however tilt technology is adopted in Canada, that figure could be doubled (5.0%) due to increased competitiveness of Canadian industry relative to U.S. componentry market requirements. If a non-tilt technology is adopted, the figure will increase by half (3.75%). (Again these split 5/6 to 1/6 in favour of the tilt scenario.)

- participating in **Established Sources of Supply** could result in up to 3.75% for rolling stock and 1.67% for other sub-systems. It is again assumed that the winning rolling stock primes from the Q\O project participates in half the U.S. projects and that the winning primes in the other sub-systems each participate in one project. (The distribution is also 5/6 tilt and 1/6 non-tilt).

8. In calculating the Total Market Share it was established that rolling stock represents 48% of the total U.S. market for components and services while the other three sub-systems together represent 52%.

8.4.2 Timing of the Projects

As the North-East corridor project will be the first in North America, in order to achieve the export shares described above, it will be important for Canada to be the second project. The potential exports related industrial benefits will be reduced substantially with each passing project in the U.S.

This will be due mainly to factors relating to market acceptance, and market positioning in view of the technology choice in the U.S. If the Canadian choice is in line with the U.S. overall direction, then that choice will have influence on the choice of the American projects.

All U.S. projects being seriously considered are anticipating the results of the technology choice of the North-East corridor as it will be judged to have undergone extensive qualification evaluation and rigorous scrutiny. It is also expected that Canada will have undertaken equally exhaustive research.

To a lesser degree being first after the North-East will be important because many of the U.S. projects will be managed by the same operator who will want standardisation and technology compatibility for cost effectiveness reasons. The few American operators, as a whole, will also not likely want to deal with more than two technologies.

It is anticipated that the prime who wins the first project in the U.S. will win half of the projects. Although the probability is slightly decreased, the second prime selected will stands a chance of winning the other half.

8.5 Canadian Penetration of Other International Projects

Using the same approach and methodology described above, and adjusting for different geographic, economic and competitive environments, we conclude that the net maximum Canadian exports to other international markets is roughly between $85 million and $200 million (Cdn), with $145 million (Cdn) being the results using the realistic market estimates. Tables 8-4 and 8-5 detail the estimated potential exports by technology adoption scenario and for all three case estimates, while a breakdown by sub-system and services based on the realistic estimates is presented in table 8-6.

Table 8-4
Estimated Canadian Exports of HSR Components and Services to Other International Markets

Total for 20 Years	Mkt Share	Optimistic	Realistic	Pessimistic
Cdn Project Scenarios		**($ Million Cdn)**		
With Cdn Proj & Tilt Tech. Adopted	3.7%	305	220	130
With Cdn Proj & Non-Tilt Adopted	2.8%	230	165	100
Without Cdn Proj	1.3%	105	75	45
Max. Net Proj. Related Exports	**2.4%**	**200**	**145**	**85**

Table 8-5
Yearly Estimates of Canadian Exports of HSR Components and Services to Other International Markets

Cdn Project Scenarios	Mkt Share	Optimistic	Realistic	Pessimistic
Each Yr for 20 Yrs		**($ Million Cdn)**		
With Cdn Proj & Tilt Tech. Adopted	3.7%	15	11	7
With Cdn Proj & Non-Tilt Adopted	2.8%	12	8	5
Without Cdn Proj	1.3%	5	4	2
Max. Net Proj. Related Exports	**2.4%**	**10**	**7**	**5**

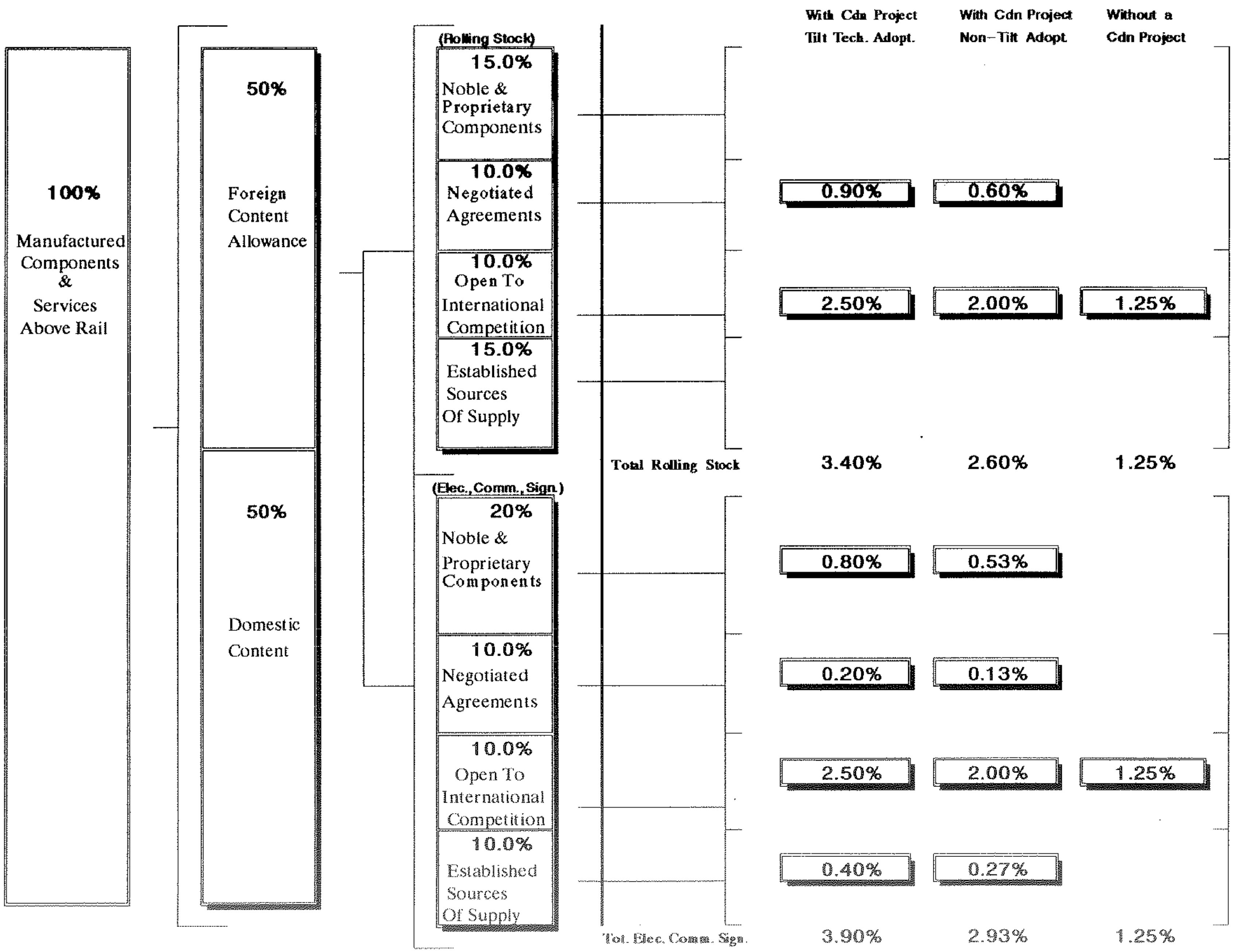
Table 8–6
Estimated Canadian Share of International Markets (excluding U.S.)
Manufactured Components & Services Above the Rail
Realistic Case Estimates
(Cdn $ '000)

