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INTELLIGENT TRANSPORT SYSTEMS (ITS)

APPLICATIONS FOR IMPROVING TRANSPORTATION FOR ELDERLY AND DISABLED TRAVELLERS

A Working Paper by Transportation Development Centre for Industry Canada

7 October 1996

Transportation Development Centre
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EXECUTIVE SUMMARY

By the year 2025, 23 percent of the Canadian population will be aged 65+, 21 percent will be disabled and 12 percent will have a specific transportation disability. Disabled drivers already account for about 11 percent of all drivers, and by 2025 the proportion of drivers who are elderly or disabled will be approaching 20 percent. Elderly and disabled people will form a significant part of the market for ITS equipment, probably about 25 percent of the total, and equipment must be designed to take account of their requirements and abilities.

ITS has the potential to improve the accessibility of public transport by the provision of pre-trip information and of real time information during a journey. The use of smart payment cards and, eventually, cards that provide optional details of traveller requirements to transport operators should also reduce barriers to travel. ITS is already in use in bus transit systems to improve service reliability and provide real time information to travellers. These ITS services should help all travellers as well as improving accessibility for people with disabilities.

The numbers of elderly and disabled car drivers will increase substantially over the next 20 years. In the near future, ITS equipment such as vision enhancement, route guidance and emergency alert has the potential to partially compensate for the physiological effects of aging and improve the safety and mobility of elderly drivers. In the longer term, developments such as intelligent cruise control, collision warning, automated lane following and, ultimately, the automatic highway, have the potential to remove most of the barriers that currently prevent elderly people continuing to drive. ITS also has considerable potential to help public transport users and pedestrians. Talking signposts, audio announcements on request from visual displays and hand-held location and guidance systems should help pedestrians with visual impairments.

The following list of development activities and products covers the things that need to be done to make ITS useful for elderly and disabled people, and to overcome problems experienced by many people. The products could well provide niche markets for Canada to exploit.

General

1. Make the ergonomic evaluation of any ITS equipment used by the public a routine part of the design process. Include elderly and disabled people in these evaluations.

2. Develop, in co-operation with USA, Europe, Japan and existing international standards committees, ergonomic guidelines for the design of ITS equipment to be suitable for elderly and disabled people.

3. Develop a family of hand-held and portable information storage and display devices.

4. Introduce to North America the Royal National Institute for the Blind contactless 'React' transponder to activate various types of equipment, including making video displays talk when required.

Car drivers

5. Set up, in co-operation with the USA, long-term trials of the use of ITS by elderly drivers.

6. Develop a system to broadcast road map corrections direct to a vehicle's navigation system, at least at the beginning of a day's driving and possibly on a continuous basis, to reflect road closures, changes to junctions, accidents and incidents.

Public transport users

7. Extend smart payment cards to make a single card cover public transport operators in many towns plus railways, air lines, major hotel chains and public telephones, and later extend these to carry, on a voluntary basis, information on passenger requirements and special needs.

8. Introduce a system that provides information on the predicted arrival times for buses at specified local bus stops, and other transit, travel and 'Yellow Pages' information, using cable to a home computer or television, the internet or broadcasts to a portable receiver (see 3 above).

9. Develop a communication system between passenger and bus to help a passenger hail a community or intercity bus.

10. Look for other low cost ways to use ITS to help disabled people, such as the use of inductive loops in transit vehicles to enable people with impaired hearing to hear announcements on a hearing aid without interference from other conversations and background noise.

It is almost certain that further ideas for niche products will be suggested in the next few years. Where the product appears to be commercially viable, its development should be encouraged. The policy of Transport Canada is generally not to become involved in the development of commercial products. In the field of specialized equipment or services for elderly and disabled people, it may well be that government assistance with development and field trials is the only way to bring new products to the market. Government assistance cannot create a market for a product that is not viable commercially, but it can overcome initial barriers that would prevent a viable product being developed.

Considering the requirements of elderly and disabled people means, firstly, ensuring that equipment is easy and safe to use by this group of people. This will almost certainly make it easier and safer for the whole population to use. Secondly, it means seeking ways of extending standard equipment to cover the special needs of elderly and disabled people. Thirdly, it means seeking ways to use existing technology to perform a service specifically for elderly or disabled people.

Research during the 1980s established guidelines for the design and operation of physically accessible transport services. Unless a continuing research programme maintains expertise on ITS and accessibility, there is a risk that the changes to road transport, and particularly to driving, that ITS will bring over the next twenty to thirty years, could unintentionally introduce new barriers to travel rather than improve accessibility.

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ABSTRACT

By the year 2025, 23 percent of the Canadian population will be aged 65+, 21 percent will be disabled and 12 percent will have a specific transportation disability. The proportion of drivers who are elderly or disabled will be approaching 20 percent. In the near future, ITS equipment such as vision enhancement, route guidance and emergency alert has the potential to partially compensate for the effects of aging and improve the safety and mobility of elderly drivers. In the longer term, developments such as intelligent cruise control, collision warning, automated lane following and, ultimately, the automatic highway, have the potential to remove most of the barriers that currently prevent elderly people continuing to drive. Elderly and disabled people will form a significant part of the market for ITS equipment.

ITS also has considerable potential to help public transport users and pedestrians. Equipment is already in use in bus transit systems to improve service reliability and provide real time information to travellers. The use of smart payment cards and, eventually, cards that provide optional details of traveller requirements to transport operators should reduce barriers to travel. Talking signposts, audio announcements from visual displays and hand-held location and guidance systems should help pedestrians with visual impairments.

The paper lists development activities and products that are needed to make ITS useful for elderly and disabled people. The products could well provide niche markets for Canada to exploit. Considering the requirements of elderly and disabled people means, firstly, ensuring that equipment is easy and safe to use by this group of people. Secondly, it means seeking ways of extending standard equipment to cover the special needs of elderly and disabled people. Thirdly, it means seeking ways to use existing technology to perform a service specifically for elderly or disabled people. Unless research maintains expertise on ITS and accessibility, there is a risk that the changes to driving that ITS will bring over the next twenty to thirty years could introduce new barriers to travel rather than improve accessibility.

INTELLIGENT TRANSPORT SYSTEMS (ITS) APPLICATIONS FOR IMPROVING TRANSPORTATION FOR ELDERLY AND DISABLED TRAVELLERS

1. INTRODUCTION

The term "Intelligent Transportation Systems" refers to the application of information systems, telecommunications, sensors and control systems to road transport. ITS has the potential to increase the capacity and productivity of the road transport system, to improve the reliability and safety of road transport and to reduce its environmental impact and the adverse consequences of incidents.

To date, the development of ITS has concentrated on the technical aspects of the equipment and systems, and the performance of the road transport system as measured by traffic flows, delays, safety and environmental impacts. The effects of ITS on travellers has usually been measured in terms of reduced delays and reduced exposure to congested driving conditions. Studies of the ergonomic aspects of ITS have usually been limited to the responses of car drivers to road-side equipment such as variable message signs and to in-vehicle equipment such as traffic information or route guidance systems. These studies have rarely included elderly or disabled drivers in the samples who tested and assessed the systems. In the European DRIVE II Program, considerable work has been done on the provision and display of real-time transit information, and some systems are in limited operational service. Again, elderly and disabled people have not usually been included in its evaluation.

The numbers of elderly people and of people with disabilities are growing rapidly in Canada, as in almost all developed countries. By the year 2025 it is expected that elderly people will form 23 percent of the adult population of Canada. By that year, people with disabilities are likely to form 21 percent of the adult population and people with specific transportation disabilities 12 percent.

There are several reasons why elderly and disabled people are often considered together. The first is that the probability of disability increases with age. The forecast increase in the number of disabled people is a direct consequence of the forecast increase in the number of elderly people. