Transportation Technologies for Improving Independence in Canada

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The Canadian Charter of Rights and Freedoms protects persons with physical and mental disabilities against discrimination in Canada. The Canadian Human Rights Act prohibits discrimination against persons with disabilities in the provision of goods and services, including transportation. Transport Canada's policy on accessible transportation states that "accessible transportation is a right, not a privilege." Transport Canada has been working since the late 1970s to guarantee all Canadian citizens access to transportation services, emphasizing the application of appropriate technologies that help to integrate all disabled groups into mainstream activities of society. The concept of complete accessibility is important, and it is necessary to design for the individual rather than for general population. Advances in mobility, information, and communication and control technologies in urban public transportation are discussed. It is concluded that appropriate technologies, although only part of the solution, will go a long way to improving the fit between the individual and the environment. Early consumer involvement is required, as is consistent application across the transportation spectrum. More user-friendly and ergonomically sound designs, in addition to user and operator training and better marketing and dissemination of technologies, are critical to success.

In the late 1970s, Transport Canada initiated a program for travelers with disabilities. This program came to include a variety of activities aimed at removing barriers to transportation services and facilities under federal jurisdiction. In 1983 Transport Canada's policy on transportation of persons with disabilities was developed. The policy set out the government's intention and responsibility to ensure that safe, reliable, and equitable services were available to travelers with disabilities on all transportation modes under federal jurisdiction. In October 1991, Transport Canada's policy on accessible transportation was further refined and stated that

> Accessible transportation is a right, not a privilege. All Canadians should be able to use Canada's transportation system without impediment. Transport Canada supports fully integrated, barrier-free transportation that accommodates the needs of seniors and persons with disabilities. (*1*)

The Canadian Charter of Rights and Freedoms, put forth in April 1982, protects persons with physical and mental disabilities against discrimination. The Canadian Human Rights Act prohibits discrimination against persons with disabilities in the provision of goods and services, including transportation. Under the National Transportation Act of 1987, as amended in July 1988, the National Transportation Agency can also regulate to eliminate undue obstacles.

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APPLICATION OF TECHNOLOGIES

The Transportation Development Center (TDC) of Transport Canada is concerned mainly with the application of appropriate technologies. A technology may be considered appropriate when its application is (a) compatible with the concept of full accessibility across the entire travel continuum, (b) in reaction to or anticipation of goals relating to full integration and self-reliance, and (c) designed for individual users.

Complete Accessibility

Transportation technology deals with all aspects of a journey: planning, access to the system, the trip itself, and egress from the system. This definition of complete accessibility encompasses the entire travel continuum: the vehicle, the terminal and transfer points, the route, the operational and procedural systems, and the emergency systems—as well as the trip planning information, orientation, and communication system (Figure 1).

Integration and Self-Reliance

Canada's disabled citizens can participate fully in the country's society and economy if they have easy access to and from work, recreation activities, and other amenities or opportunities (Figure 2). The transportation system is essential. Transportation technologies should allow individuals to realize their potential by enabling them to travel from origin to destination with independence and self-reliance and with emphasis on integration into society; for example, a self-locking wheelchair securement system is superior to one that requires assistance, because it helps to preserve privacy and dignity. Similarly, smart cards and other silent communication technologies enable travelers to convey their special needs without publicly acknowledging their impairments.

Ergonomic Design

The traditional approach to planning the transportation system has been to design for the "average" user according to a normal design curve. This approach generally results in a

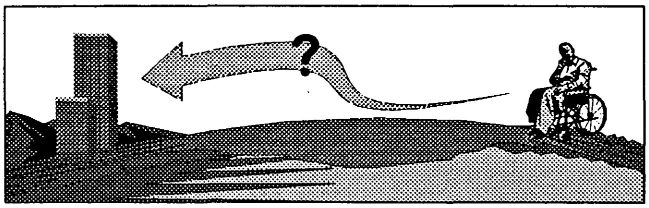

FIGURE 1 Entire travel continuum.

