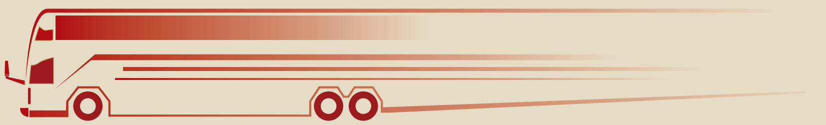
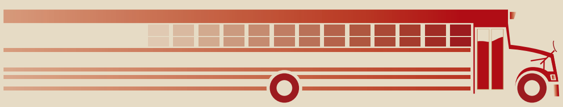




Part 2

The Impact of Technology

2.0 The Impact of Technology

2. 1 Introduction

The motor carrier passenger industry encompasses a broad array of existing and emerging technologies primarily related to vehicles, vehicle systems and communications systems.

In this context, the Canadian bus industry has taken a progressive stance as related to technology innovation and implementation in many areas (e. g. , low floor buses now account for over 24% of urban transit fleets compared to only 2. 3% in 1995). In fact many, if not most, of the technologies referenced herein are already deployed or undergoing field evaluation in Canada.

It also appears that the industry has not yet optimized this diversity of technology for maximum human resources benefit and, specifically, to help meet the prevalent and significant challenges of recruitment, selection, training and retention.

For example, some of these technologies contribute to service providers' economic viability, hence employee job security, some to a safer, less stressful working environment. There are technologies that enhance and promote the industry or service provider's image. Still others elevate training opportunity and effectiveness and promote good employer-employee relations.

The incorporation of all of the technologies discussed in this review in a well-planned industry/corporate promotional human resources agenda could contribute substantially to stabilizing and upgrading the industry's essential operating ingredient, human resources.

2. 2 Emerging Technologies

Emerging technological applications of note include real-time communications, smart cards, smart shelters, bus-rapid-transit systems, sophisticated simulators for operator training, and surveillance systems. Less-discussed but similarly relevant technologies include intelligent automatic vehicle technology and smart-traffic systems. These technologies are discussed in the following sections, with consideration to the impacts they may present.

2. 2. 1 Real-time Communications

Real-time communications technology has the potential to make public transport considerably more appealing to passengers. Real-time technology is used to input and display up-to-the-minute travel information in bus stations. Instead of wondering when the next bus will arrive, passengers can access this information directly through kiosks in bus shelters or stations (Computing and Control Engineering, 2004). It has been increasingly applied by urban public transportation systems in the U. K. and the U. S.A. Government spending and research on real-time communications equipment is on the rise (Chabrow, 2004; Transport Canada, 2004e). York region, Ontario, proposes to have such a system fully operational by 2006, supported by global positioning system tracking of buses (Toronto Star, 2004).

Involving Employees in Technology Integration

Working closely with its Drivers' Association, Pacific Western has embarked on a program that makes the presence of in-bus cameras into a bit of fun. Should there be nothing to download (no incident which prompted the camera to record because of a motion threshold being exceeded) a green light is visible on the recording module. At the end of an operator's shift, he or she can collect "green points", and trade them in for coupons, movie passes, meals at Swiss Chalet. In addition, operators have helped Pacific Western build some flexibility into the program. For instance, some events, like going over railroad tracks at certain perfectly legal and accepted speeds, may be interpreted by the software as a "red light" (event recorded).

The same technology is already being deployed in the school bus and intercity sub-sectors, but for end-use applications that differ from those in the urban sub-sector. The real-time communications technology will likely play a more significant role in safety and scheduling applications in the school and intercity sub-sectors, instead of a serving as a constant communications interface with end-users, as in the urban transit applications.

European cities are already incorporating real-time multi-media communications into their terminals called **Smart shelters**. Passengers can easily plan, change and pay for their trip through a kiosk and may soon be able to access needed information through their cell phone, personal digital assistant (PDA) or computer (Giannopoulos, 2004). In fact, Surrey County Council (England) is currently initiating a program called "Buses 4 U" that allows residents to book buses using text-messaging (Monro, 2004), a feature which is offered by all mobile phone service providers in Canada.

