TP 13947E

THE CANADIAN BUS INDUSTRY and its RESEARCH and DEVELOPMENT NEEDS

JUNE 2002

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by
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Robert Tremblay, Cohésion RC Inc.

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Since the accepted measures in the industry are both imperial and metric, both measures appear in this report.

Unless stated otherwise, all monetary values are in Canadian dollars.

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16. Abstract

This study identifies future research and development (R&D) needs and priorities within the Canadian bus industry, and identifies and determines a future role for Transport Canada in bus and coach R&D.

It also provides a portrait of the urban, intercity, school transportation and paratransit/shuttle bus transportation industry in Canada. Interviews with industry representatives and research indicate that the industry in Canada operates more than 55,000 vehicles, employs more than 85,000 people and has annual expenditures of $5.38 billion. The industry in the U.S. and Canada spends an estimated $188.3 to $214 million annually on R&D, of which approximately $24 to $30 million is spent in Canada. Transport Canada's level of R&D investment has averaged $300,000 annually. In contrast, annual U.S. government investment in transit industry R&D averages $14.25 million.

Considering the role and priorities of Transport Canada, three areas of R&D needs were identified as priorities for future investment: vehicle weight reduction, with an emphasis on the use of lightweight material and material-forming process technologies in bus manufacturing; research studies in partnership with the Canadian Urban Transit Association and the Canadian Bus Association; and public transportation ITS development and deployment initiatives.

The study makes five recommendations to guide Transport Canada in investing in bus transportation industry R&D, including a recommendation that the investment in new bus technology be supported by federal government financial incentives to encourage the purchase of lighter-weight, more fuel-efficient and technologically advanced buses.

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16. Résumé

La présente étude recense les besoins et priorités futurs de l'industrie canadienne de l'autobus/autocar en matière de recherche et développement (R&D) et détermine le rôle de Transports Canada dans cette R&D.

Ce rapport trace également le portrait de l'industrie du transport par autobus au Canada, soit du transport urbain et interurbain, du transport scolaire et du transport adapté/spécialisé (navettes). Selon les données communiquées par des représentants de l'industrie et glanées au cours de la recherche, l'industrie canadienne de l'autobus/autocar exploite plus de 55 000 véhicules, emploie plus de 85 000 personnes et dépense 5,38 milliards $ par année. On évalue entre 188,3 et 214 millions $ les montants annuels consacrés par l'industrie à la R&D, aux États-Unis et au Canada, et entre 24 et 30 millions $ la part de l'industrie canadienne. Les investissements de Transports Canada dans la R&D s'établissent à 300 000 $ par année en moyenne. Par contraste, le gouvernement américain investit en moyenne, annuellement, 14,25 millions $ dans la R&D touchant cette industrie.

Compte tenu du rôle et des objectifs de Transports Canada, les chercheurs ont déterminé trois domaines de recherche dans lesquels il y aura lieu d'investir en priorité dans l'avenir : l'allègement des véhicules, par l'utilisation de matériaux légers et de procédés de formage des matériaux, dans le secteur de la fabrication d'autobus; la réalisation d'études en collaboration avec l'Association canadienne du transport urbain et l'Association canadienne de l'autobus; et le développement et la mise en œuvre de STI adaptés aux transport publics.

L'étude formule cinq recommandations qui indiquent à Transports Canada des pistes pour investir dans la R&D se rapportant à l'industrie du transport par autobus. Selon une de ces recommandations, le gouvernement fédéral devrait soutenir l'investissement dans les nouvelles technologies applicables aux autobus en offrant des incitatifs financiers pour encourager l'achat d'autobus plus légers, consommant moins de carburant et utilisant des technologies de pointe.

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EXECUTIVE SUMMARY

BACKGROUND

The purpose of this study is to identify future research and development needs and priorities within the Canadian bus industry and to identify and determine a future role for Transport Canada in bus and coach design R&D. A particular focus of this study is on the potential for the use of lightweight material and material-forming process technologies in the industry. Funding for this study has been provided by Natural Resources Canada's Panel on Energy R&D (PERD) program, the Canadian Lightweight Materials Research Initiative and the Transportation Development Centre (TDC).

Over the past 15 years, TDC has led an advanced technology bus development program in support of the federal government's sustainable transportation policies and goals. The objectives of the program have been to:

- promote energy efficiency in public transportation through the development of urban bus and intercity coach designs that reduce energy consumption and exhaust emissions;
- promote the use of cleaner and more efficient propulsion systems and lighter weight vehicles; and
- develop vehicle designs that will further the market share in Canada and the U.S. of Canadian bus and coach manufacturers.

A number of changes in the industry have brought into question the value of Transport Canada's R&D programs and particularly its role in bus R&D. These changes include:

- the increasing dominance of foreign ownership of Canada's bus manufacturers;
- increased pressure to comply with United States laws and regulations; and
- differences in public transportation funding between the United States and Canada.

TDC's ADVANCED TECHNOLOGY BUS PROGRAM

Transport Canada's research and development activities in the bus industry have been delivered through the Advanced Technology Bus Program administered by TDC since 1985. The program has consisted of research initiatives focused on bus design changes and product advancement as well as studies into emerging bus design issues, such as low-floor buses and accessibility features.

The total value (including "in-kind" support by partners) of TDC's R&D work undertaken over the past 15 years totals $18,545,100, of which the project partners contributed $11,264,300 or 60.7 percent of the total. Transport Canada, through the Transportation for Disabled Persons Program and TDC programs, and PERD invested $4,832,167 or 26.1 percent of the total. TDC's share of this amount was $3.1 million or 16.8 percent of the total investment.

Many of the projects have contributed significantly to product development, such as the Prévost H series coaches and New Flyer's low-floor articulated bus, and to research into reducing vehicle weight, as exemplified by the studies on the impact of vehicle weight on road damage and fuel consumption, and the work with Prévost Car. However, the relatively small R&D budget available, an average of $300,000 per annum, greatly limits the opportunity for Transport Canada to effectively influence emissions levels (and thus greenhouse gas (GHG) emissions) from public transportation vehicles and improve fuel economy.

U.S. RESEARCH AND DEVELOPMENT PROGRAMS

In contrast, the United States government has an active and well-funded research and development program included as part of the TEA-21 public transit funding Act. These programs include the Transit Cooperative Research Program and the Altoona Vehicle Test Center, as well as other R&D activities. Total annual U.S. federal funding support has totalled approximately $14.25 million per year among the above programs. While the U.S. federal government does not provide direct funding for the transit bus industry, it does ensure, through the Buy America Act, that public funding is directed toward the U.S. bus manufacturing industry. This Act has served to protect the industry and has recently been responsible for some job shifting from Canada to the U.S.

In addition to the federal funding programs, many of the U.S. states provide funding for transit-related R&D. The most prominent has been California, with the amount of funding provided annually totalling approximately $10 million.

Private institutions and agencies (e.g., the Northeast Advanced Vehicle Consortium) as well as private sector companies add to the funding provided to transit and transportation-related projects in the U.S.

PUBLIC TRANSPORTATION INDUSTRY IN CANADA AND THE U.S.

The public transportation industry, the bus manufacturing industry and the market for buses and coaches in Canada and the United States are highly integrated and share similar characteristics. However, the Canadian industry and vehicle market has distinct differences, reflecting a stronger support for and use of public transportation in Canada.

The service delivery segment of the public transportation industry encompasses a wide range of services, including:

- urban and rural conventional and paratransit bus services;
- intercity highway coach services, including charter and tour services;
- light rail, heavy rail and commuter rail services;
- shuttle services at airports and to hotels; and
- school student transportation.

Table 1 provides an overview of the public transportation industry in Canada compared to the U.S.

TABLE 1
OVERVIEW OF PUBLIC TRANSPORTATION INDUSTRY IN CANADA AND THE U.S.
(CDN $)

Industry Sector	Country	No. of Service Providers	Operating Expenses	No. of Employees	Fleet Size	Passengers Carried	Kilometres Operated
Urban Transit	Canada	95	$3.40B	39,500	13,000	1.44B	0.81B
	U.S.	800	$33.3B	350,000	92,455	9.17B	6.4B
Intercity Coach	Canada	48	$ 353M	10,000	4,000	14.0M	150.0M
	U.S.	400	$4,500M	30,000	40,000	140M	3,750M
School Transportation	Canada	649	$1,400M	31,000	38,800	2.5M	646.1M
	U.S.	6,600	$11,746.5M	N/A	448,300	23.7M	6,115M
Charter/Tour	Canada	101	$225M	5,000	Included with Intercity	N/A	135.3M
	U.S.	3,200	$3,927M	110,000		N/A	N/A

BUS AND COACH MANUFACTURING INDUSTRY IN CANADA AND THE U.S.

The bus and coach market in Canada and the United States can be divided into four distinct product segments:

1. Urban transit buses
2. Intercity coaches
3. School purposes buses
4. Shuttle and paratransit buses

Table 2 summarizes the size of the bus manufacturing industry by vehicle type for each country, together with population and number of bus and coach manufacturers for each product segment.

TABLE 2
NORTH AMERICAN BUS AND COACH INDUSTRY
KEY STATISTICS

Country	Popu-lation (millions)	Market Size						Number of Manufacturers*					
		School Buses	Transit Buses		Coaches	Shuttle	Total	School Buses	Transit Buses		Coaches	Shuttle	Total
			< 9.1 m	> 9.1 m					< 9.1 m	> 9.1 m			
Canada	30.0	38,000	200	11,300	4,000	2,500	56,000	2	1	3	2	0	8
United States	282.0	448,000	2,000	74,000	40,000	30,000	594,000	5	8	3	2	10+	28+
Total	312.0	486,000	2,200	85,300	44,000	32,500	650,000	7	9	6	4	10+	36+

* Manufacturers are listed by country of head office and by predominant product line. Many have facilities in more than one country and produce more than one product line.

KEY INDUSTRY INFLUENCES AND ISSUES

The bus and coach manufacturing industry has undergone significant change over the past decade. New products and new technologies have been introduced and there has been consolidation and contraction. Key product and technology changes include the following:

– Introduction of **low-floor urban bus designs**.

– **New engines and transmissions**. Two-cycle diesel engines replaced by 4-cycle engines to meet increasingly stringent emissions standards in the U.S. and Canada. New transmission models to match the power and performance requirements of the new engines.

– **New axles and suspension systems** to meet the urban bus low-floor designs.

– Introduction of **new intercity coach models**. European influenced styling and a 13.7 m (45 ft.) long vehicle with wheelchair accessibility features.

– **Globalization of manufacturers**. Volvo AB and Daimler-Chrysler (Mercedes-Benz/EvoBus) have entered the North American market and purchased several bus and coach manufacturers. North American Bus Industries purchased the U.K. manufacturer, Optare PLC, while Chance Coach of the U.S. manufactures a small bus product developed by Wright's of Northern Ireland.

– **Consolidation of manufacturers**. Volvo AB has brought NovaBUS, Prévost and Blue Bird Body together under one ownership; Daimler-

Chrysler has brought together Orion Bus Industries, Thomas Built Buses, Setra North America and Detroit Diesel under one ownership.

Aside from the foregoing, there have been governmental and legislation changes that have influenced the bus and coach manufacturing industry in North America. The main ones include the following:

- U.S. Buy America Act
- Americans with Disabilities Act
- Federal Transit Administration (FTA) and American Public Transportation Association book of standard specifications and procurement ("White Book")
- Structural integrity testing requirements (Altoona Test, ORTECH "shaker" test)

Of these, the most influential has been the U.S. Buy America Act, which has had the effect of requiring manufacturers wishing to access the bus and coach market in the U.S. to maintain a manufacturing plant there, to meet a 60 percent U.S. content requirement and to complete final assembly in the U.S.

VEHICLE DESIGN AND MANUFACTURING PROCESS

The design, development and manufacturing process for buses and coaches is lengthy and complex as well as being highly specialized and subject to significant external influences.

Design Principles

All bus transportation vehicles in Canada and the U.S. are virtually identical in design and specification, with a high degree of parts commonality largely as a result of the predominance of U.S.-made major components such as engines, transmissions, axles and air conditioning. Notably, none of these components is manufactured in Canada.

Urban and intercity bus designs are "integral". They consist of a physical structure incorporating the chassis onto which the drive-train and axles are attached. The manufacturer then installs a variety of sub-components that have been designed and manufactured by suppliers. The frame and side wall components are fabricated using very basic bending and cutting processes. Some exterior body parts (front and rear end caps) are formed from plastic composite materials and affixed to the frame with rivets or screws. Some of these composite material parts may be affixed with special industrial glues. Interior floors consist of a treated plywood base covered by a rubber material or compound. Thus, the bus and coach manufacturer is essentially an "assembler" of components.

For school bus and shuttle vehicles, the chassis and body are separate, usually being made by separate manufacturers (in some cases, one manufacturer may make both). For these vehicles, the chassis, including the engine, transmission and axles, is generally identical to that used in trucks or in van applications and thus benefits from a lower cost structure. They benefit as well from the sharing of engineering and development costs that are spread over a much higher volume. School bus chassis sales total 35,000 to 40,000 units per year. Urban transit and intercity coach sales together total fewer than 10,000 units per year.

Design Development

From first concepts, the usual timeframe to bring a new vehicle to market can take four to five years. The vehicle goes through extensive testing, usually including completion of structural design and integrity tests at both the U.S. Altoona Test Center and Canada's Ortech test centre. These tests can take up to nine months to complete and can cost as much as $400,000.

Because of the specialized nature of bus and coach designs, many of the components involved are made for buses and coaches. Even the engines and transmissions, which may have a common design with trucks, incorporate very different features, particularly with regard to emissions reduction features and component drives.

Procurement Process

The vehicle procurement process has a significant influence on vehicle designs and specifications. For urban buses, the procurement process is particularly difficult and lengthy and can take as long as two years from the time the vehicle specifications are issued by the purchasing authority to the time the vehicle is delivered. The procurement process for school buses, shuttle/paratransit buses and intercity coaches is much simpler, relying oftentimes on a straightforward contract and resulting in delivery times of six months or less for school and shuttle buses, and six to nine months for intercity coaches.

BUS AND COACH MARKET SIZE

The annual market for buses and coaches in Canada and the U.S., based on the period from 1996 to 2000, is summarized in **Table 3**.

TABLE 3
ANNUAL BUS AND COACH MARKET

	Canada	U.S.
Transit Buses	600	4,200
School Buses	3,800	39,600
Intercity Coaches	350	3,000
Shuttle Buses	1,000	10,000
Total	*5,750*	*56,800*

The bus and coach markets in Canada and the United States are highly integrated, with the Canadian market for buses, coaches and school purpose vehicles being approximately 10 percent that of the United States. Canadian bus manufacturers dominate the Canada-U.S. market because of lower production costs, higher quality in manufacturing and a demonstrated record of innovation. Canada is home to three of the six urban transit suppliers, two of the five highway coach manufacturers (two of which do not manufacture in North America) and two (plus two subsidiaries) of the five school bus manufacturers. Clearly, Canadian manufacturers depend heavily on the United States market for their existence.

The key Canadian bus and coach manufacturers are:

Les Entreprises Michel Corbeil, Laurentides, Quebec
A. Girardin Inc., Dummondville, Quebec
Motor Coach Industries, Winnipeg, Manitoba
New Flyer Industries, Winnipeg, Manitoba
NovaBUS Corporation, St. Eustache, Quebec
Orion Bus Industries, Mississauga, Ontario
Prévost Car Incorporated, Ste. Claire, Quebec

There are over 500 suppliers to the bus and coach manufacturing industry, ranging from engines and transmissions to windows, doors, lights and relays. However, many of the major components (engines, transmissions and axles) are supplied by a small number of manufacturers. This fact reflects the small size of the bus and coach market overall, the specialized nature of the market and the high degree of standardization that exists. The vast majority of these suppliers are U.S.-based, with either minor portion of production occurring in Canada or the Canadian branch serving as a distributor.

Industry associations estimate that employment in both countries, including after-sales parts and service suppliers, exceeds 50,000.

BUS AND COACH INDUSTRY RESEARCH AND DEVELOPMENT

Vehicle research and development in the public transportation industry is being undertaken in a wide range of areas. This is dictated by a variety of factors, including market needs and regulatory changes as exemplified by increasingly stringent exhaust emissions standards. Some of the areas where R&D activity is taking place include:

Styling – more aesthetically pleasing designs

Smart Bus/Electronics Systems Integration – software programs to integrate a wide variety of electronic systems related to customer information, automatic vehicle location (AVL), and diagnostics

Stainless Steel Structure – to combat corrosion and lengthen vehicle structural life

Weight Reduction – materials and techniques to reduce vehicle weight and comply with highway vehicle weight regulations

Alternative Fuels and Emissions – new drive systems, such as hybrid diesel-electric systems, as well as development of fuel cells

Engine Noise – solutions to reduce engine-related noise internally and externally

Brakes – investigation into design and materials changes to increase brake life and reduce brake "squeal"

The level of R&D expenditure in the industry is difficult to quantify because of the competitive and confidential nature of the industry. However, **Table 4** presents an estimate for the industry based on estimated sales and percentages of sales allocated to R&D, for both product engineering and product development.

TABLE 4
ESTIMATED VALUE OF R&D EXPENDITURES

Product	Unit Sales	Average Cost	Total Sales (CDN $ millions)	R&D Expenditures (CDN $ millions)
Urban Bus	5,000	$400,000	$2,000.0	$ 50.0
Intercity Coach	2,500	$500,000	$1,250.0	$ 31.3
School Bus	44,000	$70,000	$3,080.0	$ 30.0
Shuttle	10,000	$40,000	$ 400.0	$ 10.0
TOTAL	**61,500**		**$6,730.0**	**$121.3**

The value of product engineering R&D expenditure in the bus and coach industry for Canada and the U.S. is estimated to total $121.3 million annually. The estimated level of R&D spent in Canada may be in the order of 25 percent or $30 million annually. In addition to these expenditures, manufacturers and suppliers spent a further $200 to $460 million over the past 10 years on new product development. The portion spent in Canada, given the number of Canadian manufacturers, may be in the order of $10 to $34 million annually.

These levels contrast sharply with the annual investment by TDC of $300,000 in public transportation R&D.

ASSESSMENT OF TRANSPORT CANADA ADVANCED BUS TECHNOLOGY PROGRAM

Industry reaction to TDC's bus technology R&D program has been mixed. Primarily, industry representatives state that funding is too limited and that there must be a combination of increased funding and incentives for end users (transportation providers/operators) to purchase new products.

Manufacturers also noted the various U.S. influences on the bus and coach industry that serve to retain jobs and investment in the U.S. The absence of any federal government support for transit in Canada, including a "Buy Canadian" policy or the absence of a strong policy in support of fuel-efficient technologies, reduced emissions and attaining sustainable transportation goals provides little incentive for Canadian manufacturers to invest in R&D and new products that will achieve energy conservation and fuel efficiency.

Discussions with industry representatives, including manufacturers and transit and coach operators, strongly concluded that, in order for the Canadian government to have an influence on bus technology development and to preserve the presence of the manufacturing sector in Canada, substantially more money must be available for R&D from the government.

Of the various R&D needs within the industry, the reduction of bus and coach weight is important and offers environmental benefits. However, industry practices to date indicate that change will not be achievable without incentives. These incentives will need to be in the form of financial incentives for R&D research together with regulations to enforce weight reductions and bring about compliance with existing weight limits in order to pursue weight reduction strategies.

ROLE FOR TRANSPORT CANADA IN BUS TECHNOLOGY R&D

There are a number of reasons and opportunities for Transport Canada to invest in bus and coach R&D.

- The federal government has indicated its intent to provide funding for urban transit and has recently completed several studies exploring the future role of public transit in the country.

- There are R&D opportunities and needs within the bus/coach manufacturing and public transportation operating sectors that could stimulate and encourage employment and economic growth within the industry and that could produce reductions in GHG-based bus emissions.

- There is a need for capital infrastructure renewal and expansion within the public transportation industry, estimated by the Canadian Urban Transit Association (CUTA) and the Transport Canada report, *Taking Stock*[*], at $13.5 billion over the five year period 2002-2006.

- There is expertise in Canada in manufacturing processes, materials and automotive design and manufacturing that can be advantageously applied to the bus sector even though it is an industry that is characterized by relatively low volume production.

The rationale for the government's role would be as follows:

- The federal government is committed to targets set by the Kyoto Accord to reduce GHG emissions.
- There is increasing congestion in urban areas and degradation of the quality of urban life, which warrants the intervention of the federal government. Canada is an urban country with 70 percent of the population living in the 25 census metropolitan areas.
- There is an urgent need to preserve (save) Canada's bus manufacturing industry and prevent it from being lost to the U.S.

To be effective, however, any government R&D program should be clearly focused and should be tied to an overall economic strategy for the country's public transportation and manufacturing industry, which would include incentives for capitalizing on the industry's needs and opportunities.

R&D Needs

Based on the research and development needs, the role of TDC in federal government transportation R&D, and recognizing the type of bus manufacturing done in Canada (i.e., bus body design and construction), research and development assistance should be considered by Transport Canada in two areas:

[*] Report available online at www.tc.gc.ca/programs/environment/urbantransportation/transitstudies/urban.htm

1. Lightweight materials research and strategies to reduce vehicle weight

Several Canadian bus manufacturers are already pursuing weight reduction strategies within the vehicle structure, notably Prévost Car and New Flyer. However, much more research is required into the use of alternative (to metal) materials – their effect on vehicle structure longevity and durability by their acceptance of stress and strain – and the use of glues and gluing processes, high-performance infusion moulding of composites, high-performance aluminum extrusion with thin wall, and use of sandwich panels.

2. "Smart Bus" technology

Smart bus technology brings together in the transit bus "package" the various emerging electronic systems, such as global positioning systems, customer information, AVL and diagnostics. However, linking these systems electronically and with the use of computer technology is a challenge for the bus manufacturers, given different operating systems. Research is needed to assist the bus and coach manufacturers in developing simple solutions.

Given the expertise of the bus and coach manufacturing industry in bus body building and design research; the prominence of Canadian-based bus and coach manufacturers in the North American market; and the potential to achieve environmental benefits from reduced fuel consumption through weight reduction, this R&D is a high priority. It is an area where TDC has previously provided R&D funding.

As part of renewing its role in bus industry R&D, the following program goals and criteria are suggested:

Goals

1. Promote public transportation use in Canada for the reduction of traffic congestion and GHG emissions benefits and to ensure sustainable economic growth.

2. Retain and stimulate a strong public transportation industry.

3. Stimulate economic activity in Canada by ensuring a strong urban bus and intercity coach manufacturing industry.

Criteria

1. The project should not duplicate work being undertaken by the private sector.

2. The project should not duplicate work being undertaken in the U.S.; however, efforts should be made to work jointly with the U.S. public transportation industry where possible.

3. The project should contribute toward a competitive edge for the public transportation manufacturing industry and the furtherance of the public transit operating industry.

4. The project should ensure employment and economic growth in Canadian industry.

5. Research results should be made available to as many bus manufacturers as possible.

R&D Funding Options

There are three alternative courses of action open to Transport Canada in public transportation R&D funding:

1. Status quo – Continue to provide funding for small one-off projects that address a variety of issues. This option would involve continuing to partner with a limited number of suppliers.

2. Form consortia – Invite the bus/coach manufacturers and their suppliers to form consortia to target specific design issues. Transport Canada would work with these consortia to address key R&D issues. Transport Canada would provide seed money, or matching funds.

   Under this scenario, government funding for R&D would need to increase significantly. A reasonable estimate, reflecting the annual investment made by the bus manufacturing industry in Canada and typical costs to conduct R&D work on specific issues, would be an investment of $3 million per year.

3. Increase funding, provide incentives for investment – This alternative may offer the best opportunity for achieving both government and industry objectives. The government, through TDC, would establish a specific R&D program and time period, perhaps five years, to address specific technology development issues that would benefit the entire bus and coach manufacturing industry. This approach differs from option 2 in that the R&D effort would be more focused, with the government taking leadership. There would then be incentives to the operating industry to invest in the new technology developed through the program.

   With dedicated R&D funding focused on a specific issue, such as weight reduction through the use of composite materials and innovative manufacturing methods, financial incentives could be provided to bus and coach operators (municipalities and intercity bus companies) to purchase lighter weight vehicles manufactured in Canada. This approach would ensure that lighter weight vehicles are developed and that these vehicles will be purchased.

The R&D funding investment by the federal government would depend on the estimated cost to develop the necessary lighter weight materials and body designs. Further analysis of what this cost may be is required.

Incentives

It is the view of the bus transportation industry (manufacturing and operating sectors) that any TDC research and development program should be supported by incentives directed at stimulating and supporting the Canadian bus and coach manufacturing industry. In view of the strong incentives that exist in the United States (Buy America, FTA funding) and the dominance of the European manufacturing industry globally, the federal government should adopt several measures to support an R&D program.