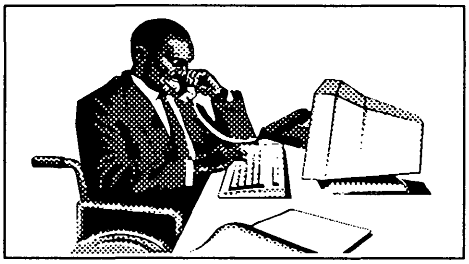

FIGURE 2 Integration and self-reliance.

minimal standard. Designs should meet the needs of individual users at the 85th percentile or higher (Figure 3). In Canada, people who reported trouble in using transportation systems include travelers with mobility or agility disabilities (about 2.0 million Canadians); those with visual, hearing, or speaking disabilities (about 1.5 million); and persons with learning, emotional, psychiatric, or developmental disabilities (about 0.7 million). Designing for individuals at the end of the normal curve will generally meet the needs of all users. Ramps for wheelchairs, for example, also help elderly persons and people pushing strollers, carrying baggage, or supervising very young children.

TYPES OF TECHNOLOGIES

There are many possible ways to classify transportation technologies; one method is according to basic functional goals of increasing travelers' independence (Table 1).

TDC has carried out projects that investigate the application of a number of technologies—including mechanical systems, information and display systems, telecommunication systems, and microelectronics—with the aim of enabling individual users to achieve the basic goals of improving mobility, information, communication, and control. This paper reports development to date in these areas, highlighting Canadian advances in the transportation arena where applicable.

Mobility Technologies

The application of appropriate technologies to improve the access of mobility-impaired travelers to public transportation is largely oriented toward the use of mechanical systems for changing levels in vehicles and terminals. These systems include lifts, ramps, and floor-lowering devices.

In Canada, the trend toward an integrated fully accessible transit system is gathering momentum. British Columbia was

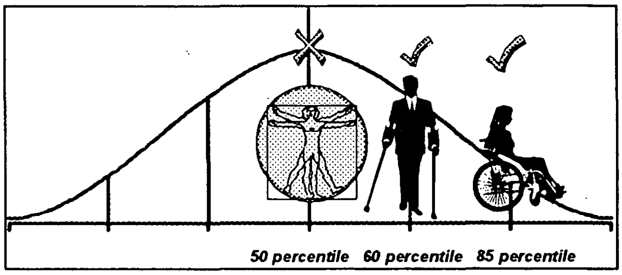

FIGURE 3 Design for individuals.

the first province to adopt a policy of full transit accessibility—for Vancouver in 1990 and for Victoria in 1991. Alberta began to bring about barrier-free transportation systems in 1991, and Ontario has adopted a policy that all new transit buses must be low-floor buses starting in 1993.

Fully accessible transit can be accomplished with lift-equipped buses or low-floor buses (Figure 4). The trend in Canada is toward low-floor buses, and TDC plans to gather data from accessible transit systems on both lift-equipped and low-floor buses to aid in the design and prototyping of an accessible urban transit bus suitable for Canadian operation. This program will be carried out in close cooperation with provincial governments, transit operators, and manufacturers. The low-floor New Flyer bus is now in operation in Victoria, British Columbia; Kitchener, Ontario; and St. Albert, Alberta. Other, smaller low-floor buses available on the market include the Elf II and Orion II. The Orion II is a 22- or 24-ft heavy-duty transit bus with front-wheel drive and low floors; it is manufactured by Ontario Bus Industries. The Elf II is a 31-ft medium-duty transit bus with front-wheel drive and low floors; it is being developed by Overland Custom Coach of Thorndale, Ontario. The prototype is being sponsored by several agencies, including TDC.

Once a passenger is on board, wheelchair securement and passenger restraint systems should be in place to ensure the traveler's safety. Many devices on the market are designed to satisfy these needs: belts and tracks, hooks and rods, clamps, rim pins, and so forth are made by a wide variety of companies. The Oregon State University undertook a project to develop a standard securement system that would work with all mobility aids (*2*). This design includes a latching mechanism and a two-point interface unit that is attached to the mobility aid. TDC has worked on securement systems for various types of vehicles and has successfully developed and tested different securement units for vans and minibuses (*3*,*4*).

Development of standards is another technique to normalize technologies in the transportation arena. The most critical issue affecting the safety of elderly and disabled travelers is the lack of national standards for vehicles, wheelchairs, and mobility aids used in transportation. TDC chose to address this problem by supporting work aimed at developing or revising Canadian Standards Association (CSA) standards relating to the vehicle, the wheelchair, securement, and restraint. A joint federal-provincial effort with CSA and the Canadian Urban Transit Association has been launched to encourage provinces to refer to the CSA standards in provincial regulations. This project is expected to end in 1992–

TABLE 1 Classification of Technologies by Goals

BASIC GOALS	OBJECTIVES	TYPICAL TECHNOLOGY
• mobility	• education, personal business • employment (for activity, self-satisfaction, livelihood)	• mechanical systems
• information	• education and information • orientation and wayfinding	• information displays
• communication	• social interaction, recreation • interaction with service providers	• telecommunications
• control	• independence, self-reliance • security (physical, psychological) • daily living (e.g., shelter, mobility)	• microelectronics

FIGURE 4 New Flyer low-floor bus.

FIGURE 5 GSM accessible taxi.

1993. Standards for accessible coaches and their wheelchair securement systems will be the next priority.

As for accessible taxis, TDC has sponsored several projects relating to developing and selecting suitable vehicles, designing the demonstration service, and evaluating the results. TDC has participated in trials of several commercially available vehicles for adaptation as accessible taxis (Figure 5). Efforts directed toward a redesign of the GSM taxi to meet the requirements of elderly and disabled users resulted in one vehicle now in demonstration service and undergoing evaluation in Montreal (*5*). The results show that driver training is crucial to the success of the service.

Information Technologies

Applying information and display technologies appears to be appropriate for helping persons with disabilities access public transportation information. The solutions to such travel problems lie less in starting new research and development (R&D) activities than in implementing well-established technology. Existing technology can help with information and orientation in vehicles, at bus stops, and in terminals.

One example is the Visual Communication Network (VCN) developed by Télécité Inc. and demonstrated on the Montreal Métro (Figure 6). The VCN provides vital information for passengers inside transit vehicles on a real-time basis, serving the general public with special emphasis on passengers with visual and hearing impairments. Another example—in London, England—is the Talking Bus Stop being implemented at 100 bus stops on the route from Sudbury to King's Cross. At the touch of a button, this system verbally announces the arrival times of the next three buses and warns of any delays.

FIGURE 6 Télécité information display.

During Expo 86, a prototype of an automated telephone information system was developed and demonstrated by Oracle

Communications as part of the Transport Canada–funded Integrated Transportation Information System project. The prototype used computerized speech to provide an automated transit information menu for the greater Vancouver area; it included general transit information, bus schedule information, and trip planning information. Callers could interact with the system using tone entry from a standard touch-tone telephone. The prototype was demonstrated to the public during Expo 86.

TDC is interested in augmentative information systems such as these, as well as signage and tactile aids for persons with perceptual and sensory impairments. Other technologies that warrant further consideration include audio pathways, warning lights, audio induction loop systems, and tactile aids. These systems have been evaluated (*6*), and the next stage is operational demonstrations.

The transportation problems of cognitively impaired travelers remain difficult to define. More work should be carried out to eliminate communication and orientation barriers via modern microelectronics and information technology. The merits of training and education of potential travelers and travel service providers should be investigated.

Communication Technologies

Telecommunication systems can be applied to help individuals with disabilities to communicate with transportation providers.

A demonstration of HandyLine, an adaptation of telephone communications that permits automatic reservation and confirmation of requests for paratransit services, is under way in Vancouver (*7*). This system promises to improve service efficiency by automating routine inquiries and services and by handling reminder calls to clients, thus reducing no-shows and boarding delays (Figure 7). In Victoria, an automated telephone information system for the general public, called BusLine, is being implemented. Extending these systems to connect with telecommunication devices for the deaf is a natural follow-on, as automated telephone information systems are becoming commonplace. The public communicates with both systems through the touch-tone keys on their telephone. Although the evaluation has just begun, it is believed that such systems will prove beneficial to travelers with disabilities, most notably those with speech impairments.

Development of an automated information kiosk (Communicaid) was completed in 1992 under TDC sponsorship (*8*) (Figure 8). This system provides traveler information (such as flight arrivals and departures, location of amenities, and ground transportation) for people with sight, speech, or hearing impairments. It includes a touch screen with simplified controls and magnification and contrast adjustment for those with sight impairments. Translaid, a portable translator, is also being developed under TDC sponsorship for application in transportation terminals. It permits individuals with speech or language difficulties to communicate directly with a service agent by keying appropriate questions and responses on a dual-screen computer terminal (one screen for the passenger and the other for the service agent).

Systems such as Communicaid and Translaid may also have application in many types of transportation terminals and multimodal stations, providing the public with another means of communicating with service providers.

Control Technologies

Another appropriate technology is microelectronics: for example, in-vehicle guidance, cellular telephone communication, and emergency location systems.

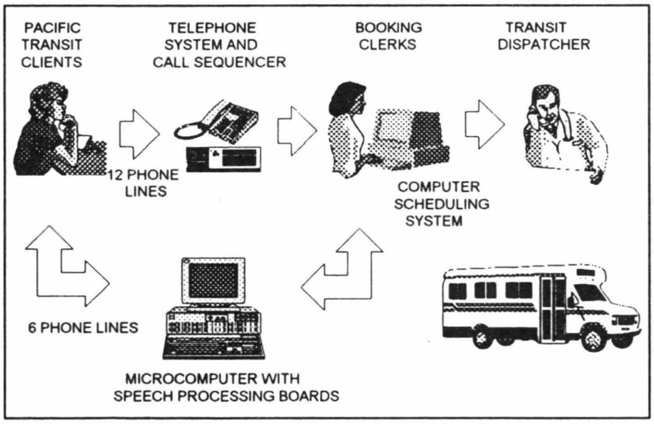

FIGURE 7 HandyLine telephone system.

FIGURE 8 Communicaid kiosk.

The application of microelectronics technology in the context of intelligent vehicle-highway systems (IVHS) programs in North America offers great promise of helping persons with disabilities to achieve mobility and independence safely. These efforts may appear to be more applicable to private transportation, but travel advisory, travel planning, priority parking, and so forth could be adjunct services for public transit clients who drive their automobiles to the park-and-ride lot of a transit station. To avoid cumbersome and unsafe retrofits, the needs of elderly people and persons with disabilities must be recognized early in the development of IVHS systems and in-vehicle devices, not as an afterthought. Public transit operators should also be involved to ensure that these systems are designed to incorporate their needs.

The application of these microelectronic devices and related computer systems also offers great promise for cost-effective control of parallel transit and dial-a-ride systems (Figure 9). In-vehicle navigation and route guidance units that include two-way communication with central control could greatly improve response times to changes in the service. Computerized dispatching is also required to better schedule the vehicles. In this area, TDC has sponsored projects such as the development of a generic computerized scheduling software package called the DART Manager in 1985.

Smart card technology may find application in the public transportation arena as a way for the user to communicate silently any special needs to the operator. Such cards could also be used for fare collection in user-subsidy programs to eliminate money-handling and accounting problems or as identity or control cards to gain access to priority parking in a park-and-ride lot.

FIGURE 9 Dial-a-ride control systems.

CONCLUSIONS

Appropriate transportation technologies can improve the fit between individuals and their transportation environment. In so doing, they benefit everybody. Table 2 illustrates the relative potential benefits—at the current level of development—of three alternative solutions to accessibility problems of various groups of travelers with disabilities.

The potential benefits of solutions differ according to the needs of individual travelers. For example, technological solutions for individuals with mobility impairments offer fewer benefits than do architectural solutions, because R&D is relatively advanced; the reverse is true for those with vision, hearing, or speech impairments. On the other hand, technological solutions to assist individuals with cognitive or emotional disabilities would probably offer fewer benefits than would solutions oriented toward training. Therefore, appropriate and ergonomically sound solutions for the different groups should be determined, and resources should be invested accordingly. To ensure the successful application of technological solutions, the following points should be considered:

- Early consumer involvement in R&D to avoid expensive and unnecessary retrofitting later;
- Consistent application over the entire transportation spectrum to allow for full integration and continuity across all aspects of the trip;
- More user-friendly and ergonomically sound designs of existing simple mechanical technologies;
- Better training of both the user and the operator in using the technologies; and
- Better marketing and dissemination of technologies through greater cooperation with users, private industry, and manufacturers to alleviate problems of ill-defined market, low economic status of users, and low interest of industry.

With cooperation from technology users and technology builders, certain solutions demonstrated here could improve the fit between the users and the environment. The remaining challenge is that of finding a compromise between the needs and desires of the users and the costs and risks of the technology.

REFERENCES

1. *Access for All: Transport Canada's Policy on Accessible Transportation*. TP 5014. Transport Canada, Ottawa, Ontario, Oct. 1991.

TABLE 2 Potential Benefits of Alternative Solutions

Disability	Accessibility Solution		
Category	Architecture	Technology	Training
Mobility	**High**	Med-High	Low
Vision	Medium	**High**	Medium
Hearing/Speech	Low	**High-Med**	Medium
Cognitive	Medium	Med-Low	**High**