Bus shelters have the potential to do even more, including allowing passengers to check their e-mail and pay for their tickets using credit and debit cards. Another feature of smart-shelters is their attractive contemporary appearance (Knecht, 2004). It is only a short step to providing wireless internet access (wi-fi hot spots) in these shelters.

Real-time communications also benefit business operations in that they allow service providers to access operator, route and bus maintenance information, in addition to speed and route tracking data (Computing and Control Engineering, 2004, Electronic News (North America), 2004).

While real-time technologies primarily affect urban public transport, they may also be used to track school buses. For example, Gecko Micro-solutions offers software that monitors the location of operators, buses and even children. Card readers and other devices track students as they enter and exit the bus and may assist operators in student monitoring (School Transportation News, 2002). Adding on-board wi-fi facilities, such as VIA Rail has added in the Toronto-Montreal corridor (2004) could reasonably be expected for intercity buses in the near future. This would add to the attractiveness of intercity bus service.

2. 2. 2 Operator Warning and Control Systems

Warning technologies are being developed to enhance safe driving. For example, the **Lane Departure Warning (LDW)** systems used in commercial trucks warn the operator when the truck unintentionally crosses lane markings (Business Wire, 2004a).

Some automakers are building **control systems** that communicate through sound or touch/vibration with the operator without requiring the operator to look away from the road to acquire information that would traditionally be displayed on the dashboard (Business Wire, 2004b).

School bus embarkation/disembarkation is an area where warning technology is progressively being addressed. A Study funded by Transport Canada's ITS (Information Technology Systems) research and development program set out to identify the optimum point/perimeter at which a **proximity warning system** would warn the operator and thereby enhance the personal safety of children or other pedestrians around a stationary school bus. Transport Canada's Transport Development Centre will be testing three such systems in 2005 (Transport Canada, 2004). Currently-available systems can detect the presence of children in most of the safety-critical zones around the school bus. Operators have found such devices helpful in situations where their mirrors could not assist them and particularly helpful in warning them of in-coming traffic in poor visibility situations such as snow and fog (L-P Tardif & Associates, 2004).

Vehicle reversing systems, which are SONAR based, "talk" to the bus operator, warning him or her if someone walks between vehicle and stationary object, or warning if there is any other type of object in the rearward path of the vehicle. The warning system recognizes changes in information hundreds of times a second, transmitting to the operator when any "data" changes regarding the rearward path. It is thought that this type of system is better than reversing cameras, because drivers still need to work with their mirrors, something research has shown they tend not to do when a TV-style monitor is on the dashboard. This type of system is also thought to be more appropriate for Canadian weather conditions than reversing cameras, whose performance tends to suffer in conditions of snow, ice and sleet.

In addition to bus shelter technologies discussed above, other smart shelters are designed in ways that have a direct effect on bus operators. For example, the **i-bus stop**, a Canadian-designed solar-powered bus stop, provides a flashing beacon that signals the operator when a passenger is waiting, of particular benefit in situations of reduced visibility such as darkness, fog or snow (Daily Commercial News and Construction Record, 2002).

2. 2. 3 Payment Systems

The **Smart card** has potential for simplifying the bus-boarding process and is considered a convenient fare-payment option. Smart card balances can be transferred from or to a credit or debit card, making payment incredibly simple. Passengers can even enjoy the convenience of using their card in newspaper stands and snack shops in bus stations (Hesseldahl, 2004). While Smart cards are currently most prevalent in the urban transit systems, the intercity sector can also use the Smart card as an alternative to traditional fare collection methods (Canadian Bus Association & L-P Tardif and Associates, 2000). While the cards may have been designed with the passenger in mind, they also assist operators by simplifying and speeding up the boarding process (Carter, 2001).

2. 2. 4 Video Monitoring

Perhaps the most controversial piece of technology is the video monitoring system, or closed-circuit television (CCTV), now used in many urban public transportation and school bus systems (Lathrop, 1998). The quality of such systems has been vastly improved with the recent advent of digital video monitoring.

2. 2. 4. 1 Passenger Monitoring

Video monitoring systems focused on bus boarding, payment and seating areas have the potential to assist the driver/operator by deterring passenger violence, verbal abuse and vandalism and by providing evidence in defence of unfair complaints or lawsuits

(Issacs, 2003). Indeed the threat of abuse and violence is very real, and video monitoring is a typical response. In New York City in response to terrorist activities, new security technologies have emerged, including tabletop scanners to detect chemicals and extensive combat-simulation systems, as has the more prevalent use of traditional methods and technologies such as CCTV, fencing and bomb-sniffing dogs.