The financial incentive would be to provide capital funding support for the purchase of lighter weight buses where such buses achieve weight reduction compared to baseline buses. This should be in the order of 20 percent or more. Financial incentives for purchasing lighter weight vehicles should offset any potential higher cost related to the development of these vehicles. The financial incentives may be in the order of 25 to 33 percent of the cost of the vehicles based on the projected cost premium for new technology buses. This would represent a potential annual investment, based on 800 urban buses and 200 intercity coaches per year and $600,000 per vehicle, of $150 to $200 million. This capital cost investment should be offset by annual savings in fuel and emissions reductions.

A regulatory incentive could be provided essentially focused on the strengthening or reinforcing existing regulations aimed at ensuring adherence to current road weight and vehicle weight regulations as mandated by the provinces.

CONCLUSIONS

The public transportation industry in Canada is large and extensive, encompassing urban, intercity, school, charter, paratransit and shuttle services. There are over 55,000 vehicles, 85,000 employees and annual expenditures of over $5.38 billion. Urban and intercity public bus transportation services can form a major component in the federal government's strategy to reduce energy consumption and GHG emissions attributable to transportation. Ensuring that public transportation services are effectively delivered and do their part to minimize fuel consumption and GHG emissions should therefore be a priority with the federal government.

There is an urgent need for capital funding to assist in the renewal of the nation's public transportation vehicle fleet, particularly buses. Emphasizing the use of public transportation also represents one of the most effective ways to significantly reduce GHG emissions by reducing the use of private automobiles, the largest single source of GHG emissions.

A wide range of industry representatives, including representatives from the manufacturers, suppliers, operators and industry associations, provided information, comments and advice on future needs in bus design research and development as well as feedback on the existing TDC bus technology program. This consultation indicated a number of areas where government assistance could further vehicle design improvements and address vehicle design deficiencies.

However, when considering the work already being undertaken by the industry as a whole, the focus of Transport Canada on systems research and development, and the potential for Transport Canada to contribute meaningfully to bus design development, the most appropriate areas for Transport Canada to participate or lead R&D efforts have been identified in three areas:

1. Vehicle weight reduction, particularly in urban buses

2. Research studies in partnership with CUTA and the Canadian Bus Association to address common concerns/issues of the public transportation industry in Canada

3. Public transportation ITS development and deployment initiatives

TDC's programs in the past have contributed to the development of unique and useful innovations and products in bus designs, and toward identifying strategies for reducing fuel consumption and exhaust emissions. Examples of TDC's work include supporting the development of Prévost's articulated highway coach, the development of MCI's 45 ft. accessible coach and New Flyer's articulated low-floor transit bus, as well as extensive research into the impact of bus weight on operating costs and road infrastructure and identifying strategies for reducing bus weight. These programs have been well-received by the industry; however, the administrative (report writing) aspects of the programs and the low level of available funding have not. Overall, there is a strong view that in order for Transport Canada to play a meaningful role in research and development, the available funding must be greatly increased. This is supported by a comparison of annual industry expenditures on R&D (estimated at $30 million in Canada) and TDC's R&D budget of $300,000.

While the federal government's role in public transportation is limited in terms of direct funding, it has had a long-standing role in research and development activities for the public transportation industry through Natural Resources Canada's PERD, National Research Council Canada's Industrial Research Assistance Program and Transport Canada's TDC. TDC's role has concentrated on R&D activities related to the bus as a "transportation system" of which the bus structure has been the primary focus.

In considering a future role for Transport Canada/TDC in funding research and development in bus technology and public transportation in general, there are several opportunities and rationale for the government to be continue to provide support. The primary area for action is in reducing vehicle weight. This offers the greatest potential for achieving government objectives related to reducing fuel consumption, reducing GHGs and economic development and investment.

However, to be effective, the government will need to significantly increase its R&D funding level beyond current levels. It will also need to provide incentives, such as funding support, for the purchase of lighter weight vehicles.

RECOMMENDATIONS

Based on the results of the review and assessment of the bus transportation industry research and development needs, the priority R&D needs identified and the mandate established for TDC, it is recommended that:

1. The federal government, through TDC, continue to fund research and development in bus technology and public transportation in general with emphasis on advanced technologies and strategies to reduce GHG emissions through energy efficiency.

2. The federal government/TDC R&D programs focus on bus system technology development with specific emphasis on bus structures and the use of modern lightweight materials and manufacturing techniques to reduce the weight of bus structures with a target objective of a 20 percent or more reduction in vehicle weight and, further, that the programs be developed and implemented in partnership with the bus manufacturing industry and the public transportation industry.

3. The R&D programs be for a minimum of five years with sufficient funding to ensure a meaningful contribution toward the successful completion of the projects. In this regard and based on industry experience to develop new products, a level of $3 million per year ($15 million in total) is recommended.

4. The R&D programs be supported by federal government financial incentives to public transportation operators and/or municipalities and provinces to encourage the purchase of lighter-weight, more fuel-efficient and technologically advanced buses. The financial incentives should bridge the gap between the cost of current technology buses and new technology buses. These may be in the range of 25 to 33 percent of the capital cost of the new technology vehicles.

5. The federal government work with the provinces and municipalities to ensure adherence to existing or proposed vehicle weight regulations of new public transportation vehicles under all operating conditions (i.e., including standing passengers on urban buses).

Sommaire

CONTEXTE

Cette étude avait pour objet d'établir les besoins et priorités futurs en matière de recherche et développement (R&D) au sein de l'industrie canadienne de l'autobus/autocar, et de déterminer le rôle que devrait jouer Transports Canada dans la R&D sur les autobus et les autocars de demain. Un sujet a particulièrement retenu l'attention des chercheurs, soit le potentiel que représente pour l'industrie l'utilisation de matériaux légers et de procédés de formage des matériaux. Cette étude a été financée par le Programme de R&D énergétiques de Ressources naturelles Canada (PRDE), l'Initiative canadienne de recherche sur les matériaux légers (ICRMLé) et le Centre de développement des transports (CDT).

Ces 15 dernières années, le CDT a piloté un programme de R&D sur la technologie des autobus, qui était assujetti aux politiques et objectifs du gouvernement fédéral concernant le transport durable. Les objectifs de ce programme s'énonçaient comme suit :

- promouvoir l'efficacité énergétique dans les transports publics par la mise au point d'autobus urbains et interurbains qui consomment moins de carburant et sont moins polluants;
- promouvoir l'utilisation de systèmes de propulsion plus propres et plus efficaces, et de véhicules plus légers;
- mettre au point des véhicules qui permettront aux constructeurs canadiens d'autobus et d'autocars d'accroître leur part de marché au Canada et aux États-Unis.

L'évolution qu'a connue l'industrie a entraîné une remise en question de la valeur des programmes de R&D de Transports Canada et, en particulier, de son rôle dans la R&D sur les autobus. Voici quelques-unes des nouvelles tendances observées dans l'industrie :

- part croissante de propriété étrangère chez les constructeurs d'autobus du Canada;
- pression croissante exercée sur l'industrie pour qu'elle se conforme aux lois et règlements des États-Unis;
- différences entre le Canada et les États-Unis en ce qui a trait au financement des transports publics.

LE PROGRAMME DE TECHNOLOGIE DES AUTOBUS DU CDT

Les travaux de recherche et développement de Transports Canada se rapportant à l'industrie de l'autobus/autocar ont été regroupés dans le programme de technologie des autobus, mis sur pied en 1985 et administré par le CDT. Les études réalisées sous l'égide de ce programme portaient sur des modifications de la conception des autobus et le perfectionnement de produits, de même que sur des véhicules utilisant des technologies émergentes, comme les autobus à plancher surbaissé, et sur des dispositifs d'accessibilité.

La valeur totale des travaux de R&D effectués par le CDT au cours des 15 dernières années (y compris la valeur des contributions «en biens et services» de ses partenaires) est de 18 545 100 $, dont 11 264 300 $ ou 60,7 p. 100, provenaient des partenaires. Transports Canada, par l'intermédiaire du Programme de transport des personnes handicapées et des programmes du CDT, et le PRDE ont investi 4 832 167 $, ou 26,1 p. 100, du total. La part du CDT s'élevait à 3,1 millions $, ou 16,8 p. 100 du total.

Beaucoup des projets ont grandement contribué au développement de produits (autocars de série H de Prévost et autobus articulé à plancher surbaissé de New Flyer) et à la recherche sur l'allègement des véhicules (études sur les effets du poids des véhicules sur la dégradation des chaussées et sur la consommation de carburant, travaux réalisés de concert avec Prévost Car). Mais la faiblesse des sommes consacrées à la R&D, en moyenne 300 000 $ par année, limite considérablement les chances de Transports Canada d'agir sur les niveaux d'émissions (et, partant, sur les émissions de gaz à effet de serre ou GES) des véhicules de transport public et d'accroître l'efficacité énergétique de ces véhicules.

PROGRAMMES AMÉRICAINS DE RECHERCHE ET DÉVELOPPEMENT

Par contraste, le gouvernement des États-Unis possède des programmes de recherche et développement dynamiques et dotés de fonds suffisants faisant partie de la loi TEA-21 sur le financement du transport public. Ces programmes comprennent le *Transit Cooperative Research Program* et l'*Altoona Vehicle Test Centre*, de même que d'autres activités de R&D. L'aide financière totale accordée par le gouvernement fédéral américain à la R&D s'est élevée à environ 14,25 millions $ par année pour l'ensemble de ces programmes. Mais le gouvernement fédéral des États-Unis ne finance pas directement l'industrie de l'autobus urbain. Il veille plutôt, par la *Buy America Act* (loi visant à encourager l'achat de produits des É.-U.), à ce que les fonds publics soient dépensés en faveur des constructeurs américains d'autobus. Cette loi a servi à protéger l'industrie américaine et a mené récemment au transfert d'emplois du Canada vers les États-Unis.

Outre le gouvernement fédéral, nombreux sont les États américains qui soutiennent financièrement la R&D se rapportant aux transports publics. Le plus généreux est la Californie, dont l'aide s'élève annuellement à quelque 10 millions $ au total.

Des établissements et organismes privés (p. ex., le *Northeast Advanced Vehicle Consortium*) ainsi que des entreprises du secteur privé participent aussi, aux É.-U., au financement de projets reliés au transport par autobus et au transport en général.

L'INDUSTRIE DES TRANSPORTS PUBLICS AU CANADA ET AUX ÉTATS-UNIS

L'industrie des transports publics, l'industrie de la fabrication d'autobus et le marché des autobus et autocars du Canada et des États-Unis sont fortement intégrés et affichent plusieurs ressemblances. Toutefois, au Canada, l'industrie des transports publics et le marché des véhicules se distinguent clairement de leurs contreparties américaines, en raison d'un soutien plus important se traduisant par une plus grande utilisation des transports en commun au Canada qu'aux États-Unis.

Le segment «prestation de services» de l'industrie des transports publics comprend une large gamme de services :

- services d'autobus urbains et suburbains, classiques et semi-collectifs (transport adapté);
- liaisons interurbaines par autocar, y compris les services affrétés et les services touristiques;
- services de trains légers sur rail, de trains lourds sur rail et de trains de banlieue;
- services de navettes assurant la desserte des aéroports et des hôtels;
- services de transport scolaire.

Le **tableau 1** offre une comparaison de l'industrie des transports publics au Canada et aux États-Unis.

TABLEAU 1
APERÇU DE L'INDUSTRIE DES TRANSPORTS PUBLICS AU CANADA ET AUX É.-U. ($ CAN)

Secteur industriel	Pays	Nombre de transporteurs	Dépenses d'exploitation	Nombre d'employés	Nombre de véhicules	Passagers transportés	Kilomètres parcourus
Transport urbain	Canada	95	3,40 G* $	39 500	13 000	1,44 G	0,81 G
	É.-U.	800	33,3 G $	350 000	92 455	9,17 G	6,4 G
Transport interurbain	Canada	48	353 M** $	10 000	4 000	14,0 M	150,0 M
	É.-U.	400	4 500 M $	30 000	40 000	140 M	3 750 M
Transport scolaire	Canada	649	1 400 M $	31 000	38 800	2,5 M	646,1 M
	É.-U.	6 600	11 746,5 M $	s/o	448 300	23,7 M	6 115 M
Services affrétés/ touristiques	Canada	101	225 M $	5 000	Compris dans interurbain	s/o	135,3 M
	É.-U.	3 200	3 927 M $	110 000		s/o	s/o

*G = milliard **M = million

L'INDUSTRIE DE LA FABRICATION DES AUTOBUS ET DES AUTOCARS AU CANADA ET AUX É.-U.

Le marché des autobus et des autocars au Canada et aux États-Unis peut être subdivisé en quatre créneaux :

1. Autobus de transport urbain
2. Autobus de transport interurbain (autocars)
3. Autobus scolaires
4. Navettes et autobus de transport adapté

Le **tableau 2** donne la taille de l'industrie de la fabrication d'autobus par type de véhicule pour chaque pays, ainsi que la population des pays et le nombre de constructeurs dans chaque créneau.

TABLEAU 2
STATISTIQUES RELATIVES À L'INDUSTRIE NORD-AMÉRICAINE DE L'AUTOBUS/AUTOCAR

Pays	Popu-lation (millions)	Taille du marché						Nombre de constructeurs *					
		Autobus scolaires	Autobus de transport en commun		Autocars	Navettes	Total	Autobus scolaires	Autobus de transport en commun		Autocars	Navettes	Total
			< 9,1 m	> 9,1 m					< 9,1 m	> 9,1 m			
Canada	30,0	38 000	200	11 300	4 000	2 500	56 000	2	1	3	2	0	8
États-Unis	282,0	448 000	2 000	74 000	40 000	30 000	594 000	5	8	3	2	10+	28+
Total	312,0	486 000	2 200	85 300	44 000	32 500	650 000	7	9	6	4	10+	36+

* Les constructeurs sont classés selon le pays où est établi leur siège social et leur principale gamme de produits. Plusieurs ont des installations au Canada et aux États-Unis et fabriquent plus d'une gamme de produits.

GRANDES TENDANCES OBSERVÉES AU SEIN DE L'INDUSTRIE

L'industrie de la fabrication des autobus et des autocars a connu une évolution rapide au cours de la dernière décennie. De nouveaux produits et de nouvelles technologies ont fait leur apparition, pendant que l'on assistait à des regroupements d'entreprises et donc à une contraction de l'industrie. Voici les tendances qui ont marqué les produits et les technologies :

– Mise en service des **autobus urbains à plancher surbaissé**.

– **Nouveaux moteurs et transmissions**. Les moteurs diesel à deux temps ont été remplacés par des moteurs à quatre temps, qui aident à respecter les normes d'émissions de plus en plus sévères aux États-Unis et au Canada. De nouveaux modèles de transmission ont été mis au point pour répondre aux besoins de puissance et de performance des nouveaux moteurs.

- **Nouveaux systèmes d’essieux et de suspension** adaptés aux autobus urbains à plancher surbaissé.
- Mise en service de **nouveaux modèles d’autocars**. Stylisme influencé par les concepteurs européens; autocar accessible de 13,7 m (45 pi) de longueur.
- **Mondialisation**. Volvo AB et de Daimler-Chrysler (Mercedes-Benz/EvoBus) ont fait leur entrée sur le marché nord-américain en acquérant plusieurs constructeurs d’autobus et d’autocars. North American Bus Industries a acheté Optare PLC, le constructeur du R.-U., et Chance Coach a commencé à construire aux É.-U. un autobus de petit gabarit mis au point par Wright’s d’Irlande du Nord.
- **Regroupements**. Volvo AB a réuni NovaBUS, Prévost et Blue Bird Body au sein d’une seule et même entreprise; Daimler-Chrysler a fait de même avec Orion Bus Industries, Thomas Built Buses, Setra North America et Detroit Diesel.

Outre les événements ci-dessus, des changements d’ordre législatif et politique ont influé sur l’industrie de la fabrication d’autobus et d’autocars en Amérique du Nord. Voici ces principaux changements :

- la *Buy America Act* des États-Unis (loi pour encourager l’achat de produits des États-Unis);
- la *Americans with Disabilities Act*;
- le guide d’approvisionnement et de spécifications normalisées publié par la Federal Transit Administration (FTA) et l’American Public Transportation Association («livre blanc»);
- les exigences touchant les essais d’endurance de la structure des véhicules (installation d’essai d’Altoona, simulateur de route d’ORTECH)

La *Buy America Act* est sans contredit le facteur dont l’effet a été le plus décisif, en obligeant les constructeurs qui voulaient avoir accès au marché américain des autobus et des autocars à avoir une usine sur le territoire américain, pour se conformer à la règle des 60 p. 100 de contenu américain, et à effectuer le montage final des véhicules aux États-Unis.

LE PROCESSUS DE CONCEPTION ET DE FABRICATION DES VÉHICULES

Le processus de conception, de mise au point et de fabrication des autobus et des autocars est non seulement long et complexe, mais il est aussi hautement spécialisé et assujetti à une foule de facteurs extérieurs.

Principes de conception

Tous les véhicules de transport par autobus exploités au Canada et aux États-Unis sont pour ainsi dire identiques sur le plan de la conception et des spécifications, ce qui fait qu’une grande partie des pièces sont interchangeables. Il faut ici préciser que les principaux composants, comme les moteurs, les transmissions, les essieux et les systèmes de conditionnement d’air, sont presque tous fabriqués aux États-Unis. De fait, aucun de ces composants n’est fabriqué au Canada.

Les autobus urbains et interurbains (autocars) sont de type «autoportant». La structure du véhicule comprend le châssis, auquel sont fixés la chaîne cinématique et les essieux. Le constructeur y installe alors divers sous-composants, conçus et fabriqués par des fournisseurs. Les membrures et les panneaux latéraux sont façonnés au moyen de procédés élémentaires de pliage et de coupage. Certaines parties de la carrosserie (faces arrière et avant) sont fabriquées par formage de matériaux composites en plastique et fixées au châssis à l’aide de rivets ou de vis. Certaines de ces pièces en matériaux composites peuvent aussi être fixées à l’aide de colles industrielles spéciales. Les planchers intérieurs sont constitués de panneaux de contreplaqué traité recouverts d’un matériau ou d’un composé de caoutchouc. Ainsi, le constructeur d’autobus et d’autocar est essentiellement un «assembleur» de composants.

Dans le cas des autobus scolaires et des autobus-navettes, le châssis et la carrosserie sont séparés, et sont habituellement fabriqués par des constructeurs différents (il arrive que le même constructeur produise les deux). Le châssis de ces véhicules, de même que le moteur, la transmission et les essieux, sont généralement identiques à ceux des camions ou des camionnettes, ce qui a l’avantage d’alléger la structure de coûts lors de la fabrication. Le même avantage s’applique aux coûts d’étude et de développement, qui sont répartis sur un grand nombre de véhicules. Les ventes de châssis d’autobus scolaires se chiffrent entre 35 000 et 40 000 par année, et celles des autobus et des autocars à moins de 10 000 par année.

Démarche de conception

Il s’écoule habituellement quatre à cinq années entre la première idée d’un nouveau véhicule et l’arrivée de celui-ci sur le marché. Dans l’intervalle, sont réalisés une série d’essais, qui visent à éprouver la conception et l’intégrité structurelle du véhicule. Ceux-ci sont menés au centre d’essai d’Altoona, aux États-Unis, et dans le simulateur d’Ortech, au Canada. Ils peuvent prendre jusqu’à neuf mois et coûter jusqu’à 400 000 $.

Comme les autobus et les autocars sont des véhicules spécialisés, nombre des composants qui leur sont destinés sont conçus expressément pour eux. Même les moteurs et les transmissions, dont la conception est parfois identique à celle des camions, présentent des caractéristiques très différentes, notamment en ce qui a trait aux dispositifs antipollution et aux systèmes auxiliaires.

Processus d’approvisionnement

Le processus d’approvisionnement influe fortement sur la conception et les spécifications des véhicules. Dans le cas des autobus urbains, ce processus est particulièrement long et ardu et il peut s’écouler jusqu’à deux ans entre l’établissement des spécifications par les autorités responsables de l’achat et la livraison du véhicule. Dans le cas des autobus scolaires, des navettes, des autobus de transport adapté et des autocars, le processus est beaucoup plus simple; il se limite souvent à la signature d’un contrat. Les délais de livraison sont alors de six mois ou moins pour les autobus scolaires et les navettes, et de six à neuf mois pour les autocars.

LE MARCHÉ DES AUTOBUS ET DES AUTOCARS

Le marché annuel des autobus et des autocars au Canada et aux É.-U., pour la période de 1996 à 2000, est résumé au **tableau 3**.

TABLEAU 3
MARCHÉ ANNUEL DES AUTOBUS ET DES AUTOCARS

	Canada	É.-U.
Autobus urbains	600	4 200
Autobus scolaires	3 800	39 600
Autobus interurbains	350	3 000
Bus-navettes	1 000	10 000
Total	*5 750*	*56 800*

Les marchés canadiens et américains des autobus et des autocars sont très intégrés, le marché canadien représentant environ 10 p. 100 du marché américain. Les constructeurs canadiens d’autobus dominent le marché canado-américain en raison de leurs coûts de production inférieurs à ceux des constructeurs américains, de la qualité de fabrication supérieure de leurs produits, et de leur capacité d’innovation reconnue. À l’échelle de l’Amérique du Nord, trois des six constructeurs d’autobus urbains et deux des cinq constructeurs d’autocars (dont deux ont leurs usines ailleurs qu’en Amérique du Nord) sont installés au Canada, et deux (plus deux filiales) des cinq constructeurs d’autobus scolaires sont établis au Canada. Il n’en demeure pas moins que les constructeurs canadiens sont très dépendants du marché américain.

Voici les principaux constructeurs canadiens d’autobus et d’autocars :

A. Girardin Inc., Drummondville, Québec
Les Entreprises Michel Corbeil, Laurentides, Québec
Motor Coach Industries, Winnipeg, Manitoba
New Flyer Industries, Winnipeg, Manitoba
NovaBUS Corporation, Saint-Eustache, Québec
Orion Bus Industries, Mississauga, Ontario
Prévost Car Inc., Sainte-Claire, Québec

L’industrie de la fabrication d’autobus et d’autocars comprend en outre plus de 500 fournisseurs, qui approvisionnent les constructeurs en pièces de toutes sortes, allant des moteurs et des transmissions aux fenêtres, portes, feux et relais. Mais une grande partie des composants majeurs (moteurs, transmissions et essieux) sont produits par une poignée de fabricants. Cela tient au fait que le marché des autobus et des autocars est restreint et qu’il s’agit d’un marché très spécialisé, où le degré de normalisation est élevé. La plupart des fournisseurs de composants majeurs sont établis aux É.-U. : ou bien ils assurent une petite partie de leur production au Canada, ou bien ils possèdent un bureau canadien qui distribue leurs produits.

Selon les estimations des associations industrielles, le nombre d’emplois dans l’industrie canado-américaine de la fabrication d’autobus, y compris les fournisseurs de pièces détachées et de services de réparation, dépasse les 50 000.

LA RECHERCHE ET LE DÉVELOPPEMENT DANS L’INDUSTRIE DE L’AUTOBUS ET DE L’AUTOCAR

La recherche et le développement sur les véhicules menée par l’industrie des transports publics va dans de nombreuses directions. Le choix des sujets de recherche est dicté par divers facteurs, y compris les besoins du marché et les nouvelles réglementations, par exemple celles qui ont pour effet de resserrer les normes relatives aux émissions. Voici quelques-uns des domaines abordés :

Stylisme – améliorer l’esthétique des véhicules

Autobus intelligents/Intégration des systèmes électroniques – logiciels permettant d’intégrer une grande variété de systèmes électroniques touchant les données sur les passagers, la localisation automatique des véhicules (AVL) et le diagnostic

Structure en acier inoxydable – permet de combattre la corrosion et d’allonger la vie de la structure du véhicule

Allègement – matériaux et procédés permettant de réduire le poids des véhicules, et de mieux respecter la réglementation sur le poids des véhicules

Carburants de substitution et émissions – nouveaux systèmes de propulsion, comme les systèmes hybrides diesel-électrique, et développement de piles à combustible

Bruit du moteur – étude de moyens pour réduire le bruit du moteur, tant pour les occupants du véhicule que pour les autres usagers de la route

Freins – recherche de nouveaux concepts techniques et de nouveaux matériaux pour accroître la durée de vie des freins et en atténuer le «crissement»

Il est difficile de chiffrer précisément les montants consacrés par l'industrie à la R&D, à cause de la concurrence qui règne dans l'industrie et du caractère confidentiel de cette information. Le **tableau 4** présente une estimation des montants dépensés pour la R&D dans l'ensemble de l'industrie. Ces montants sont établis d'après une estimation des chiffres de vente et des pourcentages de chiffres de vente alloués à la R&D, tant dans le domaine de l'ingénierie de produits que du développement.