Potential Canadian Share by HSR Sector

Potential Canadian Share by Scenario		Rolling Stock	Power Supply & Distrib.	Communi–cations Equip.	Signal. Equip.	Total Compon.	Eng. &, Project Managem.	Installation Services	Total Services	Total MKT Compon. & Services
With Cdn Proj.– Tilt Tech. Adopted	**3.66%**	80,976	40,424	11,533	22,407	**155,339**	37,016	25,697	**62,714**	**218,052**
With Cdn Proj.– Non–Tilt Tech. Adopt.	**2.77%**	61,923	30,370	8,664	16,834	**117,790**	28,015	19,306	**47,321**	**165,111**
Without Cdn Project	**1.25%**	29,770	12,956	3,696	7,182	**53,605**	12,642	8,236	**20,879**	**74,483**
Max. Net Cdn Proj. Related Exp. To U.S.	**2.41%**	51,205	27,467	7,836	15,225	**101,734**	24,374	17,461	**41,835**	**143,569**
Each Year Over 20 Years										
With Cdn Proj.– Tilt Tech. Adopted	**3.66%**	4,049	2,021	577	1,120	**7,767**	1,851	1,285	**3,136**	**10,903**
With Cdn Proj.– Non–Tilt Tech. Adopt.	**2.77%**	3,096	1,518	433	842	**5,890**	1,401	965	**2,366**	**8,256**
Without Cdn Project	**1.25%**	1,489	648	185	359	**2,680**	632	412	**1,044**	**3,724**
Max. Net Cdn Proj. Related Exp. To U.S.	**2.41%**	2,560	1,373	392	761	**5,087**	1,219	873	**2,092**	**7,178**

INTERNATIONAL HSR MARKET FOR COMPONENTS & SERVICES ABOVE THE RAIL

CANADIAN SHARE OF INTERNATIONAL HSR MARKET FOR COMPONENTS & SERVICES ABOVE THE RAIL



8.6 Total Canadian Exports of HSR Components and Services

As can be seen from tables 8-7 and 8-8 below, the total maximum net Canadian exports of HSR componentry and services ranges between $400 million and $800 million (Cdn). Based on the weighted average of the U.S. and other international market share estimates, the net maximum Canadian share of the total international HSR market would be 4.5 %.

Table 8-7
Total Estimated Canadian Exports of HSR Components and Services

Total for 20 Years	Mkt Share	Optimistic	Realistic	Pessimistic
Cdn Project Scenarios	weig. av.	($ Million Cdn)		
With Cdn Proj & Tilt Tech. Adopted	6.4 %	1,155	865	570
With Cdn Proj & Non-Tilt Adopted	3.7 %	670	500	330
Without Cdn Proj	1.9 %	355	265	175
Max. Net Proj. Related Exports	**4.5 %**	**800**	**600**	395

Table 8-8
Yearly Estimates of Total Canadian Exports of HSR Components and Services

Cdn Project Scenarios	Mkt Share	Optimistic	Realistic	Pessimistic
Each Yr for 20 Yrs	weig. av.	($ Million Cdn)		
With Cdn Proj & Tilt Tech. Adopted	6.4 %	57	43	29
With Cdn Proj & Non-Tilt Adopted	3.7 %	34	25	17
Without Cdn Proj	1.9 %	17	14	8
Max. Net Proj. Related Exports	**4.5 %**	**40**	**29**	**21**

9.0 Foreign HSR Strategy Experience

In order to take advantage from the experience of others and to provide a better understanding of the nature and magnitude of a Canadian HSR industrial strategy, this section provides a brief review of the HSR projects initiated in Spain and South Korea and their respective approach to industrial strategy .

9.1 The HSR Project in South Korea

9.1.1 Project Description

Route length:	431 km from Seoul to Pusan
Max. Design speed:	350 kph
Average trip time:	124 minutes
Rolling stock:	TGV Atlantique/AVE technology 46 trainsets of 2 power, 2 booster and 16 passenger cars with capacity for 1,000 passengers.

Signalling, communications and electrification (catenary) are French technology.

Total cost of the project: $13.425 Billion (U.S)

9.1.2 Ridership

In the first year of operation, which is expected to be 2002, it is estimated that 85 million passengers will use the system. By the 10th year of operation it is estimated that 120 million passengers will use the system.

9.1.3 Elements of Industrial Strategy

Objectives:

To maximize industrial benefits for the South Korean industry through the creation of a new industrial capacity, transfer of technology and high-tech spinoffs for existing industry sectors.

Principal elements:

- The development of clear and complete performance specifications.
- The imposition of clear requirements for maximizing industrial benefits for Korean industry.
- The establishment of a strong bidding and negotiations process.