A Study by Andre et al. (1997) determined that urban bus operators are frequently assaulted, a fact that likely deters some people from applying for employment. Monitoring systems may therefore work as a recruitment tool, demonstrating the service provider's commitment to maintaining a safe and secure working environment.

Monitoring systems may be the most beneficial to school bus operators, who have the heavy responsibility of monitoring children while driving. A small camera that sits inside the bus may deter children from misbehaving.

2. 2. 4. 2 Driver/Operator Monitoring

Video monitoring systems that record driving activity as well as sights and sounds inside and outside the vehicle can be invaluable in reconstructing the details of an incident, particularly when tied in to bus system activity monitoring (vehicle speed, acceleration, braking, etc.) and GPSs. Such systems can be controversial, and installation should be carefully discussed with staff prior to implementation, as they can be perceived as a threat to operator privacy and autonomy and convey a sense of distrust. In addition to providing objective evidence of incidents, some transit companies use such systems specifically to monitor their employees' work, often in the form of formal driving behaviour management systems. For example, James River Bus-Lines monitors operator compliance with speed regulations and other rules (School Transportation News, 2002).Though it reports excellent employee relations, Meridian Transportation Services goes so far as to use a combination of GPS (global positioning system) and wireless technology to automatically notify supervisors of a speeding bus—and to issue its own speeding tickets (Metro Magazine, 2005b). One supervisor has related that supervision equipment is used as a learning tool and that operators have been receptive to the supervision; however, the operators' attitudes about the use of video cameras have not been studied (Jones, 2004).

2. 2. 5 Operator Protection

Operator protection, in the form of shatterproof plastic shields, has also come into use. In the U. S.A. , Greyhound Lines has developed and begun installing **driver lateral shields**, which it plans on installing in 1700 of its 2400 buses, to protect drivers from physical confrontation (U. S. House of Representatives Committee on Transportation and Infrastructure Subcommittee on Highways, Transit and Pipelines, 2004; Fickes, 2003). *Greyhound Canada* has recently announced that it will be introducing a similar shield in all new vehicle purchases.

2. 2. 6 Infrastructure

Bus-Rapid Transit (BRT) is defined as "a rubber-tired rapid transit services that combines stations, vehicles, running ways, a flexible operating plan and technology into a high-quality, customer-focused service that is fast, reliable, comfortable and cost efficient" (CUTA, 2005a). BRT systems often run on separate, dedicated corridors and combine technological enhancements with unique operating and marketing plans (Federal Transit Administration, 2004, Kang et al. , 2000). They offer several benefits to passengers and the environment, including increased safety and reliability, easier payment strategies, increased accessibility and congestion-relief. The advantages to transit systems include:

- incremental implementation
- operational flexibility
- potentially lower costs
- higher capacity
- encourages land use change
- improved service speed and reliability
- increased ridership

(CUTA, 2005a)

The use of buses makes BRT extremely flexible, and depending on the implementation, these systems can be easily modified or even dismantled by shifting modular concrete barriers; rail rapid transit is far more permanent and more costly to implement. Furthermore, a BRT line can be fully operational years before an LRT carries its first passenger.

BRT is being implemented in cities around the world, and the U. S. Federal Transit Authority is currently funding 10 demonstration projects for thorough evaluation. In Canada, Ottawa's Transitway has been in operation since 1983 and Vancouver's B-Line has become a successful component of the regional transit system since its inception in 1996. The first phase of Calgary Transit's BRT service began operation on August 30, 2004.

The input of operators on BRT appears to be lacking, and so any impact on recruitment and retention is still unknown; nevertheless, BRT systems do represent an emerging trend for public transportation systems.

Smart Traffic Centres, already implemented in some U. S. cities, are intended to improve traffic flow. Cameras installed throughout intersections are connected to a central operation station, where service providers are immediately informed of accidents and malfunctioning equipment (U. S. Department of Transportation Federal Highway Administration, 2004). Access to this data by service providers may be used in real-time to adjust bus routes if an intersection is blocked. Furthermore, many cities use traffic lights controlled by approaching transit vehicles, much like Toronto's streetcars.