TABLEAU 4
ESTIMATION DES MONTANTS CONSACRÉS À LA R&D

Produit	Unités vendues	Coût unitaire moyen	Ventes totales (millions de $ CAN)	Dépenses de R&D (millions de $ CAN)
Autobus urbains	5 000	400 000 $	2 000,0 $	50,0 $
Autocars	2 500	500 000 $	1 250,0 $	31,3 $
Autobus scolaires	44 000	70 000 $	3 080,0 $	30,0 $
Navettes	10 000	40 000 $	400,0 $	10,0 $
TOTAL	**61 500**		**6 730,0 $**	**121,3 $**

Le montant affecté annuellement par l'industrie canadienne et américaine de l'autobus/autocar à la R&D en ingénierie de produits est évalué à 121,3 millions $ au total. On peut estimer à 25 p. 100 de ce total, soit 30 millions $, la part du Canada. En plus de ces sommes, les constructeurs et les fournisseurs ont dépensé annuellement entre 200 millions $ et 460 millions $, ces dix dernières années, pour la mise au point de nouveaux produits. La part de ce montant dépensée au Canada, compte tenu du nombre de constructeurs canadiens, pourrait être de l'ordre de 10 millions $ à 34 millions $ par année.

Ces montants forment un contraste marqué avec le niveau annuel d'investissement du CDT dans la R&D sur les transports publics, qui s'établit à 300 000 $.

ÉVALUATION DU PROGRAMME DE TECHNOLOGIE DES AUTOBUS DE TRANSPORTS CANADA

L'industrie a réagi de façon mitigée au programme de R&D en technologie des autobus du CDT. Le principal reproche adressé par les représentants de l'industrie concerne la faiblesse des investissements. Il faudrait selon eux accroître l'aide financière offerte aux utilisateurs finals (sociétés de transport/exploitants) pour les encourager à acheter les nouveaux produits.

Quant aux constructeurs, ils ont souligné les diverses mesures mises en place par le gouvernement américain qui ont pour résultat de concentrer les emplois et les investissements aux États-Unis. L’absence de tout soutien du gouvernement fédéral au transport urbain, au Canada, y compris d’une contrepartie canadienne à la *Buy America Act*, ou encore l’absence de politiques vigoureuses en faveur des technologies éconergétiques, de la réduction des émissions et du transport durable, font en sorte que les constructeurs canadiens ne sont aucunement incités à investir dans la R&D ni dans de nouveaux produits susceptibles d’améliorer l’efficacité énergétique des véhicules.

Des discussions tenues avec les représentants de l’industrie, y compris des représentants de sociétés de transport urbain et de transport par autocar, il est clairement ressorti que le gouvernement fédéral doit accroître de façon substantielle ses investissements dans la R&D, s’il veut influer sur les innovations technologiques touchant les autobus et préserver la part canadienne de l’industrie nord-américaine de la fabrication des autobus/autocars.

Les besoins en matière de R&D sont nombreux. Mais l’allègement des véhicules est un domaine de recherche important, et il comporte des avantages sur le plan environnemental. Mais les pratiques de l’industrie à ce jour laissent penser que rien ne changera sans mesures incitatives. Pour appuyer les stratégies d’allègement, les incitatifs devront prendre la forme d’une aide financière à la R&D, et de nouveaux règlements pour faire écho à l’allègement des véhicules et veiller au respect des limites de poids en vigueur.

LE RÔLE DE TRANSPORTS CANADA DANS LA R&D SUR LA TECHNOLOGIE DES AUTOBUS

Il existe plusieurs motifs et occasions pour Transports Canada d’investir dans la R&D sur les autobus et les autocars.

- Le gouvernement fédéral a fait part de son intention de financer les transports publics et il a récemment réalisé plusieurs études sur le rôle futur des transports publics au pays.
- Les besoins et possibilités de R&D dans les secteurs de la fabrication des autobus/autocars et des services de transport en commun pourraient constituer des occasions de stimuler l’emploi et la croissance économique dans l’industrie et de réduire les émissions de GES attribuables aux autobus.
- L’industrie des transports publics devra procéder au renouvellement et à l’expansion de son infrastructure, à des coûts évalués à 13,5 milliards $ pour la période quinquennale de 2002 à 2006, selon

le rapport intitulé *Les transports urbains au Canada – Le point*[*], publié par l'Association canadienne du transport urbain (ACTU) et Transports Canada.

– Il existe au Canada une expertise sur les procédés de fabrication, les matériaux et la conception et la construction d'automobiles, qui pourrait avantageusement être mise à profit dans le secteur des autobus, même si les volumes de production y sont relativement faibles.

Voici comment peut se justifier le rôle du gouvernement :

– Le gouvernement fédéral s'est engagé à respecter les objectifs de réduction des GES de l'Accord de Kyoto.

– L'accroissement des congestions routières et la dégradation de la qualité de vie des citadins justifient l'intervention du gouvernement fédéral. Le Canada constitue en effet un pays fortement urbanisé, 70 p. 100 de sa population vivant dans les 25 zones métropolitaines de recensement.

– Il existe un urgent besoin de maintenir (sauver) l'industrie canadienne de fabrication d'autobus et de l'empêcher de disparaître au profit des États-Unis.

Mais pour être efficace, tout programme gouvernemental de R&D doit viser des objectifs bien précis et s'inscrire dans une stratégie économique globale visant à la fois l'industrie des transports publics et le secteur manufacturier, et comportant des incitatifs pour axer les interventions sur les besoins et les possibilités de l'industrie.

Besoins en matière de R&D

Compte tenu des besoins en matière de recherche et de développement, du rôle du CDT dans la recherche sur les transports au sein du gouvernement fédéral et du type d'activités de fabrication menées au Canada (c.-à-d. la conception et la construction de carrosseries d'autobus), Transports Canada devrait soutenir la recherche et le développement dans les deux secteurs suivants :

1. Recherche sur les matériaux légers et stratégies d'allègement des véhicules

Plusieurs constructeurs canadiens, dont Prévost Car et New Flyer appliquent déjà des stratégies visant à alléger la structure des véhicules. Mais il faudra encore beaucoup de recherches sur l'utilisation de matériaux de substitution (autres que le métal) – leur effet sur la durée de vie et la résistance aux

[*] Ce rapport peut être consulté en ligne à www.tc.gc.ca/programmes/environnement/transporturbain/etudestransit/urbain.htm

contraintes de la structure des véhicules – et sur l'utilisation de colles et de procédés de collage, le moulage des composites par infusion haute performance, l'extrusion haute performance de l'aluminium pour la fabrication de panneaux minces et l'utilisation de panneaux sandwich.

2. **Technologie des «autobus intelligents»**

La technologie des autobus intelligents réunit dans un même autobus de transport en commun les nouveaux dispositifs électroniques, comme les systèmes de positionnement global, d'information sur les passagers, l'AVL et le diagnostic. Mais la liaison électronique de ces systèmes et leur branchement à un réseau informatique représentent un défi pour les constructeurs d'autobus, du fait des différents systèmes d'exploitation en usage. Des travaux de recherche s'imposent pour aider les constructeurs à trouver des solutions simples.

Compte tenu de l'expertise acquise par les constructeurs d'autobus et d'autocars dans les domaines de la fabrication de carrosseries d'autobus et de la démarche de conception; de la proéminence des constructeurs d'autobus et d'autocars canadiens sur la marché nord-américain; et des avantages pour l'environnement de la diminution de la consommation de carburant pouvant découler de l'allègement des véhicules, la R&D sur l'allègement des véhicules est considérée prioritaire. Il s'agit d'ailleurs d'un sujet auquel le CDT a déjà accordé des fonds de recherche.

Pour ce qui est de redéfinir le rôle du CDT dans la R&D menée au sein de l'industrie de l'autobus, il est suggéré de retenir les objectifs et critères ci-après.

Objectifs

1. Promouvoir l'utilisation des transports publics au Canada, afin de réduire la congestion routière et les émissions de GES, et d'assurer une croissance économique «durable», autrement dit respectueuse de l'environnement.

2. Retenir au Canada et stimuler l'industrie des transports publics.

3. Stimuler l'activité économique au Canada en assurant la vigueur de l'industrie de la fabrication d'autobus urbains et d'autocars.

Critères

1. Le projet ne doit pas faire double emploi avec d'autres travaux en cours dans le secteur privé.

2. Le projet ne doit pas faire double emploi avec des travaux en cours aux États-Unis; il convient toutefois de faire toutes les démarches nécessaires pour s'associer aux travaux menés par l'industrie américaine des transports publics, lorsque cela est possible.

3. Le projet doit contribuer à conférer un avantage concurrentiel à l’industrie de la fabrication de véhicules de transport public et à l’essor des services de transport public.

4. Le projet doit favoriser l’emploi et la croissance dans l’industrie canadienne.

5. Les résultats de la recherche doivent être mis à la disposition du plus grand nombre de constructeurs d’autobus possible.

Options pour le financement de la R&D

Transports Canada a le choix entre trois plans d’action pour financer la R&D dans le secteur des transports publics :

1. Statu quo – Continuer de financer de petits projets ponctuels visant une variété de sujets. Cette option suppose des partenariats avec un nombre limité de fournisseurs.

2. Établissement de consortiums – Inviter les constructeurs d’autobus/autocars et leurs fournisseurs à former des consortiums en vue de résoudre des problèmes précis de conception. Transports Canada collaborerait avec ces consortiums pour mettre sur pied des projets de R&D. Transports Canada fournirait le capital de départ ou des fonds de contrepartie.

   Si ce scénario était retenu, il faudrait que le gouvernement augmente substantiellement les sommes qu’il consacre à la R&D. Un montant annuel de 3 millions $ semble une estimation raisonnable, compte tenu des montants investis annuellement par l’industrie canadienne de la fabrication d’autobus et des coûts habituellement associés aux travaux de R&D consacrés à des questions précises.

3. Accroître son aide financière et mettre en place des incitations à l’investissement – Cette option est vraisemblablement la meilleure pour atteindre à la fois les objectifs du gouvernement et ceux de l’industrie. Le gouvernement, par l’entremise du CDT, établirait un programme précis de R&D, assorti d’un calendrier, étalé sur cinq ans, par exemple, qui comporterait des projets de développement susceptibles de bénéficier à l’ensemble de l’industrie de la fabrication d’autobus/autocars. Cette option diffère de l’option 2 en ce que les travaux de R&D seraient davantage focalisés, le gouvernement assurant la direction du programme. Des mesures incitatives seraient alors mises en place pour encourager les exploitants à investir dans les nouvelles technologies mises au point dans le cadre du programme.

   Avec des fonds destinés à des travaux de R&D portant sur des problèmes bien ciblés, comme l’allègement des véhicules par l’utilisation de matériaux composites et des procédés de fabrication novateurs, les exploitants d’autobus et d’autocars (municipalités et entreprises de transport interurbain) pourraient avoir droit à des mesures d'incitation financière pour l'achat de véhicules allégés fabriqués au Canada. De telles mesures favoriseraient la mise au point de véhicules allégés et l'achat de ces véhicules.

Le montant des sommes investies par le gouvernement fédéral dans la R&D dépendrait des coûts estimatifs de développement des matériaux légers nécessaires et des nouvelles carrosseries. Des analyses plus poussées s'imposent pour établir ces coûts.

Mesures incitatives

Selon les représentants de l'industrie du transport par autobus (secteurs de la fabrication et de l'exploitation des véhicules) tout programme de recherche et de développement du CDT doit être assorti de mesures incitatives destinées à stimuler et à aider financièrement l'industrie canadienne de la fabrication d'autobus et d'autocars. Au vu des puissantes mesures incitatives mises en place aux États-Unis (*Buy America Act*, fonds de la FTA) et de la place prépondérante occupée par les constructeurs européens dans le monde, le gouvernement fédéral devrait assortir son programme de R&D de plusieurs mesures d'appui.

L'incitation financière consisterait à contribuer à la mise de fonds pour l'achat d'autobus allégés, lorsque ces autobus représentent une réduction de poids par rapport aux autobus ordinaires. Cet allègement devrait être d'au moins 20 p. cent. Le montant de l'aide financière accordée pour l'achat de véhicules allégés devrait compenser le coût potentiellement plus élevé de ces véhicules attribuable aux coûts de développement. L'aide financière pourrait être de l'ordre de 25 à 33 p. 100 du coût du véhicule, compte tenu du coût supérieur prévu des autobus utilisant des technologies de pointe. Cela représenterait un investissement annuel potentiel de 150 millions $ à 200 millions $ pour l'achat de 800 autobus urbains et de 200 autocars, à un coût de 600 000 $ pièce. Cet investissement devrait être compensé par des économies annuelles de carburant et une réduction des émissions.

On peut penser à une incitation d'ordre réglementaire, essentiellement axée sur le resserrement ou le renforcement de la réglementation existante visant à garantir le respect des règlements provinciaux en vigueur sur les limites de poids sur les routes et le poids des véhicules.

CONCLUSIONS

Les transports publics sont une industrie importante au Canada, qui englobe le transport urbain et interurbain, le transport scolaire, les services affrétés et le transport adapté/spécialisé (navettes). Elle exploite plus de 55 000 véhicules, emploie 85 000 personnes et dépense plus de 5,38 milliards $ par année. Les services de transport par autobus/autocar peuvent constituer un élément majeur de la stratégie du gouvernement fédéral pour réduire la consommation d'énergie et les émissions de GES attribuables aux transports. Veiller à ce que les services de transport en commun soient efficaces et fassent leur part pour minimiser la consommation de carburant et les émissions de GES doit donc être une priorité pour le gouvernement fédéral.

Il existe un besoin urgent de capitaux pour le renouvellement du parc de véhicules de transport en commun du pays, en particulier du parc d'autobus. Promouvoir l'utilisation des transports publics est aussi un des moyens les plus efficaces de réduire les émissions de GES en diminuant le nombre de voitures particulières sur les routes, qui constituent la source la plus importante d'émissions de GES.

Un vaste échantillon de représentants de l'industrie, soit des représentants des constructeurs, des fournisseurs, des sociétés de transport et des associations industrielles, se sont exprimés sur les besoins futurs de R&D dans le domaine de la conception des autobus, de même que sur le programme actuel de technologie des autobus du CDT. Cette consultation a permis de cerner un certain nombre de secteurs dans lesquels l'aide du gouvernement permettrait d'accélérer les améliorations à la conception des véhicules et de corriger les lacunes de conception.

Mais compte tenu des travaux déjà entrepris par l'industrie dans son ensemble, de l'accent mis par Transports Canada sur la recherche et le développement de systèmes, et de la possibilité pour Transports Canada de contribuer de manière significative au développement de nouveaux autobus, trois domaines de recherche ont été retenus, dans lesquels la contribution de Transports Canada, à titre de participant ou de chef de file, serait la plus appropriée :

1. Allègement des véhicules, notamment des autobus urbains

2. Réalisation d'études dans le cadre de partenariats avec l'ACTU et l'Association canadienne de l'autobus, portant sur des préoccupations/questions communes à l'industrie des transports publics du Canada

3. Projets de développement et de mise en œuvre de STI adaptés aux transports publics

Les programmes menés par le CDT par le passé ont contribué à la mise au point d'innovations et de produits uniques et utiles destinés aux autobus, et à la définition de stratégies pour réduire la consommation de carburant et les émissions polluantes. À titre d'exemples de travaux pilotés par le CDT, on peut citer l'aide au développement de l'autocar articulé de Prévost, le développement de l'autocar accessible de 45 pi de MCI et de l'autobus articulé à plancher surbaissé de New Flyer, ainsi qu'une étude approfondie de l'effet du poids des autobus sur les coûts d'exploitation et sur l'infrastructure routière, et la définition de stratégies pour alléger les autobus. Ces programmes ont été bien accueillis par l'industrie; mais les aspects administratifs (rédaction de rapports) des programmes et le peu de fonds accordés à leur réalisation l'ont été moins. Dans l'ensemble, il se dégage un consensus clair : pour pouvoir jouer un rôle significatif en recherche et développement, Transports Canada devra accroître considérablement les sommes affectées au financement de celle-ci. Il suffit, pour s'en convaincre, de comparer les dépenses annuelles de l'industrie pour la R&D (estimées à 30 millions $ au Canada) et le budget de R&D du CDT, qui s'élève à 300 000 $.

Malgré la part infime de financement direct de l'industrie des transports publics assumée par le gouvernement fédéral, celui-ci influe depuis longtemps sur les activités de R&D qui touchent l'industrie des transports publics, par l'intermédiaire du PRDE de Ressources naturelles Canada, du Programme d'aide à la recherche industrielle du Conseil national de recherches du Canada et du CDT de Transports Canada. Au CDT, les activités de R&D se concentrent sur l'autobus en tant que «système de transport». Dans ce système, l'attention a surtout porté sur la structure de l'autobus.

Lorsque l'on envisage le rôle futur de Transports Canada et du CDT dans le financement de la R&D sur la technologie des autobus et le transport en commun en général, on constate qu'il existe plusieurs possibilités et justifications pour le gouvernement de maintenir son appui à la recherche. Le principal domaine où il doit intervenir est celui de l'allègement des véhicules. C'est en effet le domaine qui lui permettra le mieux de se rapprocher de ses objectifs de réduction de la consommation de carburant, de réduction des GES, de développement économique et d'investissements.

Toutefois, pour que son action soit efficace, le gouvernement devra accroître considérablement les fonds qu'il affecte à la R&D. Il devra également mettre en place des mesures incitatives, comme une aide financière, pour l'achat de véhicules allégés.

RECOMMANDATIONS

À la lumière des résultats d'un examen des besoins de l'industrie du transport par autobus/autocar en matière de recherche et de développement, et compte tenu du mandat confié au CDT, il est recommandé ce qui suit :

1. Que le gouvernement fédéral, par l'intermédiaire du CDT, continue de financer la recherche et le développement dans les domaines de la technologie des autobus et des transports publics en général, en mettant l'accent sur les technologies de pointe et sur des stratégies destinées à réduire les émissions de GES par une plus grande efficacité énergétique des véhicules.

2. Que les programmes de R&D du gouvernement fédéral/CDT se concentrent sur le développement des technologies applicables au système de transport que constitue l'autobus, en s'intéressant particulièrement à la structure des autobus et à l'utilisation de nouveaux matériaux légers et de procédés de fabrication susceptibles d'en réduire le poids (un allègement d'au moins 20 p. 100 du

véhicule doit être visé); que les programmes soient mis au point et exécutés de concert avec l'industrie de la fabrication d'autobus et le secteur des transports publics.

3. Que les programmes de R&D soient établis pour au moins cinq ans et qu'ils soient dotés de fonds suffisants pour contribuer de façon significative à la réussite des projets. À cet égard, et à la lumière des sommes dépensées par l'industrie pour développer de nouveaux produits, il est recommandé d'affecter à ces programmes un montant de 3 millions $ par année (15 millions $ au total).

4. Que les programmes de R&D soient appuyés par des mesures d'incitation financière mises en places par le gouvernement fédéral pour encourager les municipalités et/ou les sociétés de transport en commun et les provinces à acheter des autobus allégés, consommant moins de carburant et utilisant des technologies de pointe. Cette aide financière devrait combler la différence entre le coût des autobus ordinaires et celui des autobus utilisant de nouvelles technologies. Elle pourrait être de l'ordre de 25 à 33 p. 100 du coût d'achat des véhicules.

5. Que le gouvernement fédéral collabore avec les provinces et les municipalités pour contrôler la conformité aux règlements (en vigueur ou proposés) sur le poids des nouveaux véhicules de transport en commun dans toutes les conditions d'exploitation (y compris avec des passagers debout, dans le cas des autobus urbains).

TABLE OF CONTENTS

LIST OF TABLES & EXHIBITS

GLOSSARY

ADA	American with Disabilities Act (U.S.)
ADB	Advanced Design Bus
APTA	American Public Transit Association
ATTB	Advanced Technology Transit Bus
AVL	Automatic Vehicle Location (system)
BHP/HR	Brake Horsepower Per Hour
BRT	Bus Rapid Transit
Caltrans	California Transportation Department
CARB	California Air Resources Board
CBA	Canadian Bus Association
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide (in engine exhaust)
CUTA	Canadian Urban Transit Association
DOE	Department of Energy (U.S.)
EPA	Environmental Protection Agency (U.S.)
FTA	Federal Transit Administration (U.S.)
GHG	Greenhouse Gas (emissions)
GPS	Global Positioning System
GVW	Gross Vehicle Weight
HC	Hydrocarbons (in engine exhaust)
H-D	Heavy-duty
HRDC	Human Resources Development Canada
ITS	Intelligent Transportation Systems
LFS	Low-Floor Series (low-floor urban bus model made by NovaBUS)
LRT	Light Rail Transit
NABI	North American Bus Industries
NAFTA	North American Free Trade Act
NO_X	Nitrogen Oxide (in engine exhaust)
NRCan	Natural Resources Canada
OBI	Orion Bus Industries (originally Ontario Bus Industries)
PERD	Panel on Energy Research and Development
PM	Particulate Matter (in engine exhaust)
SCRIMP	Seeman Composite Resin Infusion Moulding Process
STRP	Strategic Transit Research Program
STRSM	Société de Transport de la Rive-Sud de Montréal
TCRP	Transportation Cooperative Research Program (U.S.)
TDC	Transportation Development Centre
TDPP	Transportation for Disabled Persons Program
TEA-21	Transportation Equity Act for the 21st Century (U.S.)

1 INTRODUCTION

1.1 PURPOSE OF STUDY

This study was commissioned by the Transportation Development Centre (TDC) of Transport Canada to identify future research and development needs and priorities within the public transportation industry. Emphasis was placed on the status of advanced technologies and on the identification and determination of a future role for Transport Canada in bus and coach R&D. A particular focus of this study was on the potential for lightweight material and material-forming process technologies in the bus manufacturing industry.

The context for this study is the urban bus and intercity coach manufacturing industry in Canada. However, because the industry in Canada is highly integrated with that of the United States, the study context includes a comparison of the public transportation industries in both countries.

Funding for this study was provided by Natural Resources Canada's Panel on Energy R&D (PERD) program and the Canadian Lightweight Materials Research Initiative.

1.2 STUDY METHODOLOGY

This study was undertaken by consultants from IBI Group who specialize in the public transportation and bus and coach manufacturing sectors. The work involved:

- research and literature review;
- collection of industry data and statistics;
- interviews with key industry representatives, particularly representatives of the bus and coach manufacturing sector; and
- a review of the Transport Canada and TDC R&D programs.

Twenty-six firms and individuals were interviewed or consulted in the course of this study. They are listed in Appendix A.

The work plan was designed to accomplish the following objectives:

- prepare a portrait of the industry;
- determine the future direction that bus and coach design development is likely to take;
- determine the needs of the industry;
- identify the factors that will influence the future of the industry and bus and coach design development;
- determine where Research and Development is undertaken; and
- determine where decisions regarding bus and coach design development will be made.

1.3 DEFINITIONS

This focus of this study is on the vehicles used in urban bus transit and intercity bus transportation, namely, urban transit buses and intercity coaches. For the purposes of this study, the following definitions apply:

Urban transit buses - vehicles that provide public transport service in urban areas. They typically have two doors and a seating arrangement that maximizes overall vehicle capacity. Urban buses may also have one door and may also be used to provide service in suburban (outlying) areas or commuter service from suburban areas into urban areas.

Intercity coaches - vehicles that provide longer distance service between urban areas. They typically feature more comfortable seating, air conditioning, under-floor baggage compartments, washrooms and other passenger amenities. These vehicles are also used to provide charter and tour services.

Suburban coaches - derivatives of either urban buses or intercity coaches or separate designs, featuring up-graded interiors and seating. They do not typically include a washroom or under-floor baggage. They are used on routes where commute times are typically 1 to 1½ hours and link urban areas.

Shuttle/Paratransit buses - small vehicles designed for a variety of applications, including specialized transit services, airport transfers, and hotel shuttles.

Integral construction - bus and coach design where there is no separate chassis; the body incorporates suitable strengthening for this purpose.

Body on chassis - vehicle design where there is a separate body and chassis.

Cut-aways - vehicle where a body is designed to fit onto the chassis and front cab section of a chassis manufacturer.

2 BACKGROUND

Over the past 15 years TDC has led an advanced technology bus development program in support of the federal government's sustainable transportation policies and goals. Its objectives have been to:

- promote energy efficiency in public transportation through the development of urban bus and intercity coach designs that reduce energy consumption and exhaust emissions;
- promote the use of cleaner and more efficient propulsion systems and lighter weight vehicles; and
- develop vehicle designs that will further the market share of Canadian bus and coach manufacturers.

These initiatives have been supported in a large part by Natural Resources Canada's PERD program. TDC's programs consisted of research study initiatives, technology and product development, and the implementation of demonstration projects. These projects have been initiated in partnership with the Canadian bus manufacturing and operating industry as well as industry associations such as the Canadian Urban Transit Association (CUTA) and the Canadian Bus Association.

However, recent trends in the industry have brought into question the value of the federal government's R&D programs and particularly its role in bus R&D. These trends include:

- increasing dominance of foreign ownership of Canada's bus manufacturers;
- increased pressure to comply with United States laws and regulations; and
- differences between public transit funding levels in the United States and Canada and their effect on the Canadian bus manufacturing industry.

Accordingly, TDC wishes to assess the future of the bus manufacturing industry in Canada, to identify trends and priorities in bus designs, and to determine what role, if any, the Canadian government might play in bus technology development and, specifically, in furthering energy-efficient and environmentally beneficial bus designs and technologies.

3 REVIEW OF TRANSPORT CANADA ADVANCED TECHNOLOGY BUS PROGRAM

Transport Canada, together with Natural Resources Canada (NRCan), furthers the federal government's mandate to promote energy conservation and efficiency through a variety of research and development initiatives. Within Transport Canada, TDC's R&D activities are aimed at the application of complete "systems", such as bus designs (versus components), in public transportation, while NRCan concentrates its transportation R&D activities on energy conversion technologies and vehicle components.

NRCan has been assisting Ballard Systems with its fuel cell development and fuel cell bus program. This assistance extends to other Canadian fuel cell companies to improve their fuel cell product and its application to transport vehicles. NRCan has worked with other alternative fuels (methanol, natural gas, propane and others), consortia and companies to develop transportation-related technologies. The federal government, through NRCan and Industry Canada, has invested substantially in fuel cell technology and bus application projects.

Because current Canadian bus manufacturing activities in Canada essentially consist of body building and the integration of various components into a complete vehicle, Transport Canada's strategy has been to focus its R&D efforts on optimizing the bus body as the most critical component in the bus system integration. For this "component", weight reduction is an obvious target for achieving energy and greenhouse gas (GHG) emissions reductions.

3.1 PROGRAM DETAILS

Transport Canada's research and development activities for public transportation industries and, specifically, bus manufacturing, have been delivered through the Advanced Technology Bus Program administered by TDC since 1985. The program has consisted of projects and initiatives designed to enhance the environmental and energy-efficient benefits of the public transportation sector. Funding for the program has been provided mainly by PERD and has averaged approximately $300,000 annually. Additional funding has been provided by Transport Canada's Transportation for Disabled Persons Program (TDPP) and the Canada-Quebec Regional Economic Development Agreement on Transportation of 1985. The programs have been undertaken in partnership with the provincial governments, notably Alberta and Quebec, as well as CUTA and the private sector.

TDC's Advanced Technology Bus Program has focused on bus design changes and product advancement as well as studies into emerging bus design issues, such as low-floor buses and accessibility features. **Table 1** summarizes the details of some of the major projects undertaken since 1985. Of the 15 projects listed, three have involved the development of new bus and coach models (accessible 45 ft. intercity coach, articulated intercity coach and articulated urban low-floor bus), while five have investigated the potential benefits of reducing vehicle weight. The Strategic Transit Research Program (STRP) undertaken in partnership with CUTA produced a wide range of studies related to transit vehicle design issues. Continuing R&D projects include the development and evaluation of a multi-mode electric bus and follow-up development on current initiatives.

For the 15 projects listed, the total value (including "in-kind" support by partners) of the R&D work undertaken totals $18.5 million, of which the project partners contributed $11.2 million or 60 percent of the total. Transport Canada, through the TDPP and TDC programs, and PERD invested $4.8 million or 26 percent of the total. TDC's share of this amount was $3.1 million or close to 17 percent of the total investment.

Funding conditions require that the details of the work undertaken, findings and conclusions of each study or project be published and shared with the industry. This requirement has been a source of difficulty for projects involving bus manufacturers, considering the highly competitive nature of the bus manufacturing industry.

TABLE 1
SUMMARY OF TRANSPORT CANADA ADVANCED BUS TECHNOLOGY PROGRAM

SUBJECT	PARTNERS	YEAR(S)	FUNDING SOURCES					
			PARTNER	PERD	TDPP	TDC	OTHER	TOTAL
1. Accessible 45 ft. Intercity Coach	Motor Coach Industries	1987-90	$2,000,000	$240,000	$145,500	$100,867	$473,633	$2,960,000
2. Articulated Intercity Coach	Prévost Car Autocars Orléans Voyageur Inc.	1987-90	$5,180,000			$1,749,000	$1,749,000	$8,678,000
3. Strategic Transit Research Program	CUTA	1992-98	$580,000	$55,000		$235,000		$870,000
4. Performance Comparison of Nova Bus LFS and Classic	STCUM MTQ	1996-99	$120,000	$27,000		$50,000	$26,000	$223,000
5. Energy and Emissions Benefits of Hybrid Electric Drive Systems	ORTECH	1994						
6. Flywheel Energy Storage Feasibility Study	Flywheel Energy Systems	1996-97	$170,000	$132,500				$302,500
7. Cost-Benefit Bus Weight Reduction Study	TDC	1994-95				$60,000		$60,000
8. Road Test Simulator for Heavy-Duty Bus (“Shaker Test”)	ORTECH Ontario Bus Industries	1996-97	$450,000	$55,000		$55,000		$560,000
9. Develop Articulated Low-Floor Transit Bus	New Flyer Industries Alberta Transportation	1993-95	$1,150,000	$250,000				$1,400,000
10. Bus Suspension Optimization	STRSM Nova Bus	1997-01	$62,500	$125,000		$52,500		$240,000
11. Application of Composite Material to Buses	Centre des Matériaux Composites	1998-99	$13,000	$35,000		$14,300		$62,300
12. Coach Weight Reduction Study	Prévost Car, ADS Martec	1999	$34,500	$85,500		$25,000		$145,000
13. Lightweight Bus Development Phase II	Prévost Car ADS Martec	2001-02	$789,000	$100,000		$100,000	$200,000	$1,189,000
14. Lightweight MMC Brakes for HD Vehicles	Centre for Automotive Material & Manufacturing	2000-01	$15,300	$70,000		$20,000		$105,300
15. Develop and Evaluate Multi-Mode Electric Bus	Overland Custom Coach, BET, Siemens	2000-02	$700,000	$400,000				$1,100,000
TOTAL			$11,264,300	$1,575.0	$145,500	$3,111,667	$2,448,633	$18,545,100
% Share of Total			60.7%	8.5%	0.8%	16.8%	13.2%	

3.2 ASSESSMENT OF PROGRAM

A review of the various studies and design initiatives sponsored by Transport Canada based on their contribution to the industry indicates that they have had varying degrees of success. A selection of these projects are reviewed below.

Articulated Intercity Bus – although unique in North America and supplied only by Prévost, this vehicle was developed in the mid-1980s but failed to attract many buyers because of its cost and complexity, and the development of the 13.7 m (45 ft.) coach. However, it did launch Prévost as a major competitor in the North American market. Production of the vehicle ceased in 1991. This project was instrumental in modernizing Prévost's coach design and manufacturing processes, which ultimately helped them to acquire a larger share of the North American market.

Prévost's model H5-60 articulated highway coach

13.7 m Accessible Intercity Coach – the 13.7 m intercity coach has become the standard of the industry. The accessibility designs included in the coach as a result of this project did contribute to the provision of accessible intercity bus services. It helped MCI, and indirectly Prévost, to meet market accessibility needs.

Articulated Low-Floor Bus – the development of this bus has been a major addition to the urban bus product line and has proven successful with over 600 now sold. Although several U.S. manufacturers (North American Bus Industries (NABI) and Neoplan) now offer low-floor articulated bus models, the early development of this bus permitted New Flyer to gain market share. These buses are now used to provide Bus Rapid Transit (BRT) service in several large metropolitan centres in Canada and the U.S.

New Flyer Low-Floor Articulated bus developed with assistance from TDC

Suspension Optimization – undertaken in partnership with NovaBUS and the Société de Transport de la Rive-Sud de Montréal (STRSM), this study helped improve the NovaBUS model LFS suspension performance. It was also of some value in that it provided a tool for bus manufacturers to better adapt suspension systems to their vehicle designs. However, it has had little real benefit to the industry and any changes to a vehicle's suspension system resulting from the utilization of the evaluation tool cannot be said to have resulted in increased product sales.

Strategic Research Projects (various) – a number of these studies were undertaken in co-operation with CUTA and addressed a wide range of issues that were of concern to the industry. While small in scope and budget, these projects did benefit the industry in general and helped to promote and educate the industry on emerging issues such as the use of low-floor buses and transit priority measures. Unfortunately, a number of projects were duplicated by the U.S. Transit Co-operative Research Program (TCRP), which had much larger budgets.

Lightweight Bus Development – a phase 1 study concluded that it was technically and economically feasible to reduce intercity coach weight by as much as 20 percent. A follow-on phase II initiative has been undertaken with Prévost and other partners to design, prototype and test lightweight structural concepts for the roof and the floor of an intercity coach. This $1.2 million project should be completed by the end of 2002.

Lightweight MMC Brakes for Heavy-Duty Vehicles – preliminary conclusions from this study, which is not yet published, estimate that aluminum-based MMC material is technically and economically feasible in heavy-duty brake drum applications. The additional capital cost is quickly balanced out by the weight reduction benefit and the reduced brake maintenance costs.

3.3 SUMMARY

Overall, Transport Canada's research program has had mixed success. Many of the projects have been useful and have contributed significantly to product development, such as the Prévost H series coaches and New Flyer's low-floor articulated bus, and to research into reducing vehicle weight, as exemplified by the studies on the impact of vehicle weight on road damage and fuel consumption, and the work with Prévost Car.

On the other hand, the requirement to share information and provide documentation, including preparation of reports on findings, has limited its attractiveness to the private sector, particularly the bus manufacturers.

More importantly, the budget available, an average of $300,000 per annum, is insufficient and pales in comparison to both the levels expended by the private sector on R&D annually and the funding provided by government in the U.S. While intending to advance the competitiveness of Canada's bus and coach manufacturing industry and to meet the federal government's goals on fuel efficiency and emissions reductions, the R&D program appears, in retrospect, to be ad hoc with limited effective benefit to the country with regard to emissions reductions or improved fuel efficiency. In fact, the small R&D budget and other constraints discussed later in this report greatly limit the opportunity for Transport Canada to effectively influence emissions levels (and thus GHG emissions) from public transportation vehicles and improve fuel economy. This condition must be considered when assessing the future direction for an R&D strategy.

4 UNITED STATES RESEARCH & DEVELOPMENT PROGRAMS

4.1 BACKGROUND

The urban transit industry in the U.S. enjoys extensive financial support for research and development at both the federal and state levels as well as for public transit operations and capital investment. School student transportation services throughout the U.S. are funded by government, either federal, state or local. There is no federal or state funding for intercity bus transportation services.

Federal transit funding is allocated within a federal bill that expires every four years and thus must be "re-authorized" after that period. The current funding bill, TEA-21 (Transit Equity Act for the 21st Century) was passed in 1999 and expires in 2003. Funds allocated by this legislation are administered through a federal agency known as the Federal Transit Administration (FTA), a successor to an earlier agency, the Urban Mass Transit Administration.

Federally sponsored R&D funding is included in TEA-21 as a separate line item. The amount is significant and consists of three main activities:

- support for and joint administration with the urban transit industry of the TCRP;
- the operation of a new vehicle test centre in Altoona, Pennsylvania; and
- support for specific product research and testing.

The U.S. Department of Energy (DOE) has also provided funding for various projects, chiefly aimed at fuel efficiency and emissions reduction, over the past 20 years.

Total annual federal funding support has averaged in excess of $14.25 million per year amongst the above programs.

In addition to the federal funding programs, many of the U.S. states provide funding for transit-related R&D, the most prominent being California. The California Air Resources Board (CARB) and Caltrans (California Department of Transportation) provide funding for research and development particularly into alternative fuels and exhaust emissions reduction products and technologies. The amount of funding provided annually totals approximately $10 million.

Private institutions and agencies (e.g., the Northeast Advanced Vehicle Consortium) as well as private sector companies add to the funding provided to transit and transportation-related projects.

4.2 TCRP

This program is developed and managed jointly with the American Public Transportation Association (APTA) and has been in effect since 1992. It generally focuses on operational issues, although some technology-based studies have been conducted.

The annual allocation for the TCRP program is currently $8.25 million, as it has been for the past five years, although each year some of these funds have been held back for “congressional earmarks”, that is, special projects.

The Transportation Research Board manages the TCRP program.

CUTA’s STRP project, of which TDC has been a partner, is similar in concept.

4.3 ALTOONA VEHICLE TEST CENTER

This facility was established in the mid-1980s for the purpose of conducting endurance and structural testing on new transit buses. Its mandate has broadened to include school buses and commercial vehicles, although its primary focus remains urban transit buses. To reinforce the value of the test centre, the “white book” standard bus specification document developed jointly by APTA and the FTA incorporates the requirement for transit buses to complete the “Altoona” test to be eligible for funding. Buses that complete the test do not achieve a “pass” or “fail”. Instead, the manufacturer receives information related to the structural or mechanical performance of the vehicle and an indication of areas requiring attention. It is then up to the manufacturer to respond to the “faults” identified and to develop a solution. Funding for the Altoona Test Center amounts to almost $6.0 million per year. The FTA funds 80 percent of vehicle testing, leaving the manufacturers and/or transit operators to fund the remainder.

4.4 PRODUCT TESTING AND SUPPORT

The U.S. federal government has not generally provided funding support to bus manufacturers or component manufacturers and suppliers for product development. However, it has provided funding for two important projects involving bus design development:

- the advanced design bus (ADB) program of the early 1970s; and
- the advanced technology transit bus (ATTB) program of the mid-1990s.

The ADB program resulted in the development of General Motors’ (now NovaBUS) RTS (rapid transit series) bus design and the Flxible ADB. The program cost approximately $10 million.

The ATTB project cost between $60 and $100 million (depending on how contributions are calculated) and produced six 40 ft. test buses. Key elements of the project included the following:

- Lightweight: use of defence conversion technologies and aerospace materials and construction techniques to reduce the curb (empty) weight of the vehicle to 18,000 lb. (8,165 kg) compared to the average 27,000 lb. (12,272 kg) weight of the standard transit bus
- Low-floor: 15 in. floor height, no interior steps, flat-floor front to rear
- Suspension: independent front- and rear-axle suspension system
- Smart Bus: advanced passenger information displays, diagnostics and Automatic Vehicle Location (AVL)

One of the six U.S. FTA-sponsored ATTB vehicles

None of the buses produced is operational and the program is deemed not to have been a success. The only element of the project that may prove beneficial to the industry is the use of composite materials to reduce bus weight. NABI has entered into an agreement with the product developer to use it in a bus design it has developed.

The money spent on the ATTB project, while seemingly large, is not out of line with new product development in the private sector. Bus and coach manufacturers have spent, individually, between $10 million and $40 million to develop new bus models.   For the five bus manufacturers based in Canada, a large portion of this money has been spent in Canada through the employment of engineers and support staff and in manufacturing.

4.5 SUMMARY

The United States government, in partnership with the public transportation industry, has an active research and development program consisting of funding for studies through the TCRP and testing at the Altoona Bus Test Center in Altoona, Pennsylvania. The federal government does not provide funding for the purchase of intercity coaches or the operation of intercity coach services. There is, however, funding for the purchase of intercity-type coaches for commuter services (e.g., services in New Jersey, Houston and New York).

Although the federal government does not now fund vehicle research and development, it has provided funding in the past for several vehicle development projects, the most recent being the ATTB.

The State of California has an active R&D program through Caltrans, which provides funding for emissions-related projects, particularly alternative fuel research and vehicle acquisition.

While the U.S. federal government does not provide direct funding for the transit bus industry, it does, through the Buy America Act, ensure that public funding is directed toward the U.S. bus manufacturing industry. This Act has served to protect the industry and has recently been responsible for some job shifting from Canada to the U.S.

5 PROFILE OF PUBLIC TRANSPORTATION OPERATIONS IN CANADA AND THE UNITED STATES

5.1 OVERVIEW

The public transportation industry, the bus manufacturing industry and the market for buses and coaches in Canada and the United States are highly integrated and share similar characteristics. However, the Canadian industry and vehicle market has distinct differences, reflecting a stronger support for and use of public transportation in Canada. However, public support for urban transit is not reflected in strong government funding which, as will be discussed later, is having an adverse effect on the industry in light of United States policies that support the operating and manufacturing industry in that country. This section provides a brief overview of the service delivery (operating) side of the public transportation industry in both countries as background to the assessment of Transport Canada's research and development program. Section 6 provides an overview of the manufacturing sector.

The service delivery segment of the public transportation industry encompasses a wide range of services, including:

- urban and rural conventional and paratransit bus services;
- intercity highway coach services, including charter and tour operations;
- light rail, heavy rail and commuter rail services;
- shuttle services at airports and to hotels; and
- school student transportation.

Although this report focuses on the urban bus and intercity coach components of the industry, an overview of the complete industry is provided in **Table 2**. This summary has been prepared based on several sources, including the 1995 Human Resources Development Canada (HRDC) study on the Canadian Motor Carrier Passenger Industry and CUTA, APTA and American Bus Association statistics.

TABLE 2
OVERVIEW OF PUBLIC TRANSPORTATION INDUSTRY IN CANADA AND THE U.S.
(CDN $)

Industry Sector	Country	No. of Service Providers	Operating Expenses	No. of Employees	Fleet Size	Passengers Carried	Kilometres Operated
Urban Transit	Canada	95	$3.4B	39,500	13,000	1.44B	0.81B
	U.S.	800	$33.3B	350,000	92,455	9.17B	6.4B
Intercity Coach	Canada	48	$0.35B	10,000	4,000	0.014B	0.15B
	U.S.	400	$4.5B	30,000	40,000	0.14B	3.75B
School Transportation	Canada	649	$1.4B	31,000	38,800	0.5B	0.65B
	U.S.	6,600	$11.75B	N/A	448,300	4.74B	6.12B
Charter/Tour	Canada	101	$0.23B	5,000	Included with Intercity	N/A	0.14B
	U.S.	3,200	$3.93B	110,000		N/A	N/A
Total	Canada	893	$5.38B	85,500	55,800	1.95B	1.74B
	U.S.	11,000	$53.48B	490,000+	480,755	14.05B	16.27B+

Source: CUTA, APTA, HROC

The urban transit and school student transportation sectors in Canada and the U.S. are well documented, while statistics for the intercity highway coach sector are not well defined, primarily because of the private and competitive nature of that sector. Information for this sector has been developed from several sources, including published reports and available industry association statistics. The following is an overview of the industry in Canada and the U.S.

5.2 URBAN TRANSIT

Canada's NovaBUS LFS buses are operating in cities in the U.S. as well as Canada. This model is operating in Chicago.

Table 3 presents more detailed statistical information on the urban transit industry. As can be seen, the prominence of urban transit services in both countries is significant.

TABLE 3
URBAN TRANSIT STATISTICS FOR CANADA AND THE U.S.
(1999)

		Canada	United States
Population		30M	282M
Ridership		1.44B	9.17B
No. of Systems		95	800
Employees		39,500	350,000
Vehicles	- Bus	11,548	75,087
	- LRT	520	1,297
	- Subway	1,419	10,306
	- Commuter	505	5,164
	- Locomotives	60	601
	TOTAL	**13,000**	**92,455**
km Operated		0.8B	6.4B
Expenditures	- Operating	$3.4B	$22.2B
	- Capital	$1.15B	$9.0B
	TOTAL	**$4.55B**	**$31.2B**
Government Funding			
(a)	Operating: Federal *	$0.0003B	$0.9B
	Province/State/Local	$1.1000B	$9.4B
	TOTAL – Operating	**$1.1003B**	**$10.3B**
(b)	Capital: Federal	$0	$3.9B
	Province/State/Local	$0.9B	$2.1B
	TOTAL – Capital	**$0.9B**	**$6.0B**
TOTAL GOVERNMENT FUNDING		**$2.003B**	**$16.3B**

* Transport Canada R&D
Sources: CUTA, APTA, HRDC

Following are some of the salient industry facts:

- In 1999, transit use in Canada totalled 1.44 billion rides; in the United States, 9.17 billion trips were taken in 2000. These give a per capita level of 48 in Canada and 32 in the U.S.
- The urban transit vehicle fleet totals 13,000 units in Canada and 92,455 in the U.S. of which buses account for 11,548 units in Canada and 75,087 in the U.S.

- Vehicle-kilometres operated total 0.81 billion in Canada and 6.4 billion in the U.S.
- In the U.S., buses carried 61.6 percent of all transit trips. A detailed modal breakdown is not available for Canada but is estimated to be 75 percent.
- Employment totals 39,500 in Canada and 350,000 in the U.S.
- Expenditures on operations and capital total $4.55 billion in Canada and $46.8 billion in the U.S., a per capita rate of $151.66 in Canada and $161.37 in the U.S.
- Government funding for transit (all levels) totals $2.003 billion in Canada and $24.45 billion in the U.S., a per capita level of $66.76 in Canada and $86.70 in the U.S.
- Transit fares account for 62 percent of direct operating expenses in Canada versus 37.3 percent in the U.S.

The average life of a transit bus in Canada is 18 to 20 years (16 in Quebec, higher in other provinces) and 12 years (with some variation) in the U.S. The lower average age in the U.S. reflects the federal government funding criteria that permit replacement after 12 years.

Interestingly, with a population of approximately 10 times that of Canada, U.S. urban transit statistics and performance do not reflect the same ratio. For example, while the per capita use of transit in Canada is 50 percent higher than in the U.S., the number of vehicles used is higher only by a factor of 7 (30 percent less) and the level of service by a factor of 8 (20 percent less). This indicates that transit systems in Canada have a higher productivity level that those in the U.S. in terms of kilometres travelled per vehicle and passengers carried per kilometre.

Noteworthy also is the level of government investment in public transit in the U.S. compared to Canada. In absolute terms, government funding for urban transit in the U.S. totals CDN $24.5 billion compared to $2.0 billion in Canada, 12 times the rate in Canada. On a per capita basis, U.S. government support is approximately $86.70 versus $66.67 for Canada, a difference of $20 per capita or $600 million.

5.3 INTERCITY HIGHWAY COACH

MCII Series E, 45 ft.
Luxury Highway Coach

This sector includes scheduled intercity services, some commuter services, and charter and tour operations. Over the past 20 years, scheduled intercity services have declined significantly in both the U.S. and Canada, reflecting a decline in ridership and economic difficulties in the industry. This has occurred for a number of reasons, some of which include increasing car and airline use, deregulation in the U.S., the bankruptcy of major U.S. and Canadian bus operators (Greyhound and Trailways), and consolidation of intercity bus companies. In contrast, there has been a significant growth in charter and tour operations. Industry associations estimate that this market now represents about 2/3 of the industry's revenue.

Statistics for the intercity industry in both Canada and the U.S. are difficult to obtain, particularly for the charter/tour segment, given the private and competitive nature of the sector. However, some basic information is available, with several sources separating the scheduled and charter/tour operations. For the purposes of this report, statistics for the scheduled service and charter/tour components have been combined for two reasons:

1. Typically, the operator that provides scheduled service also provides charters and tours using the same equipment. Thus, employees and vehicles are shared.

2. Charter/tour revenues are used to offset operating losses on the scheduled service side. Together the two services help to sustain operators.

Key statistics are:

- Fleet size: 4,000 coaches in Canada, 40,000 in the U.S.
- Companies: 149 in Canada and 3,600 in the U.S.
- Employment: 15,000 in Canada and 140,000 in the U.S.
- Operating Expenses: $578 million in Canada, $8,427 million in the U.S.

The average useful life of a highway coach ranges between 20 and 25 years, although coaches used by the mainline scheduled service and charter/tour operators are often replaced before 10 years.

As a way of diversifying their operations and strengthening their financial viability, many intercity coach operators also operate school student transportation services as well as shuttle and paratransit services.

There is little or no government funding for intercity coach operations in Canada or the U.S. except, possibly, indirectly through certain commuter services.

5.4 SCHOOL STUDENT TRANSPORTATION

The most popular school bus design, model C, conventional, consists of a BlueBird body on a Ford chassis.

School student transportation is a large operation in both countries. Using 1998-99 school year data (the most recent year for which information is available), in Canada some 2.5 million students are transported each day. In the United States, the number is over 22 million. Almost 450,000 school buses in the U.S. and 40,000 in Canada are employed to provide transportation. Total transportation costs are $1.4 billion in Canada and $11.7 billion in the U.S., with service provided by over 7,200 companies. In the U.S., a supplementary amount of $640 million was provided in about one half of the states for bus replacement. All funding in Canada comes from either the local or provincial tax base. In the U.S., the same condition applies although almost 50 percent of the cost is covered by the state governments.

In both countries, school transportation services are provided indirectly by a mix of private transportation companies operating under contract to local or regional school boards or municipal councils, and directly by either the regional or municipal government or school board. The school bus fleets may be owned by the local school board or government or by the contractor. In the U.S., 60 percent of all school buses are owned by contractors.