9.1.4 Industrial Benefits to be Achieved

(1) - 34 out of 46 trainsets will be manufactured in South Korea and at least 50% of the sub-systems. Taking account of the minimum amount of non-transferable componentry it is estimated that the net Korean content will be approximately 55% of the value of the manufactured components.

(2) - In terms of technology transfer, all necessary technology for the rolling stock, catenary and train control system will be transferred to South Korea including research, design, manufacturing, testing, operations and maintenance. Licensing agreements, where necessary, will be implemented.

(3) - The creation of a new industrial sector in Korean as the present capabilities are marginal. There is a potential for the export of manufactured HSR rolling stock components to other Asian markets.

(4) - There will be technology spin-offs for the automobile, aerospace, robotics and high-tech communications industries (although it is recognized that the value of these benefits are of a qualitative nature).

(5) - The learning of sophisticated project management techniques for large scale projects in South Korea and for export markets.

9.1.5 Source of Funds

Table 9-1
Korean HSR Project Funding

Source of HSR Project Funding	($ U.S. Million)	
Government subsidies	4.696	35%
Government loan	1.342	10%
Total Public sector	**6.041**	**45%**
Domestic bonds	4.165	31%
Foreign loans (suppliers)	2.472	18%
Private capital	.747	6%
Total private sector	**7.384**	**55%**

9.2 The HSR Project in Spain

9.2.1 Project Description

Route length:	471 km from Madrid to Sevilla
Max.design speed:	350 kph
Rolling Stock:	TGV technology with modified aerodynamics. 18 trainsets of 2 power cars and 8 passenger cars with capacity of 329 passengers.
Signal. & Comm.:	German (Siemens) technology.
Total Proj. cost:	$3.6 Billion (U.S.)

9.2.2 Ridership

In its first year of operation (April 92 to March 1993) the AVE system transported 1.931 million passengers. A forecast of future ridership is not available, however by summer of 1993 the number of commercial flights between the two cities was reduced from 12 to 2.

9.2.3 Elements of Industrial Strategy

"The primary objective was to install the best transportation system while being sensitive to the industrial impact."

Because the system had to be operational in time for the International Exposition in Sevilla in 1992 only about 48 months were available for final planning, negotiations, implementation and testing.

The Prime Contractor - GEC Alsthom - was selected on the basis of proven operational technology and before the issue of industrial benefits was addressed formally.

Spain had comprehensive capabilities in the design and production of conventional speed railway equipment and low-end HSR (TALGO) but its three State owned conventional technology firms were weak, in financial crisis and needed restructuring and modernization.

Although the Talgo technology, independently owned, could have been modified to operate at higher speeds "the political time frame imposed for the project did not make this option feasible."

The industrial benefits objective eventually developed was to correct the weaknesses of the three State owned firms through restructuring, modernization and developing new markets by making them full participants in the project through technology transfer.

The Spanish Ministry of Industry did not play a significant role in project planning and implementation.

9.2.4 Industrial Benefits Achieved

(1) - The transformation of the three State owned firms into a GEC Alsthom Spanish subsidiary with the capability to manufacture many of the HSR components and to assemble and integrate the complete system.

(2) - Technology transfer was achieved at minimal cost - estimated at $1.5 million - through documentation, training and supervision.

(3) - The two independent Spanish firms - CAF and TALGO - also directly and indirectly received HSR technology transfer which can be used to improve their capabilities and products in their own related and other markets.

(4) - Spanish content in the manufactured components is estimated at between 50% and 60%.

(5) - The restructuring and modernization of the State owned industry involves total investment of U.S. $168 million and is expected to be completed in 1996.

(6) - GEC Alsthom Espana is to be used as the supplier of both HSR and conventional technologies for the Latin American market.

(7) - A minimum of R&D was required for the project. Adaptation was required for the integration and higher power requirements of the German signalling and communication equipment and higher temperatures - from 30 to 45c.

10.0 Canadian Industrial Policy Experience

In order to develop a further appreciation for the possible magnitude of a HSR industrial strategy elements, this sections provides an examination of recent and relevant Canadian industrial policy experiences.

Three examples of Canadian industrial strategy planning and implementation experience are outlined in this section.

10.1 Examples of Canadian Industrial Development Strategy

The Canadian Government has, since the early 1970's, implemented an industrial policy to obtain project related or non-related industrial benefits arising out of major procurement projects for both military and civilian uses. Typical large projects over the last twenty years are: the Long Range Patrol Aircraft, the CF18 Fighter Aircraft, the Canadian Patrol Frigate, the Low Level Air Defense System, Radar Modernization Project, Canadian Automated Air Traffic System, Radar Modernization Project, Income Security Programs Redesign, Tactical Command Control and Communications System and Air Canada Passenger Aircraft Acquisition.

Although the implementation of the policy has been considerably refined and tightened over the years, the strategy of using major procurement projects to promote the development and expansion of high technology industry in Canada has never been altered, with the exception of placing a higher emphasis on regional development. Today, most countries have implemented a similar strategy in some form or another.

10.1.1 Policy Objectives

The Industrial and Regional Benefits (IRB) policy currently being implemented generally requires that certain procurement contracts contain opportunities for competitive Canadian companies to participate. Specifically, the policy aims to;

1. provide opportunities for Canadian firms to develop and expand into innovative new technologies and products,

2. encourage Canadian firms to become internationally competitive and establish relationships with industry in foreign countries,

3. provide opportunities for economic and technological development in all regions of the country and encourage small and medium enterprise participation.

10.1.2 Methodology

The approach to achieving the policy objectives is based on three main principles; first, the government plays a pro-active role in encouraging and enabling Canadian firms to develop into capable and competitive units being able to take advantage of high quality opportunities; second to require that Canadian firms are alerted to procurement projects and are invited to compete and third, by placing the IRB package in the competitive process. Bid evaluations contain specific criteria for the quantity and quality of the industrial benefits that can be derived from each project.

Canadian firms are invited to participate as prime contractors, as members of a consortium or as sub-contractors to either Canadian or foreign primes.

High quality industrial/business participation is evaluated on the basis of project related or non-related activities and the measurement factor includes the following:

- investment in facilities, human resource development, research and development, technology transfer, joint ventures and other high quality business relationships such as licensing.