2. 2. 7 Training Tools

Attracting suitable employees who have a good understanding of the job is an important part of retention. Both **simulation** and **web-based assessmen**t and training technologies can aid in recruitment and retention processes.

Bus simulators, similar in concept to those used in other sectors for ship navigation and aircraft operation training, are a technology new to the bus industry. This

Existing and Planned BRT Projects in Canada

- *Québec city (Métrobus)*
- *Montreal (contraflow reserved bus lanes, Viabus de l'est)*
- *Ottawa (Transitway)*
- *Vancouver (B-Line)*
- *Calgary (BRT route)*
- *Gatineau (Rapibus)*
- *Toronto (Oakville to Pickering BRT)*
- *Mississauga (bus-only roads, stations offering BRT to local transit/transportatio n connections)*
- *Toronto (TTC reserved bus lanes)*
- *Winnipeg*
- *York Region, ON (Viva)*
- *Halifax (MetroLink mixed-traffic operations)*
- *Brampton (acceleride)*
- *Edmonton (High-Speed Transit, BRT Study)*
- *Victoria (Victoria-Langford BRT)*

Source: CUTA, 2005a

International BRT Projects

Australia

Adelaide Metro O-Bahn

Brazil

Curitiba BRT

Colombia

Bogota Transmilenio

New Zealand

Auckland North Shore BRT

United Kingdom

Leeds Superbus

Transport for London BusPlus

West Sussex Fastway

technology provides an online video-based assessment that realistically simulates driving scenarios, giving trainees a demonstrable "hands-on" preview of what the job entails. Meanwhile, the company gets an idea of how candidates perform in job situations. Instructors can customize training content to replicate numerous operating conditions/requirements, and to evaluate and develop specific operator skills.

New York City Transit reports that since implementing the use of bus driving simulators within their training operation, they have reduced accident rates within the first ninety days after bus operator title appointment by 43% and have reduced trainee washout rates by 35% (FAAC Inc., 2005).

Canada's first interactive driving simulator was delivered to *GO Transit* Toronto in 2005, and the technology is currently being evaluated by several other Canadian systems. *GO Transit* has found this tool to be a very successful investment, and uses it as a key component of both new operator training and with their Professional Driver Improvement Program for experienced operators.

The *GO Transit* simulator has room for one operator and three "passengers", generally two other trainees and a trainer. The opportunity for interaction when more than one operator or trainee is in the simulator has been a positive as well. *GO Transit* states that this informal "peer critique" approach helps the trainees "catch" the little things it is often difficult for a trainer to communicate.

GO Transit's single simulator was installed for approximately $300,000 CAD. A range of simulators are on the market, offering various options and costing up to $1 million or more.

An effective **interactive website** can facilitate training and aid retention by providing staff feedback, follow-up, evaluation and coaching (Williams, 2001). Employees can take on line training courses, access and reserve their place in training programs and quickly assemble project teams through an intranet (Huntington, 1998). Canadian real estate company *Royal LePage* increased recruitment leads by 300% by adding an on line simulator to their website (Abelman, 2003). Although author Deryck Williams (2001) argues that simulation is the most effective system, web-based technologies are far less expensive and can also improve recruitment (Singh and Finn, 2003).

2. 2. 8 Propulsion Systems and Fuels

Despite clear evidence of the bus industry's superior fuel efficiency at transporting people in comparison to other modes of urban and intercity transportation (Price Waterhouse, 1997), there is public and political pressure to ensure that the industry adopt more environmentally friendly propulsion technologies.

Canada accounts for approximately 2. 1% of global greenhouse gas emissions, making us the world's 9th largest contributor. The Government of Canada ratified the Kyoto Protocol in 2002; this accord, which came in to effect February 16, 2005, commits Canada to reducing greenhouse gas emission levels to 6% below 1990 levels by 2010. In 2001, 26% of our greenhouse gas emissions came from road transportation (Transport Canada). By 2001 Canada was almost 30% above its 1990 levels, so very significant reductions will need to be implemented between now and the 2008-2012 deadline.

2. 2. 8. 1 Current Propulsion Systems

In part motivated by the preceding context, the push for environmentally-friendly propulsion systems has yielded a wide range of developing technologies, from improvements to the current diesel engine to the much talked about hydrogen fuel-cell. Though the diesel engine and fuels will be present in the bus industry for many years to come, their ability to compete over the long-term with newer technologies appears limited.

Despite advances in diesel engine and fuel technologies, diesel suffers from what has been referred to as the "diesel dilemma." Diesel engine emissions include NOx and particulate matter. Reductions in one typically result in increases in the other, with a similar trade-off occurring between NOx emissions and fuel economy (Brodrick, Sperling and Dweyer, 2002). Though bio-diesel fuels partly address environmental concerns in that they demonstrate improved emission performance and are derived from renewable resources, they also suffer from the same trade-off between particulate matter and NOx emissions in addition to being roughly 10% less efficient than conventional diesel fuel derived from fossil sources (U. S. Department of Energy, Energy Efficiency and Renewable Energy, 2004a). Similarly, compressed natural gas (CNG) engines, though more efficient than modern diesel engines, also contribute to adverse health effects, as there is evidence that they produce even greater amounts of very fine particulate matter than do diesel engines (Brodrick et al. , 2002).

2. 2. 8. 2 The Impact of Emissions on People

Though popular discussions of bus propulsion systems often highlight their impact on the ecosystem, the choice of technology can have a particularly direct impact on operators and passengers. Due to their daily exposure to diesel fuel emissions, operators are at an increased risk of developing several types of cancers (Whitelegg, 1995; Soll-Johanning, Bach, Olsen and Tüchsen, 1998). Similarly, passengers, notably children who regularly take school buses, are exposed to substantially higher than normal levels of pollutants (Wargo, 2002).

2. 2. 8. 3 Replacements for the Diesel Engine

In the search for a replacement to the diesel engine, numerous alternative propulsion system technologies have been and are being developed. The most prominent emerging technology is the **hydrogen fuel-cell**. Though clearly seen as the propulsion system of the future, it currently has neither a level of commercial development, nor the required refuelling infrastructure, to permit wide-scale deployment feasibly in the immediate future (U. S. Department of Energy, Energy Efficiency and Renewable Energy, 2004b). Overcoming the significant technical, economic, policy and administrative/operational challenges in transitioning to the fuel-cell in Canada will require the participation and coordination of transit systems, vehicle manufacturers, fuel-cell suppliers, hydrogen fuelling and storage suppliers, training institutions and governments (MARCON-DDM HIT, 2005).

Significant international government support and prototype validation are nevertheless steadily advancing this technology. The European Commission is allocating €18. 5 million to the CUTE (Clean urban Transport for Europe) demonstration project to support nine European cities in introducing hydrogen into their public transport system: Amsterdam, Netherlands; Barcelona, Spain; Hamburg, Germany; London, England; Luxembourg, Madrid, Spain; Porto, Portugal; Stockholm, Sweden; and Stuttgart, Germany. Under this program, Ballard Power Systems delivered 30 heavy-duty fuel-cell engines in 2003 to power demonstration vehicles in 10 selected European cities. In the U. S.A. , the Department of Energy is contributing to fund fuel-cell demonstration programs in several major transit markets; AC Transit, Oakland, California, which operates 800 vehicles and transports 65 million passengers annually, will take delivery of four 40-foot fuel-cell hybrid buses beginning in September 2005 (U. S. Department of Energy, 2005; Weststart-Calstart, 2003; Ballard Power Systems Inc. , 2004). Other in service transit demonstrations of fuel-cell technology include buses run Vancouver and Chicago between 1998 and 2000, as well as Palm Desert, California, between 2000 and 2001.

The most popular proven alternative technology, the **diesel-electric hybrid** powered bus, uses a battery-powered electric system to assist a scaled-down diesel engine and is gaining in popularity in cities across Europe and North America. Cities such as Seattle and New York have already deployed or ordered several hundred vehicles each. BC Transit, with three hybrid buses in Kelowna and three in Victoria, is the first urban transit system in Canada to put hybrid buses into regular service. Purchases by other transit systems across Canada, including Toronto, Saskatoon, Ottawa and Vancouver, are either in process or pending. Two Canadian companies, Orion Bus of Mississauga, Ontario, and New Flyer of Winnipeg, Manitoba, are dominant manufacturers of this technology (New Flyer Industries, 2004).

Each of these technologies offers improvement in fuel efficiency and noise levels. However, the initial cost of even the more fully developed technology, such as the diesel/electric hybrid engine, is currently roughly 50% greater than that of the modern diesel engine (Battery and EV Technology, 2004). Favourably, the Canadian federal government will now contribute 1/3 of the cost of purchasing alternative-fuel and hybrid vehicles, making such fleet conversion a more economically viable option (Toronto Star, 2005).

2. 2. 8. 4 Alternative Fuels

It is also notable that transit buses powered by **compressed natural gas** (CNG) now account for over 25% of the collective U. S. urban bus fleet and are in common use globally (e. g. , Beijing, China, operates over 2200 natural-gas-fuelled buses and is expanding fleet application). Benefits of natural gas propulsion engines include reductions in both operating costs and emissions as compared to traditional diesel engines (Weststart-Calstart, 2003; Globe and Mail, 2005). The popularity of CNG, however, is not as strong in Canada, particularly as continually improving diesel engine and exhaust after-treatments "reduce air pollutant emissions to levels that are competitive with CNG-fuelled engines for many categories of emissions" (MARCON-DDM HIT, 2005).

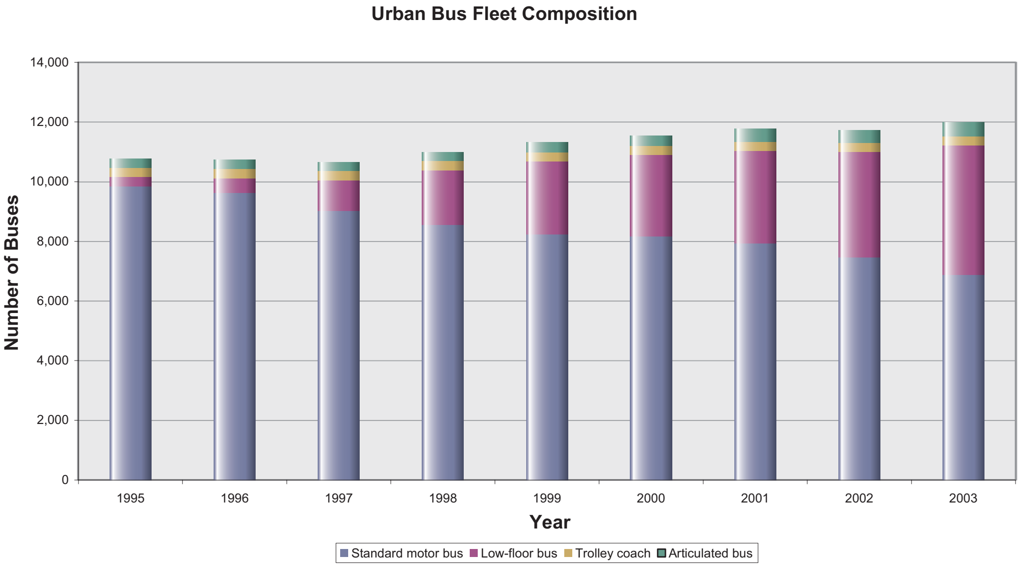
Bio-diesel fuel, widely employed in Europe and the U. S.A. , is being progressively adopted as a fuel option in Canada, where use ranges from significant in Toronto, Montreal and Halifax, to pilot projects, such as in Saskatoon. Mixed with diesel fuel in concentrations ranging from 5% to 20% bio-diesel to 80% to 95% traditional diesel, it can usually be burned without engine modification and benefits from being cleaner-burning and a renewable resource. Sources include vegetable oils, fish oils, animal fats and restaurant grease.

2. 2. 9 Bus Construction

2. 2. 9. 1 Transit Buses

Low-floor buses have improved safety and services for people with disabilities and are intended to increase passenger-friendliness and ridership (Transportation Research Board-National Research Council, 1999a). In 1995, low-floor buses represented only 2. 3% of Canadian urban transit fleets. As of 2003, this percentage had increased to 29%, a rate of uptake that lags behind fleet renewal rates, which suggest that roughly 50% of sub-sector vehicles could have been replaced over the last decade (figure 2-1). Though all future bus purchases will be accessible low-floor vehicles, Canada is far behind the U. S.A. , where transit systems are required to provide service accessible to persons with disabilities and 96. 9% of reported vehicles are accessible (APTA, 2006).

Figure 2-1: The growth of low floor bus fleets



Source:Transport Canada, 2004g

Plans are underway to build prototypes of **modularly constructed transit buses**, entire sections of which could be interchanged (Altair Engineering, 2004). This could allow mechanics to perform repairs to only the affected module, returning buses to service with replacement modules and potentially lessening the requirement to perform repairs outside of peak ridership hours.

The modern **double-deck transit bus**, which can hold up to 96 people, first came to North America when BC Transit placed them in service in 2002 and is continuing to make inroads. Fifty double-deck buses will be put into service in Las Vegas, with 26 arriving in May of 2005. Transit agencies in Portland, OR, and Oakland, CA are also considering their use (Bryan, 2005). BC Transit places their fleet of double-deck buses, now approaching 45 units, "on the highest demand regional routes, providing increased capacity and service quality in areas where the system is near or at capacity in peak periods" (BC Transit, 2005).

2. 2. 9. 2 School Buses

The conventional front-engine, rear-wheel drive school bus design is based on a ladder frame chassis with the engine in front of the operator. Rolling chassis are supplied to manufacturers who build the passenger compartments on these five-ton frames. This configuration holds from 48 to 72 passengers. Flat-nosed, rear-engine school buses are also on the road in Canada, with larger (72-84 passenger) capacities. Smaller buses, carrying up to 20 passengers, are based on ¾ ton or 1-ton rolling chassis from major manufacturers and are prepared by bus manufacturers in the same way as the larger ones. School bus designs continue to evolve, just like designs in other modes. Today, the preponderance of school buses—both large and the smaller, van-based buses use diesel engines.

2. 2. 9. 3 Motor Coaches

Motor coach construction is now highly sophisticated, and efforts are being deployed to reduce the tare weight of the buses. **Lightweight designs** have the potential to make vehicles more fuel-efficient, but weight savings are also necessary to compensate for the ever-increasing array of customer-oriented features being installed on modern coaches (IBI Group, 2002; Transport Canada, 2003). In addition, some newer coaches have highly sophisticated transaxles with 12 forward speeds or more, controlled by computers with adaptive programming capabilities, active stability management and traction control systems. The **double deck motor coach** design, which offers seating for up to 100 people and potential operating efficiencies, is popular elsewhere in the world, but has yet to penetrate the North American market.

2. 2. 9. 4 Environmental Requirements and Diesel Engine Design

With the 2007 model year, vehicle manufacturers will be required to meet new comprehensive emissions requirements laid out by the U. S. Environmental Protection Agency (EPA). Beginning in June, 2006, the EPA will also require that oil refiners produce diesel fuel with no more than 15 parts per million of sulphur. In addition to increasing the refining costs of diesel fuel, it is estimated that this program will add significantly to the cost of a new vehicle, as meeting the EPA emission standards will require significant advances in diesel engine technology, such as improved catalytic exhaust control devices (EPA, 2000). Though continuing advances in engine design will affect the ultimate vehicle price, recent estimates have put the cost of meeting the 2007 EPA exhaust emission limits at between $5,000 and $6,000 for medium-duty trucks and school buses and between $7,000 and $10,000 for heavy duty vehicles (Fleet Manager, 2005).

2. 2. 9. 5 Human Resources Management Technology

The most prevalent piece of technology being used by human resources (HR) managers is the **intranet-based HR system**. Instead of using paper documents for all transactions, needed information and tools are provided on an intranet with little HR personnel participation, resulting in improved efficiency and cost-effectiveness (Brown, 2000). Of most significance is the potential for improved relationships between HR departments and employees; HR personnel are more available to help employees create career plans, develop training paths, deal with real or perceived issues and otherwise focus on individual workers needs (Wellner, 2000; Alexander, 2001; Lengnick-Hall, 2003; and Hendrickson, 2003). Providing more individual attention may have a side benefit of improving retention (Alexander, 2001).

Also, allowing employees to access personal data, information about benefits, payment, training programs and learning and development opportunities gives employees a sense of independence and a sense of being in control of their work lives (Alexander, 2001). Enhanced production and innovation have even been cited as benefits to implementing these programs (Lengnick-Hall, 2003).

There are some cautionary notes that should accompany consideration of the deployment of intranets. Some HR specialists have argued that people read web documents differently from paper documents, and many individuals haven't learned how to use intranets effectively. Intranets can become information dumping grounds that are difficult to navigate. HR departments have been known to shrink as a result of the implementation of intranets, and HR personnel may fear being replaced by technology (Wellner, 2000). e-HR technology has also been blamed for shifting HR responsibilities onto employees. Transit companies will have the additional challenge of providing intranet access to employees on the road without negatively impacting their time both on and off the job (Lengnick-Hall, 2003).

There are many e-HR systems available, from enterprise-wide programs to small business programs that could be of great benefit to the transportation industry. CUTA has already implemented e-Learning technologies, including a web-based multi-media training system and an e-Coach, an "innovative e-mail referral system" (CUTA, 2004a).

Similarly, intercity bus service providers are monitoring the use of on-board technologies to follow the driver's hours of service and monitor compliance with the regulations as a technology that may have, should it be made mandatory, a significant impact on that sub-sector of the industry. At the moment, the use of on-board technology is voluntary, and there are no indications that this will change over the next five years.

2. 3 Human Resources Implications

The deployment of new technology will increase the skill and training requirements for the user. For example, global positioning systems (on which real-time technology is based) are subject to signal blockage, signal interference. In an urban area, where there are many signal-blocking obstacles, there is a potential for the signal to fail (Ochieng et al, 1999). Carroll (2003) argues that because of the potential for GPS signal blockage, operators should be trained to understand the limitations and vulnerabilities of the system and to recognize degradation of the technology and how to switch to an alternative navigation method.

Changes in bus industry technology also have a direct impact on the technical skills required of the industry's mechanics and will, by extension, impose on the industry the requirement to attract or train people with these new skills.

Where the upgrading of skills is required for handling new technologies, on-line training courses, simulation techniques and other technologically enhanced training programs may help provide employees with the needed skills and training.

Technology deployment has favourably influenced the health of operators. A U. S. Study by Rydstedt et al. (1998b), found that operators' health improved when technologies were used to improve the traffic environment of the bus route. In addition, Gobel et al. (1998) found that redesigning the operators' workplace environment (e. g. , expanding roads and providing buses with a separate lane) substantially reduced operators' stress levels and associated health problems. By implementing technology that increases operator satisfaction and decreases stress-levels (e. g. , shelter beacons, surveillance/warning systems and smart cards) the likelihood that individuals will see the transportation industry as an attractive place to work is enhanced.

There have been several important publications and studies conducted on the process of selecting appropriate technology. They highlight the importance of involving operations staff in all aspects of implementing a new technology; from defining technology needs, selecting the appropriate technology, identifying the effects and impacts of new technologies and so forth (Bronson Consulting Group, 1999; Transportation Research Board-National Research Council, 2002; Transportation Research Board-National Research Council, 1999a; Transport Canada, 1999). Recognizing this significance, the MCPCC has consistently involved all levels of employees in the development of all programs, with positive results, and the quality of driver/mechanic contributions has been significant.

2. 4 Summary

In general, the technologies affecting the bus industry are being developed in the following themes:

- those that are directed towards a **better rider experience**. These include the real-time technologies, kiosk improvements, Smart cards and bus designs
- those that directly influence **operator competence.** Technologies that enhance operator and general operations safety such as lane departure warning systems, and video surveillance systems, are such examples
- **system-wide technologies** that benefit overall operational and organizational effectiveness. These include the integrated bus-rapid transit and web-based intranet and internet systems

Based on a thorough review of relevant literature and related material to date, there is reasonable evidence that the committed application by the bus industry of the technologies referenced herein should be expected to favourably impact:

- industry/company image and hence the career appeal of the industry
- recruitment, selection, training, job satisfaction, career commitment and retention
- operations' safety, efficiency and communications
- ridership and profitability