School buses have been kept in most jurisdictions for 10 years, although this is trending toward 12 years.

5.5 RURAL, PARATRANSIT AND SHUTTLE SERVICES

Typical "cutaway" vehicle featuring a wheelchair lift. Bodies are supplied by various manufacturers and mounted on a Ford chassis.

This sector encompasses a wide range of services, vehicles and companies, and is linked in view of the similarity in the types of vehicles used. It is not a regulated or separately identified sector and therefore specific information is not readily available. However, a general profile of the sector has been constructed from a number of sources, primarily vehicle manufacturers and distributors. A common denominator for this sector is the type of vehicles used – typically small 10- to 20-passenger vans or small buses.

The types of services covered by this sector include:

– airport parking shuttles;
– airport to hotel, inter-hotel shuttles;
– health care, nursing home and seniors home transportation services;
– out-of-town shuttles to airports; and
– rural paratransit and community transportation services.

Very often these services are operated by intercity coach operators.

Industry sources estimate that there are 31,000 vehicles in use for these services in the United States and a further 2,500 in Canada. They represent one of the fastest growing markets in the two countries.

Employment and financial statistics are difficult to estimate although, using a factor of 3.5 per vehicle as in the intercity coach sector, employment may approximate 9,000 in Canada and 110,000 in the U.S.

5.6 INDUSTRY ASSOCIATIONS

The public transportation industries in Canada and the United States are well served by professional associations. Following are the main organizations in each sector:

Canada

Urban Transit:	Canadian Urban Transit Association, Toronto Ontario Community Transportation Association Association du transport urbain du Québec (ATUQ)
Intercity:	Canadian Bus Association Ontario Motor Coach Association The Canadian Institute of Travel Counsellors of Ontario Motor Coach Canada Association des propriétaires d'autobus du Québec (APAQ)
School Bus:	School Bus Owners Association Ontario School Bus Association Association du transport écolier du Québec (ATEQ)

United States

Urban Transit:	American Public Transportation Association Various state transit associations
Intercity:	American Bus Association United Motorcoach Association
School Bus:	National School Transportation Association National Association for Pupil Transportation School Business Officials American Association of School Administrations Various state student transportation associations

6 BUS AND COACH MANUFACTURING INDUSTRY IN CANADA AND THE UNITED STATES

6.1 OVERVIEW

The bus and coach market in Canada and the United States can be divided into four distinct product segments:

1. Urban transit buses
2. Intercity coaches
3. School purposes buses
4. Shuttle and paratransit vehicles

The intercity coach market includes coaches used in suburban and intercity services provided by operators such as Greyhound/Laidlaw, Coach Canada/Coach USA, GO Transit, Limocar and TransLink/Coast Mountain Buses in Canada, and New Jersey Transit, Houston Transit and AC Transit, among others, in the United States. As noted in section 5.3, it also includes coaches used for charters and tours.

Table 4 summarizes the size of the industry by vehicle type for each country, together with the number of bus and coach manufacturers for each product segment. Within Canada and the United States, there are 36 manufacturers in the marketplace. These are listed by country of origin (i.e., NovaBUS, New Flyer and Orion Bus Industries (OBI) are considered Canadian). For the U.S. market, the number of manufacturers includes two companies that import buses from Europe: Setra North America and VanHool.

6.2 TRENDS AND INFLUENCING FACTORS

The bus and coach manufacturing industry has undergone significant change over the past decade. New products and new technologies have been introduced and there has been consolidation and contraction. At the same time, spurred by increased U.S. funding for public transit and a strong economic climate from the mid-1990s onward, the market for urban transit buses and intercity coaches has been at the highest level since the immediate post-war period.

TABLE 4
NORTH AMERICAN BUS AND COACH INDUSTRY
KEY STATISTICS

Country	Population (millions)	Market Size						Number of Manufacturers*					
		School Buses	Transit Buses		Coaches	Shuttle	Total	School Buses	Transit Buses		Coaches	Shuttle	Total
			< 9.1 m	> 9.1 m					< 9.1 m	> 9.1 m			
Canada	30.0	38,000	200	11,300	4,000	2,500	56,000	2	1	3	2	0	8
United States	282.0	448,000	2,000	74,000	40,000	30,000	594,000	5	8	3	2	10+	28+
Total	312.0	486,000	2,200	85,300	44,000	32,500	650,000	7	9	6	4	10+	36+

* Manufacturers are listed by country of head office and by predominant product line. Many have facilities in more than one country and produce more than one product line.

Some of the changes that have occurred include:

- Introduction of **low-floor urban bus designs** in all vehicle lengths. These vehicles have been of completely new design, not a modification of older standard-floor designs. Pioneered by New Flyer Industries in 1990, low-floor bus models are now offered by all Canadian/U.S. manufacturers. These have generally been based on existing European models where the low-floor concept was first developed.
- **New engines and transmissions**. The former standard 2-cycle diesel engines of Detroit Diesel have been replaced by 4-cycle engines to meet increasingly stringent emissions standards in the U.S. and Canada. New transmission models have also been introduced to match the power and performance requirements of the new engines, and to meet operations needs.
- **New axles and suspension systems** required for the urban bus low-floor designs. These have been adaptations of European designs.
- Introduction of **new intercity coach models**. These designs have been influenced by European coach designs and feature smoother, curved styling and flush glazing. A longer coach model, 13.7 m (45 ft.) has been introduced. In addition, wheelchair accessibility features have been developed.
- **Globalization of manufacturers**. Two European bus and truck manufacturers, Volvo AB and Daimler-Chrysler (Mercedes-Benz/EvoBus), have entered the North American market and purchased several bus and coach manufacturers. At the same time, one U.S. manufacturer, NABI, which began with roots in Europe, purchased the U.K. manufacturer, Optare PLC. One other U.S. manufacturer, Chance Coach, has established a joint venture with Wright's of Northern Ireland to manufacture and sell Wright's small bus product in the U.S.
- **Consolidation of manufacturers**. Volvo AB has brought NovaBUS, Prévost and Blue Bird Body together under one ownership. Daimler-Chrysler (Mercedes-Benz) brought together Orion Bus Industries, Thomas Built Buses and Detroit Diesel under one ownership. This arrangement also includes Setra, an intercity coach manufacturer, already part of the Mercedes-Benz (EvoBus) group.
- **Contraction of manufacturers**. The Flxible Corporation, manufacturers of urban buses, and Eagle Corporation, manufacturers of intercity buses, both went out of business in the late 1990s.

Clearly, the industry has seen considerable change over the past 10 years. In general terms, the North American bus and coach industry has been greatly influenced by product and operations philosophy trends from Europe, notably the introduction of low-floor buses and styling changes with intercity coaches.

Aside from the foregoing business, market-driven trends, there have been other governmental and legislation changes that have influenced the bus and coach manufacturing industry in North America:

- U.S. Buy America Act
- Canada-U.S. Auto Pact (now expired)
- Americans with Disabilities Act
- FTA and APTA book of standard specifications and procurement ("White Book")
- Structural integrity testing requirements (Altoona Test, ORTECH "shaker" test)

Of these, the most influential has been the U.S. Buy America Act, which has had the effect of requiring manufacturers wishing to access the bus and coach market in the U.S. to maintain a manufacturing plant there, to meet a 60 percent U.S. content requirement and to complete final assembly in the U.S. The details of this legislation are discussed in more detail in section 7.3.

6.3 BUS AND COACH DESIGN AND MANUFACTURING PROCESS

The design, development and manufacture of buses and coaches is a long and complex process that is highly specialized and subject to significant external influences. This is particularly so for urban buses and intercity coaches. The influences involved are greater today than at any time in the history of the industry, with some of the key influences noted above. To appreciate the complexity of the industry and the complexity in the design and manufacture of buses and coaches, it is perhaps helpful to review what is involved in the process.

At the outset, it is important to differentiate between the process of manufacturing integral urban transit buses and intercity coaches and the process of manufacturing body-on-chassis, or "cutaway", type school bus and shuttle vehicles.

Urban buses and intercity coaches consist of a physical structure that incorporates a chassis to which the drive-train and axles are attached. There is no separate chassis. The manufacturer then installs a variety of sub-components that have been designed and manufactured by suppliers. The body design consists of separate wall, underframe and roof sections constructed of metal tubing, joined together by welding or rivets or metal fasteners, and to which external metal panels are attached by welding or rivets. The frame and sidewall components are fabricated using very basic bending and cutting processes. Some exterior body parts (front and rear end caps) are formed from plastic composite materials and affixed to the frame with rivets or screws. Some of these composite material parts may be affixed with special industrial glues. Interior floors consist of a treated plywood base that is covered by a rubber material or compound.

Thus, the bus and coach manufacturers are essentially “assemblers” of components. However, because they are both the manufacturer and the seller of the product, they have overall responsibility for the performance of the vehicle; the purchaser looks to the manufacturer to resolve issues.

For school bus and shuttle vehicles, the chassis and body are separate and are usually made by separate manufacturers (in some cases, however, one manufacturer may make both). Each has responsibility for specific parts of the vehicle although one builder, usually the body manufacturer, takes overall responsibility for the vehicle. These vehicles are typically sold through dealerships rather than by staff directly employed by the responsible manufacturer as in the urban bus and intercity coach industry. For these vehicles, the chassis, including the engine, transmission and axles, is generally identical to that used in trucks or in van applications and thus benefits from a lower cost structure as well as from the sharing of associated engineering and development costs that are spread over a much higher volume. For example, heavy truck sales total up to 150,000 annually, with lighter duty trucks and vans totalling 200,000 or more. School bus chassis sales total 35,000 to 40,000 per year. Urban transit and intercity coach sales together total fewer than 10,000 per year.

As an indication of the complexity involved, a typical bus or intercity coach consists of the following major systems or componentry in addition to the body structure:

- Drive-train: engine, transmission, cooling system
- Axles: wheels, brakes, suspension and steering systems
- Ventilation: heating, air conditioning, ductwork, fan motors, sensors, controls
- Electrical: lights, relays, diagnostics, information systems, alarm/safety systems
- Doors: controls, safety interlocks
- Air: brakes, engine throttle, door system, suspension

From first concepts, the usual timeframe to bring a new vehicle design to market (i.e., first sales delivered to the customer) can take four to five years and involve the following steps and timetable:

- Design concept: 6 months
- Design, engineer and manufacture prototype: 12 to 18 months
- Testing: 1 to 2 years
- Complete sales, manufacturing and delivery: 18 to 24 months

Testing will include completion of both the Altoona and Ortech tests, which can take up to nine months to complete. Any structural or component defects found are then corrected and the vehicle is re-tested. Each test can cost as much as $400,000.

Because of the specialized nature of bus and coach designs, many of the components involved are made just for buses and coaches and rarely for any other vehicle. Even the engines and transmissions, which may have a common design with trucks, incorporate very different features, particularly with regard to emissions and component drives.

6.4 PROCUREMENT PROCESS

The vehicle procurement process, particularly for urban buses, has a significant influence on vehicle designs and specifications. For urban buses, the procurement process is lengthy and can take as long as six months from the time the vehicle specifications are issued by the purchasing authority to the time a purchase award is made. From that point, it may be a further 12 to 18 months before the vehicle is delivered, depending on the successful manufacturer's order backlog. The procurement process for school buses, shuttle/paratransit buses and intercity coaches is much simpler, relying oftentimes on a straightforward contract, specifications agreed upon between buyer and seller, and a delivery time of six months or less for school and shuttle buses, and six to nine months for intercity coaches.

In the procurement process, the purchaser develops specifications for the vehicles, including specifying particular components. It is the responsibility of the manufacturer to ensure that the vehicle performs to expectations.

For urban buses funded in the U.S. by the FTA, the procurement process is complicated by the requirement to meet the Buy America conditions. Audits must be conducted both prior to and following the delivery of the buses (termed "Pre" and "Post" audits), usually by independent agents, to ensure that the procurement process has been fair and equitable and that the vehicle being procured meets the specification of the tender documents.

6.5 DESCRIPTION OF BUS AND COACH PRODUCTS

All bus transportation vehicles in Canada and the U.S. are virtually identical in design and specification. There is a high degree of parts commonality largely as a result of the predominance of U.S.-made major components such as engines, transmissions, axles and air conditioning. **Notably, none of these components is manufactured in Canada.** Canadian bus manufacturers (or, more accurately, "assemblers") dominate the Canada-U.S. market because of lower production costs, higher manufacturing quality and a demonstrated record of innovation. Each of the main bus and coach products is outlined in this section.

6.5.1 Transit Buses

Following are chief characteristics of transit buses in Canada and the U.S.:

– Diesel powered, automatic transmission, air-ride, air-conditioned. There are some examples of compressed natural gas (CNG)-powered vehicles.

- Length: 9.1 m (30 ft.), 10.7 m (35 ft.), 12.2 m (40 ft.), 18 m (60 ft.) articulated.
- Width: both 2.44 m (96 in.) and 2.59 m (102 in.).
- High-floor and low-floor (14 in./255 mm floor height) designs.
- Integral construction: almost all transit buses of 9.1 m length and over are of this design. Gillig Corporation vehicles are the lone exception, using a body-on-chassis, bolted design.
- High degree of standardization, especially in power train components. Engines are either Detroit Diesel (80 percent of market) or Cummins. Transmissions are either Allison (80 percent), ZF or Voith. Axles are either Meritor, formerly Rockwell (90 percent), or Dana.
- 12.2 m (40 ft.) buses are approximately 75 percent of the market; 18 m (60 ft.) articulated buses represent approximately 10 percent of the market; 9.1 m to 10.7 m buses, 15 percent.

Low-floor designs account for approximately 75 to 80 percent of sales in Canada and approximately 50 percent in the U.S. Most buses are 2.59 m (102 in.) wide, with a few 2.44 m wide buses. These are typically only found in 9.1 m and 10.7 m buses. 2.44 m wide buses of all types are estimated to be 15 to 20 percent of total annual bus sales.

The average life of a transit bus is 18 to 20 years in Canada, 12 to 15 years in the U.S.

Of interest in this study is the fact that bus weights have increased significantly over the past 15 years. Typical empty weights today are 12,000 to 13,000 kg compared to 9,500 to 10,500 kg in the late 1980s, a 25 to 30 percent increase. Much of this is the result of new features being added to buses and more powerful engines and transmissions.

Alternative fuel buses constitute approximately 7 percent of the bus universe in the U.S. and 3 percent in Canada. The larger percentage in the U.S. is the result of aggressive "clean air" legislation in several states.

Average purchase price of a 12.2 m transit bus is approximately CDN $430,000.

6.5.2 School Buses

School bus designs fall into three categories: Type A/B (up to 24 passengers), Type C and Type D (24 to 78 passengers). All school bus designs are of the "body-on-chassis" assembly method whereby there is a separate body bolted onto a chassis. Typically, the chassis is a truck-derived product supplied by truck manufacturers, although both Thomas Built and Blue Bird build their own.

The type C, or "conventional" design, with the motor in front, is the most common design and typifies the school bus image. Chassis are supplied by a number of manufacturers, notably GMC, International and Freightliner, while bodies are manufactured by a number of suppliers, the main ones being BlueBird, Thomas and AmTran. As with transit buses, there is considerable commonality in design between Canadian and U.S. buses, although a number of U.S. states have varying requirements for seating and emergency door specifications.

"Transit" style school bus designs (Type D) with the front door ahead of the front wheels and the engine either behind the windshield, midship/underfloor or at the rear, are gaining in popularity because of better visibility of school children by the driver. The body-on-chassis design continues as it is cheaper to produce and is adequate for the less rigorous duty cycle compared to transit buses. Also, there has not been the concern for longer life typical of integral design buses and the parts availability from the chassis manufacturers' dealer network is well suited to the predominantly rural nature of school bus operations.

The life span of school buses has been increasing in recent years from the previous standard of 7 to 8 years to an average of 10 to 12 years as a result of funding cuts and improvements in vehicle specifications, notably the greater use of diesel engines and automatic transmissions.

The average cost of a 78 to 84 passenger (Type C) school bus is approximately $70,000. Cost for a top-line, Type D school bus is approximately $75,000.

6.5.3 Intercity Coaches

Typical 45 ft. intercity coach, made by MCI, in service with Penetang Midland Coach Lines

The intercity, or highway, coach market includes vehicles for suburban and line-haul (intercity) services as well as charter/tour operations. The vehicles for each of these services are essentially the same.

As with the other bus products, intercity coach designs are also common to Canada and the U.S., with 12.2 m and the more recent 13.7 m (45 ft.) lengths predominating. All are of integral construction and diesel-powered. The two major manufacturers are MCI and Prévost. Manufacturers such as BlueBird and Dina have developed coach products based on body-on-chassis designs but these have not sold well.

With the charter and tour market increasing over the past number of years, coach designs have incorporated many high-quality, sophisticated features, including stereo systems, video monitors and independent passenger ventilation systems, as well as more comfortable and attractive interior fittings and decor. This segment now comprises 50 percent of the total annual market for intercity coaches.

Another important market is "prison" coaches (used to transport inmates between penal institutions) and "shells" for conversion into motorhomes or specialty vehicles. These two markets represent approximately 5 to 10 percent and 15 to 20 percent of the overall coach market, respectively.

Suburban coach products are essentially intercity coach derivatives and have fewer customer amenities (no washroom, video/stereo systems) but can include urban bus features such as electronic destination signs. These coaches are used in commuter services into large cities. TransLink (Vancouver), New Jersey Transit, GO Transit (Toronto) and Houston Metro are large operators of such vehicles. This product typically represents about 10 percent of intercity coach production, although recent large orders from New Jersey Transit and New York have increased this to about 25 percent.

Similar to the weight trend with urban buses, highway coach weights have increased significantly over the past 15 years, with these vehicles now weighing as much as 14,000 to 15,000 kg empty.

Average purchase price of a 13.7 m intercity coach is $550,000.

6.5.4 Shuttle/Paratransit Buses

These vehicles extend across a wide spectrum of designs and sizes. However, their key characteristics include the following:

- Body-on-chassis design using either a complete chassis supplied by a separate manufacturer or a portion of a chassis (front power module) to which a body and rear axle is attached.
- Generally less than 9.7 m (30 ft.) in length and carrying fewer than 30 passengers.

Many of the smaller vehicle designs are termed "cutaways", that is, they use the chassis and front cab unit manufactured by suppliers such as Ford (E350 and F350 series) to which a body is married.

Serving this market are a large number of body builders fabricating products from both metal (aluminium) and fibreglass.

6.6 BUS AND COACH MARKET – 1996-2000

The annual market for buses and coaches in North America over the five year period 1996 to 2000 is summarized in **Table 5.**

TABLE 5
NORTH AMERICAN BUS AND COACH MARKET
BY MARKET SEGMENT
1996-2000

(Vehicles 9.1 m in length and over)

Market	**Market Segment**	**Year**				
		1996	**1997**	**1998**	**1999**	**2000**
Canada	Transit Bus	700	450	660	600	500
	School Bus	3,298	3,299	3,712	4,104	4,644
	Coach	330	360	360	375	375
United States	Transit Bus	3,400	4,200	4,300	4,600	4,500
	School Bus	37,200	37,100	37,900	42,340	43,200
	Coach	2,270	2,570	2,675	3,000	2,800
	Coach Conversions	380	330	400	450	400
TOTAL	Transit Bus	4,100	4,650	4,960	5,200	5,000
	School Bus	41,100	43,000	44,900	46,740	47,884
	Coach	2,980	3,260	3,435	3,375	3,175

Source: Prepared from industry sources.

Including shuttle buses/paratransit vehicles, the annual market for transit buses, school buses and intercity coaches has averaged 5,750 in Canada and 56,800 in the U.S. as illustrated in **Table 6**.

TABLE 6
ANNUAL MARKET FOR BUSES AND COACHES – CANADA AND THE U.S.

	Canada	U.S.
Transit Buses	600	4,200
School Buses	3,800	39,600
Intercity Coaches	350	3,000
Shuttle Buses	1,000	10,000
Total	*5,750*	*56,800*

As noted earlier, the bus and coach markets in Canada and the United States are highly integrated. The Canadian market for buses, coaches and school purpose vehicles is approximately 10 percent that of the United States. At the same time, Canada is the home base for three of the six urban transit suppliers, two of the five highway coach manufacturers (two of which do not manufacture in North America) and two (plus two subsidiaries) of the five school bus manufacturers. Clearly, Canadian manufacturers dominate the North American market but depend heavily on the United States market for their existence.

6.7 MARKET PROJECTIONS – 2001-2003

The bus and coach markets in Canada and the United States over the next three years are projected to remain stable with expected gains in Canada offsetting some decline in the U.S. The Canadian bus and coach market is about 1/10 the size of the U.S. market for all three sectors, although the urban bus market is slightly larger.

TABLE 7
BUS AND COACH MARKET FORECAST
2001-2003

Market	**Product**	**Year**			
		2001	**2002**	**2003**	**Average**
Canada	Transit Bus	600	700	800	700
	School Bus	3,500	3,200	3,200	3,300
	Coach	200	250	250	235
United States	Transit Bus	4,400	4,200	4,100	4,250
	School Bus	37,000	37,000	36,000	37,600
	Coach	1,900	2,000	2,100	2,000
	Coach Conversions	250	300	350	300
Total	Transit Bus	5,000	4,900	4,900	4,950
	School Bus	40,500	40,200	39,200	40,000
	Coach	2,350	2,550	2,700	2,550

Source: Prepared from industry sources.

The forecast detailed in **Table 7** is based on the following key influences:

Canada

- The transit bus market in Canada will increase marginally, compared to the past five years, up to 2003 but likely will increase markedly thereafter on the strength of bus replacement requirements in Toronto and new capital funding for Ontario transit systems.
- The intercity coach market has declined significantly (-25 percent) over the past two years and is anticipated to continue to be soft, particularly in the short term, as a result of September 11, 2001. Beyond 2003, it can be expected to increase moderately but not to be comparable to the 1997-1999 period when sales exceeded 3,000 units per year.
- School bus sales declined in the early 1990s but picked up significantly over the 1998-2000 period. The next two years will see some decline as a result of over-buying in the previous three years followed by a period of stability with the need to replace aging buses in the western provinces offsetting anticipated fleet declines in Ontario and Quebec.
- The shuttle bus market has seen some growth in Canada over the past 10 years as the number of airport parking lots, airport hotel shuttle operations and paratransit services has increased. A number of the higher quality models of the shuttle bus vehicles are now being used in transit services across Canada, particularly in small municipalities but also in larger cities, most notably Edmonton and Calgary.

United States

- The demand for transit buses in the three-year period 2001-2003 will continue to be strong, consistent with the past three-year average.
- The coach market has declined by 1/3 over the past year to about 1,900 units and is expected to continue to be soft for the next three years. More typical volumes are 2,500 to 2,700 units per year.
- The school bus market will increase on the strength of the need to replace large numbers of aging school buses. Type D school buses can be expected to increase in sales for safety reasons. Overall, the increasing average age of school bus fleets will soften the annual market in the longer term. Reduced school bus operations will also affect annual sales.
- The shuttle bus market has seen significant growth over the past 10 years with the increase in the number of rural and paratransit services. The number of vehicles in use has more than tripled, although the market is now seen as being a stable market with minor growth projected. Because of the variety of vehicles sold and large number of body manufacturers involved, obtaining realistic estimates of sales is difficult.

6.8 BUS AND COACH MANUFACTURERS AND KEY SUPPLIERS

This section provides a general overview of the major bus and coach manufacturers and suppliers currently active in Canada and the United States.

6.8.1 Transit Buses

As indicated previously in **Table 4**, a total of 26 manufacturers supply the bus and coach markets in Canada and the United States. **Table 8** provides a summary of estimated production for the past four years for the 16 more prominent manufacturers.

TABLE 8
SUMMARY OF CANADA AND U.S. BUS AND COACH PRODUCTION BY MANUFACTURER, 1997-2000
(9.1 m AND OVER)

(All figures approximate)

Manufacturer	Year			
	1997	1998	1999	2000
AmTran	3,500	3,500	4,000	4,000
Blue Bird Body Co.**	15,000	18,500	21,500	19,000
Champion Coach**	1,340	1,500	1,600	1,400
Les Entreprises M. Corbeil	2,400	2,450	2,400	2,500
A. Girardin**	1,000	1,000	1,000	1,250
Gillig Corporation	1,000	1,000	1,100	1,200
Motor Coach Industries*	1,200	1,650	1,950	1,900
Neoplan U.S.A.	237	300	450	450
New Flyer Industries	1,000	1,100	1,350	1,350
N.A. Bus Industries	354	450	550	750
Nova Bus Corporation	1,260	1,300	1,200	900
Orion Bus Industries**	723	700	700	950
Prévost Car*	850	970	1,000	900
Setra North America	50	70	70	50
Thomas Built Buses**	14,000	15,000	18,000	16,000
Van Hool	400	550	600	600
Total	44,389	50,190	57,620	53,225

* Includes motorhome shells ** May include vehicles under 9.1 m
Source: C. H. Prentice from industry sources.