- exposure of Canadian firms to major international projects and/or markets

- obtaining world product mandates for units, components or systems.

- opportunities in project Management and Systems Integration.

- access to activities in projects/markets with similar technology

- opportunities for longer term - life cycle - product modifications and support

10.1.3 Results Achieved

In July of 1992, Industry Canada, which administers the IRB policy, undertook an internal evaluation of the results of this policy (A Review of the Industrial and Benefits (IRB) Policy). Following the analysis of 25 major Crown procurement projects, valued at over $100 million each, and interviews with several dozen companies involved, it was determined that the average Canadian content of the projects was 60% for the overall measurable return to the Canadian economy. The evaluation concluded that there was a $1.16 return for every $1.00 spent on procurement for these projects. With respect to Canadian content it should be noted that infrastructure accounted for only a minor part of total expenditures.

As a further example of the implementation of pro-active industrial strategies and support programs by the Federal Government, the Canadian Aerospace Industry (including Aerospace Electronics) produced $9 Billion of complete systems and componentry in 1992, $6 billion of which were exported. Although these impressive results are not solely due to IRB support, that Strategy and its predecessors were a significant factor in the competitive internationalization of that Canadian industry sector.

The Federal Government's involvement in the Hibernia Petroleum Project was also examined to determine whether an IRB approach was used. In fact it was not, mainly because this project was identified as energy production, thereby meeting other Government objectives, and because the Government's involvement was in the form of a temporary equity participation, without the procurement leverage. It was concluded however that in the industrial development context support for this project resulted in the creation of a high technology niche which had exportable potential.

10.2 Example of an Export Market Penetration Strategy

An example of an export strategy regarding a particular economic sector (although not related directly to a infrastructure or a procurement project) was one developed in 1992 by the Gouvernement du Québec, Ministère de l'Agriculture et de l'Alimentation. This strategy wishes to help develop the Quebec "bioalimentaire" industry with the benefit of strategic elements that were based on the needs and demands of the marketplace.

The industrial and commercial strategy that the ministry has designed aimed essentially to support the "dynamism" of the affected enterprises and their ability to react to constantly evolving market requirements. This strategy closely followed the overall government objectives of; increasing added value of the products; training the present and future labour force and to provide the industry with the appropriate, leading edge tools; and most importantly, to conquer external markets.

The strategic options, directed both at the companies and at the government, were aligned in the context of the markets in order to optimize the potential of this sector. The government planned to help develop the competitive position of the companies with six main action initiatives (what they refer to as orientations). These are;

- favour access to information,
- improve the management of the enterprises,
- invest in innovation,
- develop export markets,

- encourage concertation and strategic alliances,
- support regional dynamism.

A sector action plan was then establish by priorizing a series of ten (10) target sub-sectors of the industry (Cibles d'actions sectorielles) that demonstrate the most opportunity to develop its competitive advantage and penetrate export markets.

The strategic initiatives which seem to be the most relevant to the HSR industrial strategy include; assistance in access to information and to encourage concertation and strategic alliances, as well as helping to develop export markets.

In our opinion, some weaknesses of this particular sector strategy include;

- general approach with limited specific strategic actions (in particular with respect to penetrating export markets),

- no method of measurement in order to determine success of the strategy,

- insufficient evaluation of the potential size of export markets, and of the competition existing in these markets,

- no systematic evaluation of potential trade constraints.

10.3 Example of R&D (Technology) Strategy

The objectives of the Science Council of Canada's Sectoral Technology Strategy (1992) was to first assess the overall competitiveness and ability to export in fifteen sectors (including the automotive-parts and automotive-vehicle sectors, the nonferrous-metals sector and the iron and steel sector) and to develop an appropriate technology strategy to be adopted by Canadian industry in these sectors.

As part of the methodology for developing each strategy, the council sought to assess each sector according to a framework of three strategy classification including "adopt and adapt", "Innovation" and technology "breakthrough". Major companies in these sectors were interviewed and a description of the company was developed involving seven key factors influencing its technology strategy. These factors included competitive position, capacity for innovation and vision, which are internal to the company and four external dynamics such as customer demands, competitive rivalry, supply conditions and available technology.

The methodology to develop an overall strategy incorporated essentially a three-step process for each sector.

1. the main elements in the competitive and R&D performance of the Canadian sector and leading foreign competitors where analyzed,

2. evaluation of this analysis by external experts in the field, and Science Council staff,

3. development of a sector action plan which was produced often in a workshop type environment with the initial contractors, the external reviewers and members of the steering committee (acting as liaison for the particular sector under evaluation.)

The reports indicated that the automotive assembly and parts sector in Canada contributes greatly to the Gross National Product (GNP), exports, and employment. In 1988, they directly accounted for $41 billion of production, $36 billion in exports, and 154 000 jobs. After the signing of the Canada - U.S. Automotive Products Trade Agreement (the Auto Pact) in 1965, Canada's share of North American vehicle production rose steadily from 7.1 per cent to 14.6 per cent in 1988. However, an attendant growth in automotive R&D and supplier activity did not occur.

It was determined that governments can help business in these sectors to sustain long-term competitiveness both by helping to build partnerships between individual firms and by generating consensus on the formulation of innovation strategies within the various industrial sectors. The process of building consensus on a strategy for a particular sector will involve close and on-going consultation with the companies concerning;

- the current role of technology and R&D in the sector,
- the opportunities foreseen and the nature of the source,
- stimuli and forms of technological innovation.

The Science Council hopes that the process of building consensus "will generate commitment to priorities, areas for cooperation, and an agenda for action". Although the "strategies" developed in these reports are general, they are mainly focused on R&D expenditure strategies and "niche-engineering" strategies. The action plans recommend that companies go beyond the "adopt and adapt" strategies, which was found to be the norm within many companies, and towards "innovation" and "breakthrough" strategies. These strategies involve incremental improving on winning technology to get greater market share or even to seek to create a discontinuity in the marketplace, thereby leaping ahead of the competitions. The reports complain that "adopt and adapt" strategies, were at one time necessary but are now insufficient to achieve long term success.

The reports involving the automotive industry warn that as the sector becomes technologically intensive, and the parts sector becomes "tiered", Canada risks losing its share of high value-added jobs. With increased emphasis on product and process engineering, both the assembly and parts plants must be provided with (or develop) process-engineering skills. Failure to do so will lead to the attrition of our basic manufacturing capability and assemblers will prefer to source components from a low-wage country unless sizable value is added on.

Although the respective sizes and relative economic importance of the Canadian Automotive Industry and the potential size of the Canadian HSR Industry are dissimilar, their are important parallels. One of the most prominent being a Canadian automotive parts and components industry which is structured to supply exports to assembly plants located south of the border.

As a general remark, following the conclusion of both the Uruguay round of GATT and NAFTA, Canada will need to review its industrial, export and R&D policies to insure that they are in line with all new negotiated agreements.

11.0 Development of a Canadian HSR Industrial Strategy

Before outlining the various strategic elements of a Canadian HSR Industrial Strategy, it would be useful to review the relevant finding and conclusions that will influence the nature and magnitude of the proposed strategy.

11.1 Summary of Strategic Findings & Conclusions

Canadian Rail Industry Profile

- Canada has developed a strong, fully integrated and internationally competitive industry composed of builders in rolling stock and infrastructure, supported by component and sub-component manufacturers, supplying the North American conventional passenger rail and mass transit markets.

- The Canadian industry includes engineering, manufacturing and assembly of rail cars and locomotives, vehicle components, power supply and distribution equipment, signalling equipment and rail and track equipment for urban mass transit, freight and passenger rail transportation.

- Over 250 companies operating in Canada are currently active in all segments of the rail industry. A large number of these are small and medium enterprises which manufacture components and sub-components to supply almost all of the Canadian Market.

- Examples of industry project participation are: mass transit vehicles and equipment for New York, Los Angeles, Boston, Philadelphia, Montreal, Toronto; the Vancouver Skytrain, the electrification of Tumbler Ridge and of Deux-Montagnes.

- Canadian industry is considered world class for state-of-the-art conventional rail technology. Bombardier is a major player in North America. GM Locomotives Canada has a mandate to build diesel-electric locomotives for world markets.

High Speed Rail Requirements

- HSR technology is an amalgamation of state-of-the-art components and sub-systems (with a few specialised advanced components) which allows for the attainment of speeds considerably higher than conventional technology with safety and comfort. HSR is not a revolutionary technology.

- Two technologies are included in the terms of reference of this study; medium high speed technology that is designed to attain speeds of between 200 to 250 kph and high speed technology that is designed to attain speeds of more then 300 kph.

- There are 9 HSR technology products that are presently in competition within these two technology groups.

  - Medium high speed products include A.B.B.'s X-2000 as well as GEC-Alsthom\Bombardier's hybrid titling system and Siemens\Fiat's hybrid tilting system which are presently in development. (Products that could also be included are the TALGO and LRC which although are older technologies that achieve speeds of only 200 kph, are being considered in certain U.S. markets to satisfy their HSR rolling stock requirements).

  - Higher speed technology products include GEC-Alsthom's TGV, Siemen's ICE train, the Italian ETR 500 and the Japanese Shinkansen, all three of which are non tilt.

Technology Transfer

- Ownership of HSR technology is informal rather than formal and is due to economics rather than to law. Few patents exist. Control is through acquired know-how, product qualification and established market position. However, since HSR technology is sold as a system, effective control of the technology resides with the prime.

- Technology transfer has various levels of complexity. In terms of the value of components and sub-assemblies;

  - 70% to 75% does not require technology transfer or requires the simple transfer of engineering drawings;

  - 10% to 15% requires technical assistance and perhaps some licensing agreements, in addition to engineering drawings;

  - 15% to 20% is considered "noble" and not likely to be transferred for strict economic and proprietary reasons.

  - There are no other constraints to technology transfer.

- The cost of technology transfer, whether it includes technical assistance, licensing agreements or start-up costs, is not constraining.

Research and Development

- For the Quebec-Ontario HSR project, R & D is characterized both as:
  - » the need to adapt HSR technology to North American standards and climatic conditions;
  - » on-going work to further develop the technology in terms of speed, safety, comfort and cost-effectiveness.
- The cost of adapting HSR technology to N.A. is estimated at roughly $20 million (Cdn) to cover some 40 R&D projects.

Canadian Capability Relative to HSR

- A survey was conducted with 40 firms manufacturing in Canada, representing all segments of the industry.
- Survey results:
  - » All firms anticipate no technical or economic obstacles to participating in the Q/O project. All are qualified or in process of qualifying to ISO or equivalent standards;
  - » 26 firms have recent and relevant experience with technology transfer, 6 firms stated that no technology transfer is required;
  - » 20 firms are wholly owned Canadian, 20 are foreign owned subsidiaries;
  - » 21 firms have America-wide mandates for some HSR products, 33 firms export to the U.S.;
  - » 18 firms currently maintain business relationships with suppliers to HSR current projects. Of remaining, 8 invested resources in market research, search for alliances or relevant R&D;
  - » Most firms perceive the Buy America Act as obstacles to penetrating the U.S.

market;

» All firms state that Canadian project component volumes would be sufficient to justify required investment in training, tooling and machinery.

- Canadian consulting engineers and construction companies have capabilities to undertake an HSR project.

- It is estimated that 70% to 75% of components above the rail bed could presently be manufactured in Canada under present capabilities or with a minimal amount technology transfer and assistance.

The Canadian HSR Project

- The manufactured components (above the rail bed) for the Canadian project are estimated at roughly $2.9 billion (Cdn), for both technologies.

- With appropriate strategic initiatives, Canadian firms could supply an estimated 85% of these manufactured components, with little or no cost premiums incurred.

- The distribution of the manufacturing activity would be in the order of 45% Ontario, 35% Quebec and 5% Rest of Canada and 15% imports.

- The remaining 15% foreign content results from the need to import "noble" components, technical assistance as well as some specialised sub-components and materials for component assembly.

- The choice of technology is industrial benefit (IB) neutral relative to the Canadian content of the project.

International Markets for HSR Component and Services

- HSR projects in the U.S. will be implemented in an incremental manner.

- Of the 14 projects identified in the U.S., 6 projects will likely be implemented over the next twenty years.

- It is our conclusion that most U.S. corridors will adopt tilting technology.

- The total U.S. market for components and services above the rail is estimated at between $5.2 billion and $10 billion (Cdn) over a twenty year period, (with a realistic estimate at $7.6 billion). The market for other international HSR project is estimated at between $3.6 and $8.4 billion (with a realistic estimate at close to $6 billion).

Global and North American Trading Environments

- One failure of the NAFTA is the continued exclusion of the Buy America provisions. The possibility of Canada gaining preferential treatment under Buy America is unlikely.
- Both Via Rail Canada Inc. and Canadian National Railway Company are listed to comply with obligations on Government Procurement under NAFTA and must follow strict requirements in awarding major contracts.
- The mere presence of a Buy America requirement acts as an overwhelming incentive to consider only U.S. producers even where the Buy America requirements would permit purchases of non-U.S. goods.
- Opportunities for Canadian exporters exist through waivers to the Buy America requirements. After analysis of Buy America, and an evaluation of non legislated local content rules, it is estimated that 50% of market for components and services above the rail will be allowable foreign content.
- Some relevant benefits of the successful conclusion of the NAFTA include tariff advantages relative to third country imports into the U.S. and specifications on rules of origin regulations.
- Some relevant benefits of the successful conclusion of the GATT include the subsidy to regional development and R&D being exempt from countervailing duties.

Potential Canadian Exports

- Canadian primes could be developed. Canadian consortia in signalling, communications and electrification could emerge to compete in the U.S. market and internationally.
- Main competing factors for achieving U.S. HSR market share;
  - products designed for tilting technology,

» flexibility to conform to requirement dictated by incrementality.

- A realistic maximum net export of Canadian components and services to the U.S. resulting from the Q/O HSR project is 6 %, or roughly $ 450 million (Cdn).

- A realistic maximum net export of Canadian components and services to the other international markets resulting from the Q/O HSR project is 2.4 %, or roughly $ 150 million (Cdn).

Foreign HSR Strategy Experience

- The difference between the HSR industrial strategy objectives of the Spanish, South Korean and Canadian projects are as follows;

  » In Spain, the main objective was to strengthen a weak domestic industry.

  » In South Korea, it is to instate a rail component manufacturing industry.

  » In Canada, it is to maximize the attainment of potential industrial benefits based on an industry that exists and that is relatively strong.

- Key issues relevant to the Spanish HSR industrial strategy include;

  » minimal cost in technology transfer (straightforward, simple and minimum effort) as Spanish industry reached a level of quality comparable to prime suppliers,

  » the Talgo tilt technology that was developed in Spain, was not adopted for their primary and most visible HSR project and has reduced their potential for penetrating the U.S. tilt market,

  » the Spaniards did not incorporate a timely negotiating strategy to maximise industrial benefits and hence resulted in roughly a 55% domestic content. Industrial benefits was a secondary objective.

- Key issues relevant to the South Korean HSR industrial strategy include;

  » it is expected to result in a 55% domestic content because there is insufficient domestic industry capabilities. (Because of a strong bidding strategy they were able to go from a marginal participation up to 55%),

» the bidding process incorporated very clear requirements for maximising industrial benefits,

» establishment of an effective bidding and negotiations process.

Canadian Policy and Strategy Experience Relative to Major Procurement Projects

- Canada has a great deal of experience in maximising the industrial benefits of infrastructure and procurement projects.

- IRB policies were successful in producing industrial benefits for Canada.

- Based on Canadian experience, the most successful R&D initiative for producing industrial benefits are niche-engineering "innovation" or "breakthrough" strategies as opposed to "adopt & adapt" strategies .

11.2 Canadian HSR Industrial Strategy

As a Canadian passenger rail industry exists and possesses most of the required capabilities for HSR, and since technology transfer in non-constraining and constraints affecting export market participation cannot be influenced by public policy, there is limited scope for developing an HSR industrial strategy in Canada.

Within this limited scope however, 7 strategic elements have been outlined that could maximize the attainment of potential industrial benefits resulting from the implementation of the Quebec-Ontario HSR project. The means of affecting the maximization of the potential benefits, which are implicitly incorporated into the strategic elements, include;

- maximising the Canadian content in terms of the manufactured components required to undertake the Q/O HSR project,

- maximising the Canadian export of HSR components and services to the U.S. and other foreign markets.

- maximising the Canadian participation in R&D expenditures related to the adaptation and ongoing development of the chosen technology.

11.2.1 Proposed Strategic Elements

The strategic elements presented here have been developed predicated on the assumption that the project will be implemented by the private sector, with public sector support, and that the competitive process will initially be based on performance specifications for the HSR system as a whole.

Of the seven strategic elements provided, only the first element is technology specific. The other six elements are technology neutral and should be implemented regardless of which of the two technologies is adopted in the Q/O corridor.

The required elements include;

1) Technology Choice

2) Timing of Canadian Project

3) Competition

4) Formation of Canadian Primes

5) Negotiation of Industrial Benefit Agreements

6) Government Support Programs

7) R&D Strategy

1) Technology Choice

Considering our findings that the same industrial benefits will result from the construction and operation of the Canadian project using either technology and that exports will be maximized by adopting tilting technology, from a strictly industrial benefit perspective, tilting technology should be adopted in the Q/O corridor. This conclusion is not inconsistent with the findings of the economic impact study (volume I) if viewed with respect to the direct and indirect effects on the railway industry and its associated suppliers.

The overall economic impact results however suggest that adopting tilt technology could provide slightly less employment, income and GDP since it has been found that this technology would attract fewer riders and would require more public funding to operate. Based on the assumption that the project would be funded by public sector expenditure reallocation, relatively more negative economic impacts will occur from the implementation of tilting technology in other industrial sectors not related to the railway industry. It could be argued therefore that based on overall economic impact results emanating from this funding assumption, non-tilting technology should be favoured.

If the choice of technology however is based strictly on a criteria of maximized industrial activity within the Canadian railway sector and its associated suppliers, the **Q\O HSR project should favour the adoption of a tilting technology.**

2) Timing of the Canadian Project

As discussed in section 8.4.2, the timing of the Canadian HSR will be important in terms of maximizing export related benefits. The potential export related industrial benefits will be reduced substantially with each passing project in the U.S.

As the North-East corridor project will be the first in North America, it will be very important for Canada to be the second project.

A main element of the industrial strategy is that **if Canada decides to implement an HSR project, that a decision be made prior to the 2nd U.S. project.**

3) Competition

The project should involve separate RFPs for each sub-systems, specifically with respect to rolling stock, electrification, signalling and communication. These RFP's should be provided to all potential international competitors.

In addition to clearly stated performance specifications within the RFPs, guidelines should be provided to clearly indicate the anticipated industrial benefits to be derived from the project. The RFPs should also request that a clear plan regarding the attainment of the prime's IB objectives be included in all bid proposals.

Following this approach, bid evaluation will be based on a combination of the potential prime's ability of meeting performance specifications, price and industrial benefits.

The guidelines proposed as part of the RFP should cover Canadian content relative to the Canadian project, to U.S. and other international projects and to R&D.

The RFPs should also include guidelines relative to the elimination of technology transfer obstacles and the minimization of any cost premiums related to attempting to achieve the proposed industrial benefit objectives. Managing technology transfer should be the direct responsibility of the primes.

It is important to insure that only guidelines are provided since allowing flexibility and market forces to influence the specific structure of the prime's Canadian participation are important means for the prime of insuring costs premiums (if any) are minimized.

The mere presence of a competitive bidding process should help to reduce the instance of cost premiums. Costs, if any, associated with meeting Canadian content levels, should be clearly identified and defined by the potential prime.

The governments should also provide to each interested bidder an inventory of potential Canadian suppliers which would outline their capabilities and qualifications.

A main element of the industrial strategy is **to have individual HSR sub-systems open to a competitive international bidding process.**

4) Assist in the Formation of Canadian Primes

In view of maximizing export related benefits, the governments should encourage and support Canadian firms to enter into alliances (where required) with other Canadian or foreign firms, in order to take leadership roles in the areas of electrification, signalling and communications.

These firms or alliances could effectively develop distinct competitive advantages that would enable them to effectively compete for the Canadian as well as international projects.

The governments should also identify appropriate Canadian and foreign firms and provide potential Canadian primes (leaders) with support regarding the potential export market opportunities.

The main factors influencing the choice of foreign partners should be technology contribution and knowledge of foreign markets.

R&D should be encouraged that would help maximize the distinctiveness and contribution of Canadian technology in these three sectors. Examples could include refinement of satellite technology and long range sensing with regard to developing a distinctive Canadian HSR signalling technology. The adoption of this new technology for the Quebec-Ontario project could provide it with the status of being a commercially proven state-of-the-art technology, providing it with a competitive advantage in foreign markets.

A main element of the industrial strategy is **the encouragement and assistance for the formation of Canadian primes in signalling, communications and electrification.**

5) Negotiation of IB Agreements

An industrial benefit agreement should be a main element of negotiation with each potential wining prime for each sub-system.

Within the IB agreement the following five subjects should be addressed;

Canadian Content

Based on this study's assessment of attainable levels of Canadian content, the following guidelines for the sourcing of componentry and related manufacturing activity should be established as the minimum negotiating position for the operator. These guidelines include;

Rolling Stock	85%
Power Supply & Distribution	88%
Signalling	70%
Communication	80%

It is assumed that labour expenses related to installation will be 95% Canadian content and that those relating to project management will be 90% Canadian.

Technology Transfer

It will be the responsibility of the prime contractors to transfer or have transferred, where there is a need, all necessary drawings, documentation, training, supervision, tools, engineering exchanges etc. in order to meet its negotiated Canadian content obligations.

Penetration of International Markets

Prime contractors should guarantee, a minimum Canadian content of 5% of the manufactured components sourced from all international projects in which they participate.

Adaptive R&D

It should be required that all adaptive R&D undertaken relative to the Q/O HSR project, by the project manager or the prime contractors, should be undertaken in Canada with 95% Canadian content on labour and 85% Canadian content on materials.

Other Project Related and Unrelated Industrial Benefits.

Examples of other project related IBs could involve ongoing R&D related to the evolution of HSR (including a preference for any R&D done relative to MAGLEV technology), or investment in related or unrelated sectors of manufacturing activity.

A main element of the industrial strategy is **the negotiation of an IB agreement which would include a specific plan relative to Canadian content, technology transfer, penetration of international markets, adaptive R&D, and other IBs.**

6) Government Incentive & Support Programs

In support to Canadian firms in order to strengthen and build on existing Canadian capabilities, the Canadian and Provincial Governments should first and foremost review pertinent support programs to ensure their relevancy for the potentially specific needs of firms in this sector.

The tools which are at the disposal of the Governments in order to help build on Canadian capabilities, as well as implement the strategic elements presented above, are those various means, incentives and support measures common to most governments. These will not be described in any detail here. They include;

Industrial Development; such as direct investment (grants & contributions), tax credits or other fiscal incentives, consortium facilitation programs, manpower & skill training etc.

Export Promotion; such as missions and promotion of alliances (e.g. actively persuing alliances with U.S. defense contractors), funding of market and feasibility studies etc.

R&D; such as direct investment or tax credits.

As part of the HSR industrial strategy, the governments should have an information strategy which would establish a Government/Industry structure with responsibilities which could include the following;

- prepare a project by project identification of structure, technology, volume, timing, special content conditions and likelihood of implementation. This should be done for all potential international projects and distributed to Canadian manufacturers.

- prepare documentation on evolving U.S. policy regarding support for potential U.S. projects including financing and legislative support.

- inform Canadian companies with respect to the precise rules of trade with the U.S. in this industry sector. Inform them of the exact nature of language of the Buy America legislation, as well as the WBE and DBE legislations.

- actively promote the participation of Canadian manufacturers in international projects by arranging seminars, missions, visits and introductions in Canada and in export markets.

A main element of the industrial strategy **is for the government to use appropriate tools in helping develop Canadian capabilities in HSR and to implement an information strategy relative to HSR.**

7) R&D (Technology Development) Strategy

As an element to the industrial strategy that would be supplemental to the terms of reference of this study, an R&D or technology development strategy could be undertaken **independently of a Canadian HSR project**. The implementation of this strategy could increase the prospects for industrial benefits arising from exports into international markets.

A technology development strategy, based on niche-engineering, would involve the design and/or development of products able to respond to the market requirements in the U.S., specifically with respect to the phased requirements of the incremental approach, and the anticipated arrival of very high speed rail MAGLEV technology.

As part of this supplemental strategic element we have outlined four R&D projects that could be initiated/supported by the governments of Canada in alliance with the private sector. These potential projects are briefly outlined below in order to encourage technical discussions. No attempts have been made to cost out these opportunities or quantify the potential industrial benefits arising from them. What is known however is that these project would strengthen Canada's ability to penetrate all international markets and increase the likelihood of achieving the market shares that were estimated in section 8 of this study.

These projects include the development of distinctive Canadian technology in the areas of HSR tilting, signalling, communications, turbine locomotives and MAGLEV.

Upgrade of Canadian developed tilting technologies

Facilitate Bombardier in the upgrade of the LRC tilting technology by supplying appropriate R&D tax credit and by making available all appropriate and available government resources and facilities to accomplish this goal as soon as possible.

Development of Canadian Capabilities in Signalling and Communications

These two economic sectors are in line with Canada's overall technology development strategy and revealed comparative advantages. Canada already has developed expertise in long range sensing, satellite and fibre optics technologies that could be used in developing these HSR sub-systems.

Although the Canadian capabilities in these sectors has been discussed in sections 2.3 and 5.4, as well as part of the fourth strategic element of the HSR industrial strategy outlined above, it is important to note that support for these R&D projects should be initiated as soon as possible and independently of whether a Canadian project is undertaken.

Also, as part of an HSR signalling technology strategy, the opportunities of developing car barrier netting that would be used as a more effective vehicle impediment safety measure at grade crossings, should be investigated.

Development of Dual Powered Turbo Locomotive Technology

Encourage and support the further development of existing Canadian capabilities in turbo locomotive technology that could satisfy the upcoming needs in the american market place.

Amtrak's stated objectives, of initially equipping its "hybrid" HSR systems with turbo locomotives prior to the electrification of some corridors, presents a strategic opportunity for Canada as the GM locomotive plant located in London (Ontario) holds the North American product mandate for GM. Joint initiatives in this area of R&D or traditional incentives and credits should be considered as soon as possible.

Canada, having already developed experience in this area could act quickly to establish a competitive technology advantage, in line with Amtrak's anticipated requirements.

Development of a MAGLEV Strategy

As discussed in section 7, it is probable that lower speed steel wheel HSR technology only be implemented as a transitory solution in the U.S. in anticipation of the commercial application of a U.S. developed MAGLEV technology. If so, the commercial application of this technology should come in approximately twenty years time. If significant U.S. government funding initiatives for MAGLEV are advanced in the coming years, Canadian governments, in association with Canadian industry, should initiate a MAGLEV technology strategy in anticipation of its commercial implementation.

This Canadian MAGLEV technology strategy should be a niche-engineering product development strategy based on market requirements which would concentrate on a specialised technical capability to insure participation through competitive advantage ("Canadarm" type strategy). This strategy should also take into consideration the considerable work that has been initiated by Transport Canada's Transport Development Centre regarding MAGLEV.

This technology development strategy could include initiatives such as;

- a market study to determine the size of the future market potential and the industrial benefits that could be expected for Canadian industry,

- facilitate private sector R&D and product development in MAGLEV,

- assist in the formation of strategic alliances in product development between Canadian companies and U.S. defence contractors who are presently active in developing MAGLEV technology.

A main element of the industrial strategy **is a R&D strategy that could be developed and implemented regardless of the Q/O HSR project.**

12.0 Addendum Regarding Franco-Canadian Tilting Technology

Although the terms of reference for this study did only foresee the possibility of identifying scenarios involving commercially operational systems, such as the representative X-2000 and the TGV, a short assessment of potential industrial benefits from the adoption of a new Franco-Canadian system is warranted due to its recent implication in the North-East corridor project.

As discussed in sections 7.2, based on specific performance specifications, Amtrak has qualified three systems to compete for the supply of 26 trainsets for their HSR project linking Washington, New York and Boston. One of these qualified systems is the GEC Alsthom/Bombardier hybrid technology based on both the TGV and LRC technologies. It is estimated that up to 30% of this combined technology would be Canadian.

We anticipate that all three competing systems have an equal chance of being awarded the contract in the North-East corridor. Although in theory only one systems (the X-2000) has achieved commercially operational status, in practice, due to the nature and extent of the technical specifications demanded by Amtrak, all three primes must adapt their initial systems to conform with performance targets. In practice, none of these redesigned systems have been commercially tested. Also, since they have been qualified technically, Amtrak feels that all three primes (and their associated builders) have the ability and experience to supply a commercially viable system within the stated production delivery and system operating schedule.

With the assumption that the Franco-Canadian tilt system is purchased for the North East corridor project and that this system is adopted for the Canadian project, it is estimated that the maximum net Canadian project related exports to the U.S. will be $575 million (Cdn) (based on the realistic market estimates).

These results are based on the same assumptions and methodology outlined in section 8.4.

If compared with the level of exports presented in table 8-2 of section 8, this new scenario results in a total increase of $120 million (Cdn).

Without including the increased industrial benefits resulting from greater Canadian participation in other international projects, it is evident that this new scenario would maximise the potential industrial benefits arising from the Quebec-Ontario HSR project.