The products these manufacturers offer are listed in **Table 9**. Twenty of these companies produce a single product, seven manufacture only small buses under 9.1 m, four (two Canadian and two U.S.) manufacture only school bus vehicles and four manufacture or supply only intercity coaches. Two firms, NovaBUS and Gillig, only manufacture full-size transit buses. Through recent acquisitions (see section 6.2), Volvo and Daimler-Benz now provide more than one product line and have a significant role in the industry.

TABLE 9
SUMMARY OF CANADA AND U.S. BUS AND COACH MANUFACTURERS
BY COUNTRY OF ORIGIN AND PRODUCT

Country	Product				
	Transit Bus		School Bus	Coach	
	< 9.1 m	> 9.1 m		Suburban	Intercity
Canada					
A. Girardin			✓		
Les Entreprises M. Corbeil			✓		
Motor Coach Industries				✓	✓
New Flyer Industries		✓		✓	
NovaBUS Corporation		✓			
Orion Bus Industries	✓	✓			
Overland Custom Coach	✓				
Prévost Car Inc.				✓	✓
United States					
Blue Bird Body Company	✓	✓	✓	✓	✓
Braun Corporation	✓				
Care Concepts	✓				
Carpenter Manufacturing			✓		
Champion Coach	✓				
Collins Bus	✓		✓		
Diamond Coach	✓				
Eldorado National	✓				
Gillig Corporation		✓			
Goshen Coach	✓				
Metro Trans Corp. (Irizar)	✓				✓
Mid-Bus			✓		
Neoplan U.S.A.		✓		✓	✓
North American Bus Industries		✓			
Setra North America					✓
Supreme Corp.	✓				
Thomas Built Buses		✓	✓	✓	
Van Hool					✓

Note: Companies are listed by country of origin. Companies may have manufacturing plants in more than one country.
Suburban – a modified version of a highway coach

Table 10 summarizes the key information for the bus and coach manufacturers, including ownership, plant location(s), head office location, employment, location of R&D, products, sales volume for 2000, production capacity and estimated percentage of R&D expenditures.

TABLE 10
BUS AND COACH MANUFACTURERS – CANADA AND THE U.S.
(CDN $)

Company Name	Ownership	Head Office	Plant Locations	Employment	Products	Manufacturing Process	Sales	Sales Value	R&D Expense
Transit Bus									
Orion Bus Industries	DaimlerChrysler Commercial Buses North America Division	Greensboro, North Carolina	• Mississauga, Ontario • Oriskany, New York	Total - 1,220 Canada - 620 U.S. - 600	• Low-floor - 7.9 m (26 ft.), and 12.2 m transit buses • High-floor - 9.1 m, 10.7 m and 12.2 m transit buses • Alternative Fuels - CNG • Hybrid - diesel-electric	Bodies built in Mississauga, finishing and final assembly in Oriskany, some finishing in Mississauga	950 (est.) units	$400 mil lion	2% of sales. R&D done in Mississauga
New Flyer Industries	KPS Special Investment Fund	Winnipeg, Manitoba	• Winnipeg, Manitoba • St. Cloud, Minnesota • Crookston, Minnesota	Total - 2,400 Canada -1,470 U.S. - 930	• Urban transit buses and a suburban coach • High-floor - 12.2 m and 18 m (articulated) • Low-floor - 9.1 m, 10.7 m, 12.2 m, 18 m (articulated) • Suburban - 13.7 m, 3-axle • Alternative fuels/power - electric (trolley), CNG, LNG, Fuel cell (Ballard)	Bodies built in Winnipeg and St. Cloud; finishing and final assembly in St. Cloud and Crookston.	1,600	$750 mil lion	$2.5% of sales. R&D done in Winnipeg
Gillig Corporation	Herrick-Pacific (Dorncife family) Corporation (private)	Hayward, California	• Hayward, California	1,300 (est.)	• High-floor transit buses, 9.1 m, 10.7 m and 12.2 m, 2.44 m and 2.59 m widths • Low-floor transit bus, 10.7 m, 12.2 m • Alternative fuels: CNG • Hybrid under development	All manufacturing in Hayward	1,200	$400 mil lion (est.)	N/A (likely 1.5% of sales). R&D done in Hayward
Neoplan U.S.A	Willis, Stein and Partners (private). Manufactures designs under licence from Neoplan Germany	Lamar, Colorado	• Lamar, Colorado	500 (est.)	• High-floor transit buses: 10.7 m, 12.2 m, (13.7 m - demo only), 18 m (artic.) • Low-floor transit buses: 12.2 m • Coaches: 12.2 m and 13.7 m, double deck - 12.2 m • Alternative Fuels: CNG, LNG	All manufacturing in Lamar	450	$200 mil lion	N/A. R&D done in Germany and Lamar

TABLE 10 (cont.)

Company Name	Ownership	Head Office	Plant Locations	Employment	Products	Manufacturing Process	Sales	Sales Value	R&D Expense
North American Bus Industries	First Hungarian Fund (56%), Public ownership (44%). Also owns Optare UK PLC	Los Angeles, California (Optare – UK)	• Anniston, Alabama • Cepasbar, Hungary	NABI - 2,100 US - 750 Hungary - 750 Optare - 600	• High floor transit buses - 107 m, 12.2 m and 18 m • Low-floor - 12.2 m, 18 m • Compobus - 12.2 m, 13.7 m (composite material construction) • Alternative Fuels: CNG, LNG	Bodies built in Hungary, final assembly and finishing in Anniston	600 (projected 775 for 2001)	$240 mil lion	2.0% of sales. R&D done in Hungary and Anniston
Nova Bus Corporation	Subsidiary of Prévost Car Inc.	St. Eustache, Quebec	• St. Eustache, Quebec • Schenectady, New York	Total - 750 Canada - 450 US - 300	• St. Eustache - LFS, 12.2 m low-floor	LFS, Canadian orders – all work completed at St. Eustache; US orders – bodies built in St.Eustache, final assembly and finishing in Schenectady.	850	$325 mil lion	2.5% of sales. LFS R&D done in St. Eustache
Overland Custom Coach	Ray and Joseph Dries	Thorndale, Ontario	• Thorndale, Strathroy (body frames) • Brown City, Michigan	Total - 25 Canada - 15 US - 10	• ELF 25 ft. (diesel), 28 ft. (CNG) • Developing ELF electric drive • Distributor for Eldorado National products	Canada – body built in Strathroy, final assembly and finishing in Thorndale US – body built in Strathroy, final assembly in Brown City, finishing by Starcraft	100	$15 milli on	2% of sales. All R&D done in Thorndale
School Bus									
AmTran (American Transportation Corporation)	International Truck and Engine Corporation	Conway, Arkansas	• Conway, Arkansas • Tulsa, Oklahoma	1,200	• School buses – Types C and D	Bodies built in Conway; chassis supplied by International (Navistar); complete vehicles assembled in Tulsa	8,000	N/A	N/A

Table 10 (cont.)

Company Name	Ownership	Head Office	Plant Locations	Employment	Products	Manufacturing Process	Sales	Sales Value	R&D Expense
Blue Bird Body	Volvo AB	Fort Valley, Georgia	• Fort Valley, Georgia • LaFayette, Georgia • Brantford, Ontario	Total - 7,000 (est.) US - 6,500 Canada - 500	• School buses (primary product) - all types • Transit buses (7.3 m to 11.9 m) - body-on-chassis, front and rear engine • Coach - 12.2 m, rear engine (also produce motor homes) • Alternative fuels- CNG, LNG • Developing hybrid	US – Bodies and chassis built in Fort Valley and LaFayette. Canada – bodies assembled from kits and mounted on chassis supplied by other manufacturers	Total – 18,000 US – 14,500, Canada – 3,500	N/A	N/A
Thomas Built Buses	DaimlerChrysler Commercial Buses North America Division	Greensboro, North Carolina	• High Point, North Carolina • Woodstock, Ontario • (Note: Daimler-Chrysler has recently announced the closure of the Woodstock assembly plant as of January 1, 2002)	6,000 (est.)	• School buses (primary product) - all types • Transit Buses (9.8 m to 12.2 m) - body-on-chassis • 9.1 m Low-floor transit • Alternative Fuels - CNG	School buses: US - Bodies and chassis built in High Point, Canada – bodies in Woodstock assembled from kits, mounted on chassis supplied by other manufacturers. Transit low-floor – bus now built in High Point	Total – 14,000 US – 11,500 Canada – 2,500	N/A	N/A
Les Enterprises Michel Corbeil	Private shareholders	Ville des Laurentides, Quebec	• Ville des Laurentides, Quebec	200 (est.)	• School buses - types A/B, C and D	Assembles body kits from Carpenter and mounts on chassis supplied by other manufacturers	2,500 units per year. Now exporting approx. 20% to the U.S.	N/A	N/A
Autobus A. Girardin	N/A	Drummondville, Quebec			• School buses, Type A/B. Manufacturers products from Bluebird				

IBI GROUP

Table 10 (cont.)

Company Name	Ownership	Head Office	Plant Locations	Employment	Products	Manufacturing Process	Sales	Sales Value	R&D Expense
Intercity Coach									
Motor Coach Industries	Consorcio G. Grupo Dina (Mexico)	Winnipeg, Manitoba	• Winnipeg, Manitoba • Pembina, North Dakota • Des Plaines, Illinois	Total - 3,000 (est.) Canada - 1,500 US - 1,500	• Coaches - 12.2 m, 13.7 m, prison coaches and conversion shells for motorhomes.	Bodies manufactured in Winnipeg, final assembly and finishing in Pembina and Des Plains	1,900	$1.14 billion (est.)	2.5% of sales
Prévost Car Inc.	Henlys PLC (51%) Volvo AB (49%)	Ste. Claire, Quebec	• Ste.Claire, Quebec	1,150	• Coaches - 12.2 m, 13.7 m, conversion shells for motorhomes	All manufacturing done in Ste. Claire	800	$550 mil lion	2.5% of sales
Van Hool N.V.	Van Hool N.V.	Belgium	• Belgium	None in North America (use contractor for minor work in U.S.)	for North America • Coaches (12.2 m, 13.7 m)	All work done in Belgium. Minor finishing work in U.S.	500		
Setra North America	DaimlerChrysler Commercial Buses North America Division	Ulm, Germany	• Ulm, Germany	5	for North America • Coaches (12 m)	All work done in Ulm. Minor finishing work in U.S.	50		

6.8.2 School Buses

Two manufacturers have historically dominated the school bus product segment in the U.S. and Canada: BlueBird and Thomas Built. In Canada, two Canadian-owned builders, M. Corbeil and A. Girardin, are prominent. In the U.S., AmTran, owned by International Harvester, has risen in prominence in the U.S. over the past 10 years through the acquisition of several school bus body builders. Daimler-Chrysler recently announced the closing of the Thomas Built plant in Woodstock.

6.8.3 Intercity Coaches

There are three manufacturers of intercity coaches in Canada and the United States as well as two distributors of European coaches.

Domestic:

BlueBird Body Company
Prévost Car Inc.
Motor Coach Industries

Imported:

VanHool NV
Setra North America (now part of the newly formed DaimlerChrysler Commercial Buses North America Division)

Blue Bird produces some highway coaches but their production is small, approximately 75 to 100 units per year.

6.8.4 Shuttle Buses

This sector of the vehicle market has limited information regarding vehicle supply, finances and ownership readily available. There is a large number of small body builders throughout the United States and Canada that are difficult to identify and document. In addition, many of these vehicles are sold through a dealer network that may include truck or automobile dealers. As a result, it is difficult to determine the number and type of vehicles supplied annually under this category. Industry sources indicate that the annual number of units sold may total 10,000 units, with over 31,000 in service throughout the U.S. and 2,500 to 3,000 in Canada.

The most prominent manufacturers (not distributors) are:

Champion Motor Coach, Imlay City, Michigan
Coach & Equipment, Canadaigua, New York
Collins Bus Corporation, Hutchinson, Kansas
Diamond Coach, Oswego, Kansas
ElDorado National Company (Thor Industries), Salina, Kansas

Federal Coach, Fort Smith, Arkansas
Mid Bus Inc., Bluffton, Ohio
Glaval Bus Inc., Elkhart, Indiana
Goshen Coach, Elkhart, Indiana
Girardin Minibuses, Drummondville, Quebec
Krystal Koach Inc., Brea, California
Advanced Vehicle Systems, Chattanooga, Tennessee
Starcraft, Goshen, Indiana
Stratus Specialty Vehicles, Kansas City, Missouri
Supreme Corporation, Goshen, Indiana
Turtle Top, New Paris, Indiana
Thomas Built, High Point, North Carolina
World Trans, Hutchinson, Kansas

Employment estimates for this sector have not been able to be identified but on the basis of annual production of 10,000 to 2,000 units, employment may be in the order of 3,000 to 4,000.

6.8.5 Key Suppliers

There are over 500 suppliers to the bus and coach manufacturing industry, ranging from engines and transmissions to windows, doors, lights and relays. However, many of the major components (engines, transmissions and axles) are supplied by a small number of manufacturers. This fact reflects the small size of the bus and coach market overall, the specialized nature of the market and the high degree of standardization that exists. A list of the key suppliers to the bus and coach industry in Canada and the United States is presented in **Table 11**.

The vast majority of these suppliers are U.S.-based, with either minor portion of production occurring in Canada or the Canadian branch serving as a distributor.

Industry associations estimate that employment in both countries, when including after-sales parts and service suppliers, exceeds 50,000.

TABLE 11
COMPONENT SUPPLIERS – CANADA AND THE U.S.

Product	Company	Country of Manufacture		
		Canada	U.S.	Other
Engines	Cummins Engine Company		✓	
	Detroit Diesel Corporation		✓	
Microturbine	Capstone Turbine Corporation		✓	
Fuel Cells	Ballard Power Systems	✓		
Transmissions	Allison Transmission		✓	
	Voith Transmissions		✓	
	ZF Industries			Germany
Axles	Dana Corporation		✓	
	Meritor Automotive		✓	
	Voith Transmissions		✓	
	ZF Industries			Germany
Brakes	American Brake and Clutch		✓	
	Bendix Commercial Vehicle Systems		✓	
	BRAKEPRO	✓		
	Carlisle Motion Control Industries		✓	
	Dana Corporation		✓	
	Meritor Automotive		✓	
Wheels	Accuride Corporation		✓	
	Alcoa Wheel Products International		✓	
	Aluminum Company of America (ALCOA)		✓	
Seats	American Seating Company		✓	
	C.E. White Company		✓	
	Coach & Car Equipment Corporation		✓	
	Freedman Seating Company		✓	
	Multina	✓		
	Magnifoam Technology International	✓		
	Otaco Seating Co. Ltd	✓	✓	
	Recaro North America		✓	
	Transportation Seating		✓	
	USSC Group			
Flooring	Altro Floors			UK
	Baultar Composite	✓		
	R.C.A Rubber Company		✓	
	Taraflex			France
Shock Absorbers	Arvin Ride Control Products		✓	
	Munroe		✓	
Windows	Atwood Mobile products		✓	
	Storm Tite	✓		

Table 11 (cont.)

Product	Company	Country of Manufacture		
		Canada	U.S.	Other
Air Conditioning	Carrier Transport Air Conditioning		✓	
	Mobile Climate Control	✓		
	ThermoKing		✓	
Tires	Bandag		✓	
	Bridgestone		✓	
	Goodyear Tire and Rubber Company		✓	
	Michelin	✓		
Suspensions	Dana Corporation Division		✓	
	Meritor Automotive		✓	
	Ridwell Corporation		✓	
Lifts	LIFT-U (Hogan Manufacturing)		✓	
	Ricon		✓	
Wheelchair & Occupant Restraint Systems	Ancra International		✓	
	Kinedyne Corporation		✓	
	Q'Straint		✓	
	Transportation Seating		✓	
Lighting	Dialight Corporation		✓	
	Specialty Bulb Company		✓	
	TDG Transit Design group	✓		
	TruckLITE		✓	
	Grote	✓		
	Trans-Industries		✓	
Fuel Tanks	Lincoln Composites		✓	
Visual Information Systems	ALSTOM Transport Telecite (Canada)	✓		
	Luminator		✓	
	Trans-Industries		✓	
	Twin Vision NA		✓	
Annunciation, microphones	Clever Devices		✓	
	Digital Recorders (Twin Vision)		✓	
	Luminator		✓	
	Vultron Division of Trans Industries		✓	
Engine Starters, Generators & Batteries	Delco-Remy America		✓	
Passenger Counting Systems	Dilax International			Germany
	Infodev			
Fans (engine, transmission, hydraulic & air conditioning)	Electric Fan Engineering		✓	
Emissions Control and Engine Performance	Engelhard Corporation		✓	
	Engine Control Systems		✓	
	Johnson Matthey Environmental Products		✓	
	Trans-Industries		✓	
	Turbodyne Systems		✓	

Table 11 (cont.)

Product	Company	Country of Manufacture		
		Canada	U.S.	Other
Heating	Espar Products Mobile Climate Control Thermo King Webasto Thermosystems	✓ ✓	 ✓ ✓	
Ventilators	Flettner Ventilator Mobile Climate Control	 ✓		U.K.
Engine Air Starting Systems	Ingersoll-Rand Company		✓	
Bus Hybrid-Electric Drive Systems	BAE (Lockheed Martin) ISE Research Corporation Allison Transmission		✓ ✓ ✓	
Bus Treadle Switches and Safety Zone Mats	London Mat Industries		✓	
Carpet Underlay, Padding, Thermal Insulation & Fire Barrier Foam	Magnifoam Technology International	✓		
Bus Parts	Mohawk Manufacturing Prévost Parts – Coach & Transit	 ✓	✓	
Bus Bicycle Racks	Sportworks Northwest		✓	
Bus Bumpers and Safety Vents	Transpec Worldwide		✓	
Door Components, Controls and Panels	Vapor Corporation		✓	

7 KEY INDUSTRY INFLUENCES AND ISSUES

There is a wide range of factors that influence the bus and coach manufacturing industry in Canada and the U.S., along with a variety of issues within which the industry must function. Many are government-driven (environmental, economic), while others are industry-driven (cyclical demand, low bid). The following is a brief review of the most prominent factors and issues.

7.1 CYCLICAL DEMAND

The public transportation vehicle market is highly cyclical in nature in addition to being very competitive. Seven manufacturers compete for the 4,500 unit annual large bus market while another five (one is a duplicate from the urban bus market - Neoplan) compete for the 2,000 to 2,500 unit coach market. In comparison, seven compete for the 40,000 unit school bus market.

Over the 20-year period between 1973 and 1993, Canada/U.S. urban bus volumes fluctuated between a low of 3,115 units (1987) and a high of 6,381 (1975). Although the fluctuations over the past 10 years have been less pronounced, annual variations of as much as 20 percent do occur. The coach market has had similar fluctuations, ranging from a low in 1992 of 2,100 units to an expected high of 3,750 in 1998.

The cyclical nature of the industry and the specialized nature of the products that dictate a complicated manufacturing process tend to discourage manufacturers from increasing production volumes on a short-term basis. As a result, delivery lead times become lengthy during periods of high demand and are currently in the order of 18 months.

7.2 LOW BID

Most urban bus (and some coach and school bus) purchases are publicly funded, 95 percent in Canada and about 85 percent in the U.S., which dictates that procurements be through the public tender process. In almost all occasions, decisions are made on the basis of low bid. This condition has had a significant negative impact on the health of the urban bus manufacturing industry. The cyclical nature of the industry and strong competition has meant that many bus and coach manufacturers have either opted out of the industry or suffered financially. Indeed, of the eight major bus and coach manufacturers in the marketplace today, only two (Gillig and Prévost) can be said to be sound financially.

While there are some examples of “negotiated” bids for urban buses, in actual fact the majority of purchases are based on low bid. This process has had the effect of stifling innovation at the manufacturer level. There is little credit given for innovative designs. One example is OBI’s and NovaBUS’s low-floor bus models. Both incorporate a full-length flat floor design that was intended to maximize passenger safety and convenience compared to designs with a raised rear section and internal steps. However, they suffered from significantly lower passenger seating numbers compared to the competitive design (30 to 32 versus 40). This was seen as a distinct disadvantage by transit operators. Accordingly, both manufacturers have had to re-design their product (NovaBUS) or introduce a completely new vehicle (OBI).

At the same time, there have been innovative-design successes. New Flyer's decision to introduce a low-floor 12.2 m bus (with raised rear section) in the early 1990s as an accessible alternative to expensive lift-equipped high-floor buses has since revolutionized the industry. Today, 90 percent of buses purchased in Canada and 75 percent in the U.S. are low-floor. However, Flyer's success was slow and difficult.

7.3 BUY AMERICA

The U.S. Funding Bill TEA-21, which is a re-authorization of the ISTEA (Intermodal Surface Transportation Efficiency Act), includes a requirement that all buses purchased in the U.S. with federal funds after September 1, 1999, have to comply with "Buy America". Approximately 80 percent of all urban buses and 20 percent of intercity type coaches purchased in the U.S. are FTA-funded. Buy America is a condition for federal funding; it is not a trade- or tariff-based condition. Therefore, it has not been eliminated by NAFTA. Buy America requires that there be 60 percent U.S. content in a federally funded transit vehicle and that final assembly of the vehicle occur in the U.S. These two conditions control the whole North American urban bus market.

The definition of what constitutes "final assembly" was more clearly defined in 1999, with the result that more production must now occur in the U.S. Essentially, the definition now requires, for example, that axles and doors be installed in the U.S. Previously, they could be installed in Canada. The effect of this tightening of the final assembly definition has to shift more production and labour content to the U.S. A shift of 10 percent of Canadian bus industry employment appears to have occurred.

The Buy America requirement is unlikely to change in the foreseeable future. Clearly, any non-U.S. based vehicle manufacturer wishing to qualify for federally funded (even partially funded) vehicle purchases must have a U.S. final assembly production facility.

7.4 U.S. TRANSIT INDUSTRY "WHITE BOOK" BUS SPECIFICATIONS

The FTA and the APTA have developed over the years a standard bus specification document, known as the "white book", which is intended to establish performance and funding benchmarks for the procurement of transit buses. While this document is a reference source and its contents (i.e., specifications) are the basis for FTA funding of new bus purchases, deviations from the specifications are possible, since it is largely "performance" based. As such, it is not necessarily a limiting document for prospective new features or materials. What would be required, however, if new features, specifications or materials were wanted to be included, is a justification to the FTA. The process, generally speaking, is no different than the process used to procure buses in Quebec or Ontario previous to 1998, when there was a list of approved specifications for funding purposes.

7.5 CONSOLIDATION/PRESENCE OF EUROPEAN OWNERSHIP

As evidenced by recent purchases of U.S. and Canadian bus manufacturers, globalization of the North American industry is underway, a trend found in Europe as well as the rest of the world. Volvo AB of Sweden purchased three prominent North American bus and coach manufacturers between 1998 and 1999: NovaBUS Corporation, Prévost Car (in partnership with Henlys PLC) and Blue Bird Body. Daimler-Chrysler, which includes the EvoBus (Mercedes-Benz and Setra) bus and coach group in Europe, purchased Orion Bus Industries and Thomas Built Buses in 2000 as well as Detroit Diesel Corporation. They have recently formed the DaimlerChrysler Commercial Buses North America division, which links their three bus manufacturing operations. These two purchases give Volvo and Daimler-Chrysler Corporation a commanding presence in the North American bus and coach marketplace.

NABI's purchase of Optare of the UK in 2000 and the joint venture between Chance Coach in the U.S. and Wright's of Northern Ireland further illustrate the trend toward globalization of the bus and coach industry.

An investment firm from New York, KPS Special Investment Fund, has recently acquired a controlling interest in New Flyer Industries, which allows the company to improve its financial position and cash flow.

Thus, as a result of the foregoing trends, the question of the role or influence that the European companies may have in future on the North American, and particularly, Canadian bus and coach companies has been raised.

On the one hand, European influence has already been taking place in such matters as styling (particularly for intercity coaches) and design: larger windows, low-floor buses. On the other hand, the North American market is quite distinct compared to that of Europe. Not only are vehicle dimensions different but construction methods and durability standards are different (some would say higher). This latter condition is likely to continue to differentiate North American buses from European models in so far as there is unlikely to be a direct transfer of a European product to North America. As an example, Setra North America is introducing a "North Americanized" model in 2002. This work is being done in Germany.

VanHool had previously adapted its European coach models to North American dimensions and design standards and this engineering work was similarly undertaken at its headquarters in Belgium. Both of these manufacturers are exporters of products to North America and do not manufacture on this continent.

VanHool's T2140 intercity coach is built in Belgium to North American standards.

However, for established North American manufacturers, engineering, design development and R&D are likely to continue to be undertaken in North America for the foreseeable future. However, European influence is likely in a couple of areas:

- Greater integration of truck and bus technologies (engines, axles, transmissions), parts sourcing and particularly European products (engines, axles, transmissions) likely supplanting North American products.
- Continuing trend to adopt European bus and coach styling features to North American vehicles, particularly as the U.S. market seeks to enhance the image of the bus.

7.6 AMERICANS WITH DISABILITIES ACT (ADA)

In the United States, the ADA has had a major impact on vehicle specifications in the form of accessibility features (wheelchair lifts and low-floor buses) and audio/visual aids (annunciator systems) for persons with disabilities. It has also spurred the development of specialized transit services, particularly in rural areas, and has been the basis for the surge in the small/mini-bus market. Intercity and charter services are now facing pressure to provide accessibility. (Interestingly, the need to provide space for wheelchairs and accessibility to washrooms was the initial justification for the 45 ft. intercity coach product.) The ADA will continue to influence the transit bus and coach market in the U.S. in the future.

In Canada, no similar legislation exists at the federal level. Each province is on its own to respond to the needs of the disabled. Ontario has recently enacted the Ontarians with Disabilities Act. This Act has the potential to require public transportation services to be made accessible. No other similar legislation is being considered by the other provinces.

7.7 FUNDING

In Canada, funding for public transportation, excluding intercity railways, is a provincial responsibility. Downloading and a trend to reduce government debt have resulted in reductions in provincial and municipal budgets. This has had a negative impact on transit bus and school bus services, with consequent reductions in fleet sizes and delays in vehicle replacements. This situation will continue to influence the market for these two products over the next five years until a degree of stability is reached. The current level of discussion about federal funding presents a positive outlook and may help to stimulate capital asset purchases, primarily urban buses.

In the U.S., the anticipated re-authorization of public transportation funding through TEA-21 in 2003 can be expected to continue to have a positive influence on public transportation. Money will continue to be available to expand services, including funds for some intercity and suburban services, as well as to renew fleets and reduce the average age. This will create an increase in demand for transit buses as well as suburban and, to a lesser degree, intercity coach products. Less certain is the impact on the school bus market since funding for school student transportation is not part of TEA-21.

7.8 CLEAN AIR ACT / KYOTO ACCORD

The U.S. has been aggressive in passing legislation to reduce smog and tighten emissions standards. Public transportation, because of its federal funding, was one of the first to be targeted to improve emissions through alternative fuels. A number of states, notably Texas and California, have passed their own clean air requirements, which have resulted in large numbers of alternatively fuelled buses being purchased. The U.S. continues to advocate clean air strategies, which has pushed forward interest originally in natural gas and currently in fuel cell and hybrid drive technology.

The U.S. Environmental Protection Agency (EPA) dictates the clean air standards in the U.S., with California leading the way. The standards set by the EPA form the basis for similar standards adopted by Transport Canada. Canada, in reality, has little or no influence on these standards in view of all engine production being located in the U.S.

Canada, although advocating clean air, has not been as pro-active as the U.S. in reducing emissions and promoting alternative fuel use. This is largely the result of constitutional limitations on the federal government in being able to be involved in urban issues, which are the purview of the provinces, and the absence of funding by the federal government. Thus, interest in alternative fuels has been limited to Ontario, where the purchase of CNG-powered buses was promoted in the early 1990s. However, by signing the Kyoto Accord, the pressure is on the federal government to demonstrate a commitment to reducing emissions of GHG. Provided a way can be found for the federal government to provide funding and develop programs to reduce emissions and promote greater use of public transportation, the Kyoto Accord could provide a stimulus for greater use of public transit and sales of transit vehicles.

7.9 DEREGULATION

Deregulation of the intercity bus transportation industry in the U.S. several years ago resulted in significant changes to the intercity coach industry. Line haul services and coach fleets were reduced and the two major carriers, Greyhound and Trailways, merged. Charter and tours companies expanded. Today, the intercity coach industry continues in decline as ridership falls, a trend likely to continue.

The recent purchase of Greyhound by Laidlaw may accelerate these trends. Laidlaw wants to rival the expanding Coach USA organization, which is focused on the charter/tour market. Coach USA has been formed through purchases, consolidation and alliances among a large number of private operators. It is understood that Laidlaw's strategy is to further reduce intercity, line-haul services in favour of the charter/tour market. This suggests that the market for middle-of-the-road specification intercity coaches will decline, with an increase in the higher end, charter/tour specification coaches. The aging population supports this trend.

Deregulation of the intercity coach industry is not being pursued in Canada because of opposition from within the industry. The Province of Ontario has recently back-tracked, with the Province of Quebec also deciding against deregulating, for now, fearing the intrusion of U.S. and Ontario carriers, especially if Ontario does not deregulate.

8 BUS AND COACH INDUSTRY RESEARCH AND DEVELOPMENT

This section reviews current or emerging design and operational trends in the Canadian and U.S. bus and coach industry and the level of research and development that the manufacturing sector is expending today by answering the following two key questions:

1. What influences vehicle designs?

2. Where are these design trends initiated?

8.1 VEHICLE DESIGN ISSUES AND TRENDS – MANUFACTURERS

In general terms, apart from government intervention, designs are influenced or driven by market conditions. Either customers demand a new product or a manufacturer sees an idea or a market niche and decides to develop a product for that. An example of the former would be the recent emergence of new small bus designs from Thomas, Overland Custom Coach and Chance Coach. An example of the latter would be the introduction of the low-floor bus by New Flyer, an idea borrowed from Europe, followed by the introduction of the Invero with new styling features.

Apart from market-driven trends or needs, in recent years, design trends at the manufacturer and supplier level are being heavily influenced by current U.S. engine emissions standards, particularly those set for 2007. **Exhibits 1** and **2** illustrate the emissions targets for all engine classifications. Both Cummins and Detroit Diesel anticipate that their existing diesel engine models will meet the 2007 standards, although some form of pre- and post-exhaust treatment will be required.

The clear preference of the public transportation industry, both urban bus and intercity coach, is for continued use of diesel. The diesel fuel distribution infrastructure is widespread, posing no restrictions for the movement of intercity coaches (compared to the use of CNG or hydrogen) and it is safe, easy to handle and not costly to construct. As a result, engine and power train suppliers are working on both the ultimate certification of diesel engines for 2007 and the development of hybrid drive systems.

EXHIBIT 1
EPA HEAVY-DUTY ENGINE EMISSIONS STANDARDS

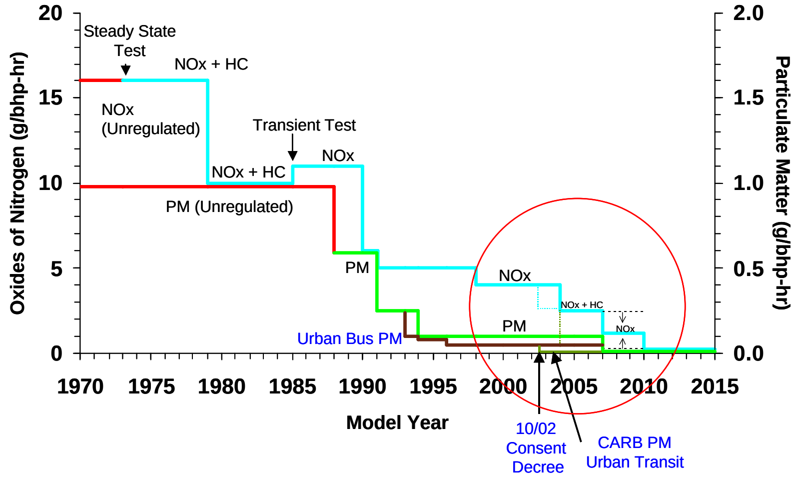


EXHIBIT 2
EPA & CARB – EMISSIONS STANDARDS

H-D Urban Transit Buses

Model Yr.	NOx	HC	CO	PM
1988 E/C	10.0	1.3	15.5	.60
1990 E/C	6.0	1.3	15.5	.60
1991 E	5.0	1.3	15.5	.25
1991 C	5.0	1.3	15.5	.10
1993 E/C	5.0	1.3	15.5	.10
1994 E/C	5.0	1.3	15.5	.07
1996 C	4.0	1.3	15.5	.05
1996 E	5.0	1.3	15.5	.05
1998 E/C	4.0	1.3	15.5	.05
2002 E #	2.5		15.5	.05
2002 C	2.5		15.5	.01
2004 C	.5	.05	15.5	.01
2007 E/C (1)	.2	.14	15.5	.01

Motorcoach, School Bus, Shuttle Bus

Model Yr.	NOx	HC	CO	PM
1988 E/C	10.0	1.3	15.5	.60
1990 E/C	6.0	1.3	15.5	.60
1991 E/C	5.0	1.3	15.5	.25
1994 E/C	5.0	1.3	15.5	.10
1998 E/C	4.0	1.3	15.5	.10
2002 E/C #	2.5		15.5	.10
2007 E/C (1)	.2	.14	15.5	.01

E = EPA
C = CARB

- October 2002 - Consent Decree Requirement
Note: All emissions in gms/bhp-hr
(1) 50% of sales must be at this level.
Effective total production level is 1.18 grams NOx/BHP/HR

In addition to the hybrid drive development, the following are the other active design trends. These are separate from any manufacturer or supplier-specific design initiatives.

Styling

Large urban buses in North America have become unattractive and "boxy" in appearance, with some exceptions. European urban buses are more aesthetically pleasing. Intercity coach designs in North America have adopted some of the European styling features (large windows, flush glazing, curved windshields and front end). There is now a trend toward more aesthetically pleasing urban buses. New Flyer Industries recently introduced their "Invero" bus design, which greatly advances the look of the bus.

New Flyer's new transit bus model, the 'Invero'. First deliveries will begin in spring 2002.

New small buses from the UK with attractive styling have also been introduced by several manufacturers (Thomas, Chance Coach).

Chance Coach has teamed with Wright's of Belfast, N.I., to produce a distinctive 30 ft. transit bus for the North American market.

NABI purchased Optare PLC of the UK in 2000 and is now marketing Optare's 10.4 m bus as the 30LFN.

At the same time, the U.S. transit industry is promoting the notion of Bus Rapid Transit (BRT) as an alternative to more expensive fixed-guideway Light Rail Transit (LRT). It is also a way of promoting public transportation in general. One of the key elements of BRT is a more attractive vehicle design. Thus, in this context, there is a trend toward more attractive vehicle design.

Smart Bus/Electronics Systems Integration

The growing presence of computer-based and electronic technology in the transit industry has reached the stage where a wide range of Intelligent Transportation Systems (ITS) are being specified in urban buses as well as intercity coaches. Examples of these systems include drive-train diagnostics, customer information (Next Stop announcements, service information, advertising), operations management systems (Global Positioning Systems (GPS), AVL), and smart card/electronic fare collection systems.

Bus and coach manufacturers are incorporating these features into their vehicles. However, the inter-operability and inter-connection of these systems, as is being requested by transit systems, is posing a challenge to the engineering staff of the manufacturers.

The trend toward multiplexed electrical wiring systems, pioneered by Canadian bus manufacturers, greatly simplifies the ability to integrate all of the smart bus features. Multiplexing also has permitted a reduction in vehicle weight (200 to 500 lb.) as an added value.

Stainless Steel

Transit operators have been specifying a 12-year life target for the bus structure to coincide with the 12-year replacement cycle permitted under U.S. FTA funding guidelines. One of the methods being requested by the operators is the use of stainless steel for the vehicle frame. This material is more resistant to corrosion, the chief cause of a vehicle’s physical deterioration, although it is more expensive and presents some obstacles to vehicle design. Chiefly, it is more brittle than carbon steel and could require more repair work following an accident.

Nevertheless, manufacturers are working to incorporate the use of this material into their vehicle structure design.

Weight Reduction

Bus and coach weights have increased by an average of 25 percent over the past 15 years. Urban bus weights now are in the range of 27,000 to 28,000 lb. (12,250 to 12,700 kg) empty. There are four main reasons for the increase in weights of urban buses:

1. A change to a frame versus a monocoque (the vehicle skin is load-bearing) type vehicle structure. A frame structure is more adaptable to design variations such as different door widths and positions. However, it is about 15 percent heavier than a monocoque design.

2. Adoption of low-floor bus designs that are based on a frame construction and that have had to incorporate greater strength in the lower side structure of the vehicle for safety purposes.

3. Incorporation of components specified by transit operators. Examples include digital destination signs, electronic fareboxes, more powerful engines and transmissions, and wheelchair lifts.

4. The use of alternative fuel options such as CNG or liquefied natural gas (LNG), with the requirement for large pressurized (or cooled – LNG) fuel cylinders. Hybrid drive systems also increase vehicle weight through their requirement for large banks of batteries.

For intercity buses, the main reasons for the weight increase are:

- Increase in vehicle length to 13.7 m.
- Incorporation of added design features, including audio and visual systems, other customer-oriented features, more powerful, larger and heavier engines and transmissions, and larger windows.

Intercity coach curb weights are now in the range of 33,000 to 34,000 lb. (15,000 to 15,500 kg).

The increased vehicle weight means that buses and coaches, when fully loaded, now regularly exceed the axle load limits as specified by local highway authorities. This has negative implications for vehicle safety (safe stopping, physical structure), reduced passenger capacity and increased road damage. Studies conducted by TDC (e.g., Cost Benefit Bus Weight Reduction Study, TP 12558, 1994-95) have documented the trend toward increased vehicle weight and the cost impact on the road structure and fuel consumption. Manufacturers are taking some small steps to reduce vehicle weight, such as re-evaluating their vehicle body design, using multiplex wiring and potentially fibre optics instead of standard wiring systems. However, there are no strong incentives for them to be more aggressive, particularly on the urban bus side. Most highway authorities overlook the weight violations. Some transit authorities, notably in British Columbia, have limited vehicle capacities to comply with axle loading standards in that province.

But, simply put, because of the low-bid method of urban bus procurement, transit systems are not prepared to pay a premium for lower weight. In the U.S., there are currently only two transit systems (Chicago and Los Angeles) that provide any incentive within their vehicle specifications for lower weight and this is a modest $5,000 advantage in the case of Chicago. In Canada, there are none.

At the same time, relatively low fuel prices and the introduction of more fuel-efficient bus and coach engines and transmissions in recent years have produced major fuel cost savings to the degree that transit operators see little cost advantage in specifying a lower weight bus.

New Flyer and NovaBUS have undertaken some engineering work to reduce the weight of their body structures with limited success. TDC has worked with Prévost Car to reduce the weight of its products. This work is not yet complete but early indications are that a weight savings of up to 20 percent may be achievable.

Overland Custom Coach is developing a lighter weight version of their ELF bus using aluminum and a prototype should be completed shortly for in-service testing. This manufacturer is interested in developing a vehicle using lighter weight materials such as foamed aluminum.

In the U.S., NABI has developed a lightweight bus, called the "CompoBus", which uses a single-piece structure containing the vehicle's body and chassis elements. The material used in this structure is a glass-fibre reinforced vinyl-ester resin laminate, produced using SCRIMP® technology and which is resistant to corrosion. SCRIMP (Seeman Composite Resin Infusion Molding Process) is a specialized and patented resin-transfer technique performed under high vacuum. SCRIMP® technology has been used to produce a wide variety of high-strength composite structures from 80 ft. windmill blades to hulls for racing and pleasure boats. NABI has two orders for this vehicle – 43 from Phoenix for a 13.7 m version, and 20 from Los Angeles for a 12.2 m version. It is just commencing production of the L.A. vehicles now. Interest in the vehicle has been limited and NABI has developed it as a potential niche market.

However, apart from these efforts, there is no concerted move to pursue lightweight vehicle structures.

Alternative Fuels and Emissions

On the supplier side, the EPA emissions standards have forced the industry into developing alternative fuel systems, notably CNG and LNG, and fuel cells.

Fuel Cells – Excelsis and Ballard Power Systems of B.C. have been the leaders in the development of fuel cells and are entering into agreements to supply 30 buses to the State of California for operational testing and demonstration purposes with state funding. Although initial development and testing of the bus fuel cell system occurred in Vancouver, the absence of any sustained funding from either the Province of B.C. or the federal government will likely see further development of the fuel cell system shift to the U.S. and Europe. In any event, industry experts believe that the fuel cell is still 8 to 10 years away from commercial viability in the bus industry and there remains the question of the method for sourcing hydrogen fuel.

CNG/LNG – These alternative fuels have been the most prominent and active choices for transit systems, primarily in the U.S. Strict alternative fuel legislation in certain states (California, Texas, Arizona) has forced the use of natural gas but overall, the interest in it is limited because of higher capital costs, fuel quality problems, low engine life and higher maintenance costs. As a result, further R&D in natural gas products is limited.

Electric Vehicles – There are several manufacturers in the U.S. that produce electric transit buses powered by batteries. However, these are generally used in local tour or shuttle services since their range and power are limited. As battery technology improves, the range and power of these vehicles may improve and they may become suitable for more transit applications. Overland Custom Coach is working with BET and Siemens Canada to develop a multi-mode electric version of its ELF bus. TDC is providing financial assistance.

8.2 VEHICLE DESIGN ISSUES AND TRENDS – OPERATIONS

On the transit operator side of the industry, the following are the key design issues and trends currently of interest.

Bus Rapid Transit

BRT is a higher order of bus transit that combines the flexibility of bus technology with features typical of rail transit designed to increase travel speed, reliability, passenger comfort and convenience to be more competitive with car travel. BRT involves a wide range of applications from limited stop express routes operating on arterial streets as found in Vancouver and Quebec City to fully segregated rights-of-way as found in Ottawa. BRT may involve a specially designed image (“branding”) and paint schemes as well as transit priority measures (traffic signal pre-emption, separate lanes) and advanced communications and operations control technologies made possible through the use of GPS. BRT may also involve the use of vehicles with distinctive design features to give the image of a light rail vehicle, although this is not a pre-requisite for BRT applications. The essential ingredient in BRT is providing buses with greater priority over automobiles and attracting increased transit use through the prospect of reduced travel times (compared to conventional transit services) and an “up-scale” image.

BRT is exemplified by the LRT-inspired Civis vehicle produced by Irisbus.

A new vehicle design has been introduced in the U.S. by Irisbus with its Civis vehicle for demonstration in Las Vegas. It is possible that this design may spawn changes in bus aesthetics generally. However, it is not anticipated by the industry to generate new bus sales or to form a significant market for vehicle sales overall.

Engine Noise

The noise from urban transit buses, primarily exterior but also interior, is now a major issue with transit operators. It does not appear to be an issue with intercity coach operators. New and larger engines with different sound profiles compared to older engines (4 cycle vs. 2 cycle) and more extensive cooling fan and exhaust emissions systems all contribute to the high noise level.

Brake Life and Noise

Reduced brake life and increase brake noise (squealing) is the second major source of concern. More powerful, faster accelerating drive-trains, the use of non-asbestos brake material and the introduction of low-floor buses with reduced wheelhouse clearances, all contribute to higher heat build-up and noise. While transit operators and suppliers are working on the issue, little progress has been made.

Hybrid Drive

A growing number of transit operators are interested in hybrid drive systems as the answer to reducing emissions and increasing fuel efficiency. These systems also offer reductions in maintenance costs compared to existing power transmission systems. Thus, many transit operators are anxious to see the introduction of an affordable, proven system. Development has been slow and many component costs, notably the batteries, remain high.

Electronics/Systems Integration

The application of electronics (drive-train diagnostics, farebox systems, customer information) and ITS (GPS, AVL, transit priority) to public transit operations means that the transit bus is becoming a rolling computer. Transit systems want to embrace more use of electronics and ITS in their operations but feel limited by difficulties in linking all of the various systems. There is strong interest in finding solutions to how to link these systems.

Structural Longevity

Either as a result of poor product quality in the late 1980s and early 1990s or as a way to ensure that vehicles require no physical maintenance during their lifetime, as noted in section 6, operators are increasingly specifying 12-year warranties. They want structures that will be free from deterioration (cracking) and corrosion. Stainless steel frames are one solution.

8.3 TYPES OF R&D

The bus and coach manufacturers and component suppliers each have extensive R&D programs, spending large sums of money annually. Their R&D falls into two broad categories:

1. Product engineering and support, including engineering of products to meet specific customer requirements

2. New product design and development

Product engineering and support involves such activities as problem solving and finding solutions to a design fault or a product or component failure while in use on the completed vehicle. It also involves designing improvements to existing products to meet new standards, such as emissions standards, or to improve reliability.

New product design and development involves the development of new products such as a bus model, an engine, a seat, etc.

Expenditures in these two areas can be 2 to 5 percent of annual sales, although most manufacturers indicate that a sustained rate of 2.5 percent is more typical. Where a new product is being developed, the level of R&D expenditure would rise to 5 percent.

8.4 ESTIMATED R&D EXPENDITURES

In general, the bus manufacturing industry has not invested in R&D at the rate experienced in other industries primarily because of the conservative nature of the industry, low profit margins, cyclical demand for buses and resulting limited incentive to change vehicle designs and products. To underscore this point, most of the R&D expenditures made over the past 20 years relate to product changes and improvements introduced in response to U.S. government programs or regulatory changes associated with the environment (EPA emissions reductions) or accessibility (ADA).

Quantifying the level of industry R&D expenditures is difficult to estimate because of the confidential nature of these expenditures by each manufacturer and supplier. However, some magnitude of these expenditures can be formulated based on several assumptions:

– annual number of bus and coach units sold in each sector;

– estimated average vehicle costs for each sector (which includes the value of components installed in those vehicles); and

– average percentage of 2.5 percent spent on R&D for buses and coaches and 1 percent for school buses.

These assumptions indicate the estimate of bus and coach industry R&D expenditures as shown in **Table 12**.

TABLE 12
ESTIMATED VALUE OF R&D EXPENDITURES
(CDN $)

Product	Unit Sales	Average Cost	Total Sales (millions)	R&D Expenditures (millions)
Urban Bus	5,000	$400,000	$2,000.0	$ 50.0
Intercity Coach	2,500	$500,000	$1,250.0	$ 31.3
School Bus	44,000	$70,000	$3,080.0	$ 30.0
Shuttle	10,000	$40,000	$ 400.0	$ 10.0
TOTAL	**61,500**		**$6,730.0**	**$121.3**

On this basis, the value of R&D expenditure in the bus and coach industry for Canada and the U.S. is estimated to total $121.3 million annually.

For a number of the component suppliers, particularly those related to the drive-train (engine, transmission, axles) and air conditioning systems, their R&D expenditures will cover a larger product range and sales volume than just buses and coaches, with the result that their total R&D effort will be much larger and thus more effective. Under this scenario, the bus and coach industry benefits from the larger financial resources associated with a “bigger picture”.

Determining what portion of this expenditure occurs within Canada is difficult. However, with three of the six urban bus manufacturers and the two main coach manufacturers plus a small portion of the school bus and shuttle/paratransit vehicle manufacturers located in Canada, **a reasonable estimate of the bus and coach R&D spent in Canada may be in the order of 25 percent or $30 million annually.**

8.5 NEW PRODUCT R&D

The above-estimated annual R&D expenditures generally relate to on-going product engineering and improvement. Development of new products, particularly an engine or a bus or coach, involve large expenditures. Although there is a high degree of confidentiality surrounding any R&D expenditure on a new product, discussions with manufacturers suggest that the expenditures for this purpose may be in the order of $40 million annually based on the following:

- Each of the six urban bus and two coach manufacturers have introduced new models within the past 10 years – 8 models at an average development cost of between $10 and $40 million. **$80 to $320 million**
- Each of the two main engine manufacturers (Cummins, Detroit Diesel) has introduced new or re-designed products to meet changing emissions standards. **$40 million**
- One fuel cell and three hybrid drive manufacturers are developing new products. These expenditures may total between **$80 and $100 million** thus far.

This level of expenditure totals between $200 and $460 million over the past 10 years, or between $20 and $46 million annually. The portion of this amount spent in Canada would apply to a large share of the new bus and coach design development and the development of the fuel cell technology: $100 to $340 million, or $10 to $34 million annually.

All internal combustion engine and hybrid drive design development takes place in the U.S.

Overall, bus and coach industry R&D expenditures for on-going product development and new product development are estimated to total $188.3 to $214 million annually of which expenditures in Canada may be estimated to be $24 to $30 million annually.

8.6 RESEARCH AND DEVELOPMENT NEEDS

The foregoing sections outline the areas where R&D is currently underway among the bus and coach manufacturers and where R&D is required from the bus operator's point of view. Based on this information and discussions with industry representatives concerning needs and priorities, the following are the primary areas where R&D is required:

- **Engine noise reduction**. Technical and design solutions are required to develop noise abatement or attenuation measures, including design of cooling fans, engine exhaust noise muffling, use of noise insulation material and encapsulation of the engine compartment.
- **Brake noise reduction**. Technical and design research is required to determine the causes and sources of brake noise, and to investigate alternative brake pad materials, improved brake designs and improved ventilation to reduce heat, brake wear and vibration as solutions to eliminate (or minimize) brake noise.
- **Battery technology**. Research and testing is required to improve the life and to reduce the size, weight and cost of storage batteries used for hybrid drive systems. Research is required to develop alternative energy storage systems to eliminate the cost and weight of batteries.

- **Electronic systems integration**. There is a need to investigate and develop protocols, programs or standards to effectively integrate the various electronic systems now being specified in new buses.
- **Bus and coach weight reduction.** Research, development and testing is required to explore methods and opportunities for reducing the weight of buses and coaches. This would include working with component suppliers to reduce the weight of their products as well as assisting bus manufacturers to investigate, test and implement the use of new metal or composite materials and construction methods to reduce the weight of the vehicle structure.
- **Fuel cell technology.** Provide research into the production and distribution of hydrogen for use in fuel cell vehicles. This activity would be separate from on-going development and testing of fuel cell technology and its application to public transportation vehicles.

These needs reflect the views of transit operators and some of the bus manufacturers based on current industry conditions. Their views, however, tend to focus on immediate needs rather than on longer term market requirements primarily because of external market and industry constraints. In this regard, the issue of bus weight is a good example of where the need to develop solutions is being frustrated by industry practices external to the manufacturers.

Through the interview process, bus weight was not highlighted as a major issue with the manufacturers, although it was a recurring topic with bus and coach operators. This apparent divergence between industry need and manufacturer's response stems primarily from the low-bid process with city bus purchases and the lack of regulations to enforce adherence to weight limits.

In the urban bus market, the high cost to develop alternative vehicle designs using lighter weight materials and construction methods is frustrated by the low-bid process. Manufacturers cannot afford to invest to the extent necessary to bring lighter weight products to market since little or no financial incentives exist in the procurement process in favour of lighter weight vehicles.

However, external concerns and the impact of excessive bus weight are beginning to come to the forefront, which may soon heavily influence the future demand for lighter weight vehicles. These concerns include:

- increasing concern among highway authorities regarding road damage;
- increasing concerns about non-compliance of buses and coaches with axle-loading standards. Most buses and coaches now exceed limits on one or both axles under average maximum load conditions. If licensing authorities enforced axle-load limits, bus carrying capacity would be reduced (as has occurred in B.C.), in turn potentially requiring more vehicles to be added with higher cost and emissions implications;

– reduced bus and coach weight would result in fuel savings, as demonstrated by several TDC projects, and in turn would reduce GHG emissions, thereby helping to achieve environmental objectives;

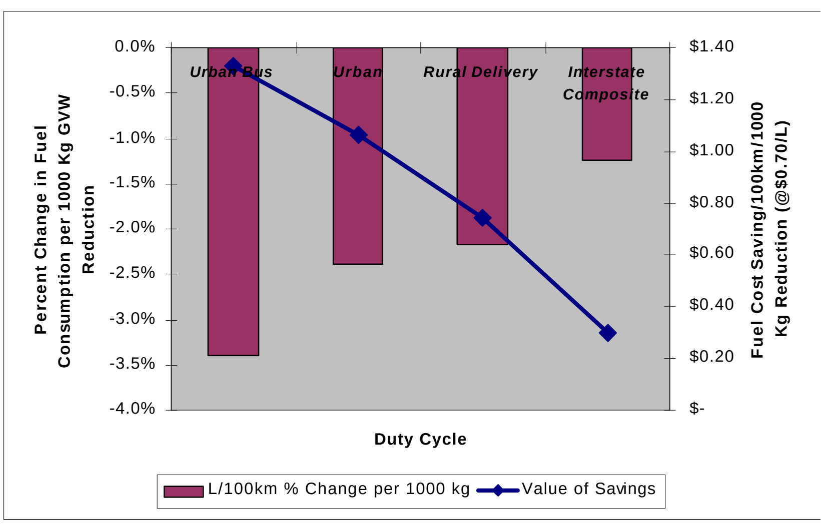
– reduced bus and coach weight, particularly for urban buses, would improve brake life and performance, and likely reduce brake noise (squeal).

As can be seen from **Exhibit 3**, the urban bus, which continually operates in a stop-and-go duty cycle, is the ideal application for weight reduction technologies because of the maximum fuel consumption reduction potential of almost 3.5 percent L/100 km per 1000 kg of weight saved. There is a similar magnitude of GHG and local pollutant emissions reduction.

According to an earlier study on the cost benefit of bus weight reduction, *Cost/Benefit Analysis of Lighter Urban Transit Buses* (TDC publication TP 12558E), a 10 percent reduction in vehicle weight would increase the procurement cost of a transit bus by approximately $15,000. However, the weight reduction would yield, conservatively, a cost saving in reduced road damage, tire wear, brake maintenance, fuel consumption and environmental costs of $0.04/bus-km.

On this basis, bus weight reduction strategies, materials and designs merit active consideration. They could, in turn, form the basis for a market niche for Canadian manufacturers.

EXHIBIT 3
IMPACT OF BRAKE WEIGHT REDUCTION



8.7 REACTION TO EXISTING TRANSPORT CANADA R&D PROGRAM

As indicated earlier, Transport Canada's bus technology R&D program has had limited success for several reasons. Industry experience with the programs has been mixed with the following comments received:

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– The funding is too limited to be of value or to be meaningful. While manufacturers appreciate the funding, in some instances, particularly for small projects, the administrative burden of the project offsets the financial contribution by Transport Canada. To be meaningful, any government support must be much larger.

– The results of the projects have to be shared with the industry. Given the competitive nature of the industry, the manufacturers do not want to share what may be proprietary information and have expressed concern about the need to share research and expertise through Transport Canada's requirement to document the results of projects undertaken through their programs. [However, this perception is not correct. Transport Canada can work with the private sector and leave the outcome of the R&D work to the manufacturer to exploit. Any published report is not required to divulge any commercial proprietary information.]

– Government tax incentives provide a form of financial incentive for research and development and serve to retain this work in Canada. The government should continue and expand these tax incentives in addition to direct R&D funding.

Manufacturers also noted the various U.S. influences on the bus and coach industry that serve to retain jobs and investment in the U.S. The absence of any federal government support for transit in Canada, including a "Buy Canadian" policy or the absence of a strong policy in support of fuel-efficient technologies, reduced emissions and attaining sustainable transportation goals, provides little incentive for Canadian manufacturers to invest in R&D and new products that will achieve energy conservation and fuel efficiency.

Discussions with industry representatives, including manufacturers and transit and coach operators, strongly concluded that, in order for the Canadian government to have an influence on bus technology development and to preserve the presence of the manufacturing sector in Canada, substantially more money must be available for R&D from the government.

While there are a number of key R&D needs within the industry, the reduction of bus and coach weight is important and offers environmental benefits. However, industry practices to date indicate that change will not be achievable without incentives. These incentives will need to be in the form of financial incentives for R&D research together with regulations to enforce weight reductions and bring about compliance with existing weight limits in order to pursue weight reduction strategies.

9 ROLE FOR TRANSPORT CANADA IN BUS TECHNOLOGY R&D

Identifying a future role for Transport Canada in bus technology research and development must consider the specific characteristics of the bus manufacturing industry, the needs and restrictions of the operating (service delivery) side of the industry and the opportunities and rationale for Transport Canada to continue to provide funding. The role of Transport Canada must reflect the agency's mandate to focus on "systems" rather than component research.

At the outset, it should be recognized that Transport Canada has very little influence on many aspects of urban and intercity bus transportation, on the reduction of GHG-contributing emissions (NOx) from public transportation vehicles or, in turn, on public transportation vehicle research and development in Canada for the following reasons:

- Transport Canada is not in a position to set bus and coach engine emissions standards independent of those in the U.S.
- The federal government does not provide funding for urban transit or intercity bus transportation, either for operations or capital expenditures.
- Requirements are dictated by the U.S. market, which is 10 times the size of the Canadian market.

Further, U.S. Buy America funding requirements force bus manufacturers to design vehicles according to the needs of the U.S. market, to incorporate predominantly American components and to perform a portion of the manufacturing process in the U.S. These conditions leave little scope for a Canadian R&D program.

Notwithstanding these facts, there could be a continuing role for Transport Canada and the federal government in bus and coach R&D, provided a link is made between an energy/GHG emissions-focused program and financial incentives from the federal government for the operating side of the sector to invest in new Canadian-based bus technology.

9.1 OPPORTUNITIES

In support of a federal government role in bus and coach R&D through TDC, there are several opportunities that provide justification for a continued role:

- The federal government has indicated its intent to provide funding for urban transit and has recently completed several studies exploring the future role of public transit in the country. The government could use this funding lever to promote advanced technology buses that are lighter, more fuel-efficient and therefore better for the environment.
- There are R&D opportunities and needs within the bus/coach manufacturing and public transportation operating sectors that could stimulate and encourage employment and economic growth within the industry and that could produce reductions in GHG-based bus emissions.

- There is a need for capital infrastructure renewal and expansion within the public transportation industry.

- There is expertise within Canada in manufacturing processes, materials and automotive design and manufacturing that can be advantageously applied to the bus sector even though it is an industry that is characterized by relatively low volume production.

The rationale for a continued government role would be as follows:

- The federal government is committed to targets set by the Kyoto Accord to reduce GHG emissions.

- There is increasing congestion in urban areas and degradation of the quality of urban life, which warrants the intervention of the federal government. Canada is an urban country with 70 percent of the population living in the 25 census metropolitan areas.

- There is an urgent need to preserve (save) Canada's bus manufacturing industry and prevent it from being lost to the U.S.

To be effective, however, any government R&D program should be clearly focused and should be tied to an overall economic strategy for the country's public transportation and manufacturing industry, which would include incentives for capitalizing on the industry's needs and opportunities.

9.2 R&D NEEDS

Based on the research and development needs identified in section 8.6, the mandate of TDC in federal government transportation R&D, and recognizing the type of bus manufacturing done in Canada (that is, bus body design and construction), the following are areas where research and development assistance could reasonably be considered by Transport Canada:

- **Lightweight materials research and strategies to reduce vehicle weight**

  Several Canadian bus manufacturers are already pursuing weight reduction strategies within the vehicle structure, notably Prévost Car and New Flyer. However, much more research is required into the use of alternative (to metal) materials – their effect on vehicle structure longevity and durability by their acceptance of stress and strain – and the use of glues and gluing processes, high-performance infusion moulding of composites, high-performance aluminum extrusion with thin wall, and use of sandwich panels. The other challenge is to introduce these new material and manufacturing processes and adapt them to low-volume products typical of the bus industry.

Given the expertise of the bus and coach manufacturing industry in bus body building and design research, and the prominence of Canadian-based bus and coach manufacturers in the North American market, as well as the potential to achieve environmental benefits from reduced fuel consumption through weight reduction, this area for R&D should be a high priority. It is also an area where TDC has previously provided funding.

– **Hybrid drive systems: development of energy storage systems (batteries, ultra-capacitors)**

  Considerable research is still required to reduce battery weight or to develop alternatives to batteries. However, the component and drive system manufacturers are very active in R&D and are spending significant funds to improve their systems and to research alternative energy storage systems. Since hybrid drive system production occurs in the U.S., there is less opportunity for TDC to provide R&D funding for the advancement of these products. At the same time, providing research into these products would be outside TDC's current R&D mandate vis à vis NRCan.

– **Research studies to advance effective, efficient public transportation operations and promote use of leading-edge information and smart technologies**

  Transport Canada has had a lengthy history of promoting and supporting this type of research through CUTA and the Canadian Bus Association (CBA). The results of this work have been valuable to the urban transit industry and should be continued. There remain many areas for operational, vehicle maintenance and vehicle technology research in the urban bus and intercity coach industries. This area should continue to be one for TDC funding support.

– **Smart bus electronic systems integration**

  There is a need to improve the electronic integration of the vehicle systems on board buses. Multiplex electrical wiring systems have recently been adopted by bus manufacturers to provide efficient and reliable control of systems operation, simpler system diagnostics and improved vehicle maintenance scheduling. For the operator, it is important that the operation protocol for the Canadian systems be of an open architecture using standard hardware/software. Much work is being done within the manufacturing, operations and component supply industry to provide solutions to this issue. Therefore, assistance from Transport Canada is unlikely to further the pace or extent of the development. As a result, there would appear to be no meaningful role for Transport Canada in this area.

  However, there is a growing need to integrate ITS technologies within the bus as part of a system designed to improve the efficiency of operations and the quality of service to the public. ITS applications typically involve real-time fleet management, passenger information, transit priority and data gathering for service planning functions. Each system needs to be integrated within the vehicle system to transfer data between the bus and a ground-based control centre via a wireless communication system. This is an area where Transport Canada can play a useful role. Transport Canada is taking a lead in the implementation of an ITS Plan for Canada, including the development and support of a multimodal ITS R&D program. Bus transportation should be an important component of this program.

The remaining areas of R&D needs identified by the industry and outlined in section 8.6, specifically engine noise, brake noise and fuel cells, are not priority areas for TDC. These are areas that either the private sector is investing heavily in or are the mandate for other federal departments, typically NRCan for fuel cell technologies.

9.3 PROGRAM OPTIONS

Prior to identifying program options for Transport Canada, program goals and criteria should be identified to guide the development of the program. The following are suggested:

Goals

1. Promote public transportation use in Canada for the reduction of traffic congestion and GHG emissions and to ensure sustainable economic growth.

2. Retain and stimulate a strong public transportation industry.

3. Stimulate economic activity in Canada by ensuring a strong urban bus and intercity coach manufacturing industry.

Criteria

1. The project should not duplicate work being undertaken by the private sector.

2. The project should not duplicate work being undertaken in the U.S.; however, efforts should be made to work jointly with the U.S. government and the public transportation industry where possible.

3. The project should contribute toward developing a competitive edge for the public transportation manufacturing industry and the furtherance of the public transportation operating industry.

4. The project should ensure employment and economic growth in Canadian industry.

5. Research results should be made available to as many bus manufacturers as possible.

Consistent with the above, there would appear to be three alternative courses of action open to Transport Canada and TDC in public transportation R&D funding:

1. Status quo

TDC would continue to provide funding for small one-off projects that address a variety of issues. This option would involve continuing to partner occasionally with one supplier/manufacturer.

While this approach would maintain some government role in transportation R&D, it would provide limited overall benefit to the public transportation industry in Canada or toward the federal government's GHG reduction and sustainable transportation objectives.

2. Form consortia with bus/coach manufacturers and target specific issues

This alternative would involve TDC working with more than one bus/coach manufacturer to address specific design or technology issues. Attempting to bring together more than one manufacturer in a project will be difficult given the level of competition and confidentiality in the industry. Also, given the TDC's focus and mandate, the number of potential design or technology issues that it would consider funding would be limited to the body structure and weight, and, potentially, electrical/electronic integration initiatives. TDC would stimulate the formation of consortia through a competitive call for R&D proposals on pre-determined topics. These consortia would comprise a bus manufacturer, component suppliers and likely other specialists in the subject area. The best proposal on each of the topics (one or two) would be selected to implement the R&D initiative over a five-year period. TDC would provide cost-sharing support and the program would need to be re-evaluated every five years.

Under this scenario, government funding for R&D would need to increase significantly. A reasonable estimate would be an investment of $3 million per year.

3. Increase funding, provide incentives for investment

This alternative may offer the best opportunity for achieving both government and industry objectives. The government, through TDC, could establish a specific program and time period, perhaps five years, for addressing specific issues that would benefit the entire bus and coach manufacturing industry.

Together with dedicated R&D funding focused on a specific issue, such as weight reduction through the use of composite materials and innovative manufacturing methods, financial incentives could be provided to bus and coach operators (municipalities and intercity bus companies) to purchase lighter weight vehicles manufactured in Canada. This approach would ensure that lighter weight vehicles are developed and that these vehicles will be purchased.

The R&D funding investment by the federal government would depend on the estimated cost to develop the necessary lighter weight materials and body designs. Further analysis of what this cost may be is required.

Incentives are viewed by the industry, both manufacturing and operating segments, as essential to the value and success of new vehicle technologies. As such, what should these incentives be?

As suggested earlier, to be effective, a TDC R&D program should be supported by incentives directed at stimulating and supporting the Canadian bus and coach manufacturing industry in the production of new technology vehicles. In view of the strong incentives that exist in the United States (Buy America, FTA funding) and the dominance of the European manufacturing industry globally with its extensive R&D and financing resources, the federal government should adopt two incentive streams to support an R&D program – one financial, the other regulatory.

The **financial stream** would provide capital funding support for the purchase of lighter weight buses where such buses achieve significant weight reduction compared to baseline buses. This should be in the order of 20 percent or more based on current TDC studies, which indicate that this level of vehicle weight saving is achievable, as well as the weight savings indicated by the NABI CompoBus vehicle. The federal government could bridge the gap between the cost of existing technology vehicles and any cost premium for new technology vehicles if made in Canada. Financial incentives for purchasing lighter weight vehicles should offset any potential higher cost related to the development of these vehicles. The financial incentives may be in the order of 25 to 33 percent of the cost of the vehicles based on the projected cost premium for new technology buses. This would represent a potential annual investment, based on 800 urban buses and 200 intercity coaches per year at an average cost of $600,000 per vehicle, of $150 to $200 million. This capital cost investment should be offset by annual savings in fuel and emissions reductions.

A **regulatory stream** could be essentially focused on the strengthening or reinforcing of existing regulations aimed at ensuring adherence to current road weight and vehicle weight regulations as mandated by the provincial governments.

An example of the application of lightweight materials and a reduction of bus weight is evidenced by the U.S.-based NABI vehicle, the “CompoBus”, which combines an injection moulding construction method with composite materials. The existence of this vehicle, however, must be considered when developing any Canadian bus R&D initiatives aimed at reducing bus weight. The threat stems from the standpoint that a lightweight full-size transit bus design already exists in the U.S. (although not for intercity coach), and any initiative by the Canadian government to develop a lightweight design could end up supporting the U.S. manufacturer. However, the introduction of federal government funding tied to the purchase of lightweight buses from Canadian manufacturers with a Canadian content requirement would provide the necessary incentive for Canadian transit operators to purchase Canadian products. It would also very likely give the Canadian bus and coach manufacturing industry a marketing edge with regard to reduced fuel and maintenance costs for municipal transit and intercity coach operators in the North American market.

NABI's CompoBus features advanced composite fibre materials to reduce vehicle weight by up to 25 percent.

10 CONCLUSIONS

The public transportation industry in Canada is large and extensive, encompassing urban, intercity, school, charter, paratransit and shuttle services. There are over 55,000 vehicles, 85,000 employees and annual expenditures of over $2.8 billion. Urban and intercity public bus transportation services can form a major component in the federal government's strategy to reduce energy consumption and GHG emissions attributable to transportation. Ensuring that public transportation services are effectively delivered and do their part to minimize fuel consumption and GHG emissions should therefore be a priority with the federal government.

There is an urgent need for capital funding to assist in the renewal of the nation's public transportation vehicle fleet, particularly buses. Emphasizing the use of public transportation also represents one of the most effective ways to significantly reduce GHG emissions by reducing the use of private automobiles, the largest single source of GHG emissions.

A wide range of industry representatives, including representatives from the manufacturers, suppliers, operators and industry associations, provided information, comments and advice on future needs in bus design research and development as well as feedback on the existing TDC bus technology program. This consultation indicated a number of areas where government assistance could further vehicle design improvements and address vehicle design deficiencies.

However, when considering the work already being undertaken by the industry as a whole, the focus of Transport Canada on systems research and development, and the potential for Transport Canada to contribute meaningfully to bus design development, the most appropriate areas for Transport Canada to participate or lead R&D efforts have been identified in three areas:

1. Vehicle weight reduction, particularly in urban buses

2. Research studies in partnership with CUTA and CBA to address common concerns/issues of the public transportation industry in Canada

3. Public transportation ITS development and deployment initiatives

TDC's programs in the past have contributed to the development of unique and useful innovations and products in bus designs, and toward identifying strategies for reducing fuel consumption and exhaust emissions. Examples of TDC's work include supporting the development of Prévost's articulated highway coach, the development of MCI's 45 ft. accessible coach and New Flyer's articulated low-floor transit bus, as well as significant research into the impact of bus weight on operating costs and road infrastructure and identifying strategies for reducing bus weight. These programs have generally been well-received by the industry; however, the administrative (report writing) aspects of the programs and the low level of available funding have not. Overall, there is a strong view that in order for Transport Canada to play a meaningful role in research and development, the available funding must be greatly increased. This is supported by a comparison of annual industry expenditures on R&D (estimated at $30 million in Canada) and TDC's R&D budget of $300,000.

While the federal government's role in public transportation is limited in terms of direct funding, it has had a long-standing role in research and development activities for the public transportation industry through NRCan and Transport Canada's TDC. TDC's role has concentrated on R&D activities related to "systems", of which the bus structure has been the primary focus.

In considering a future role for Transport Canada/TDC in funding research and development in bus technology and public transportation in general, there are several opportunities and rationale for the government to continue to provide support. The primary area for action is in reducing vehicle weight. This offers the greatest potential for achieving government objectives related to reducing fuel consumption, reducing GHGs, and economic development and investment. The other area is in research studies.

However, to be effective, the government will need to significantly increase its R&D funding level beyond current levels. It will also need to provide incentives, such as funding support, for the purchase of lighter weight vehicles.

11 RECOMMENDATIONS

Based on the results of the review and assessment of the bus transportation industry research and development needs, the priority R&D needs identified and the mandate established for TDC, it is recommended that:

1. The federal government, through TDC, continue to fund research and development in bus technology and public transportation in general with emphasis on advanced technologies and strategies to reduce GHG emissions through energy efficiency.

2. The federal government/TDC R&D programs focus on bus system technology development with specific emphasis on bus structures and the use of modern lightweight materials and manufacturing techniques to reduce the weight of bus structures with a target objective of a minimum 20 percent reduction in vehicle weight and, further, that the programs be developed and implemented in partnership with the bus manufacturing industry and the public transportation industry.

3. The R&D programs be for a minimum of five years with sufficient funding to ensure a meaningful contribution toward the successful completion of the projects. In this regard and based on industry experience to develop new products, a level of $3 million per year ($15 million total) is recommended.

4. The R&D programs be supported by federal government financial incentives to public transportation operators and/or municipalities and provinces to encourage the purchase of lighter weight, more fuel-efficient and technologically advanced buses. The financial incentives should bridge the gap between the cost of current technology buses and new technology buses. These may be in the range of 25 to 33 percent of the capital cost of the new technology vehicles.

5. The federal government work with the provinces and municipalities to ensure adherence to existing or proposed vehicle weight regulations of new public transportation vehicles under all operating conditions (i.e., including standing passengers on urban buses).

APPENDIX A

PERSONS INTERVIEWED

Name	Title	Company
Paul Smith	VP, Sales and Marketing	New Flyer Industries
Jean-Pierre Baracat	Manager of Product Planning	NovaBUS Corporation
George Bourelle	President	Prévost Car Inc.
Alain Dulac	System Engineer	Prévost Car Inc.
Patrick Scully	President	Setra of North America Inc.
Bill Coryell	VP, Sales	North American Bus Industries, Inc.
Mark Braegar	Director, Sales	Orion Bus Industries
Ray Dries	President	Overland Custom Coach
Michel Corbeil	Président	Les Enterprises Michel Corbeil
Sheilagh Beaudin	Executive Director	Canadian Bus Association
Brian Crowe	Executive Director	Ontario Motor Coach Association
Michael Roschlau	President and CEO	Canadian Urban Transit Association
Dave Sarcona	Development Engineer	Detroit Diesel Corporation
Gary R. Farrell	Eastern Account Executive	Cummins Inc.
Peter York	Director of Product Development	Allison Transmission
Kathy Gearth	Regional Sales Manager	Otaco Seating
Jocelyn Grenier	Directeur des ventes	Compositech
Michel Pusnon	Vice President	CamoPlast
Gordon Much	Vice President, Engineering and Transportation Division	Bodycote Materials Testing Canada Inc.
Bill Brown	Manager, Surface Vehicle Engineering	Toronto Transit Commission
Jean-Marie O'Hearn	Directeur exécutif	Société de transport de la Communauté urbaine de Montréal
Al Little	Fleet Manager	Victoria Regional Transit System
Chris Lythgo	VP, Engineering	Coast Mountain Bus Company Ltd
Don Haire	President	Proteus Transportation Enterprises Inc.
Robert Merrit	Program Manager	Ballard Power Systems
Charles Walsh	Program Manager, Auto Sector	Industry Canada
Sidney Diamond	Program Manager	Office of Heavy vehicle technologies, U.S. Department of Energy
Shang Q. Hsiung	Transportation System Analyst	U.S. Department of Transportation
S. Bilodeau	Director of Engineering	NovaBUS Corporation
André Audet	Sales and Marketing Manager	Technologie Balios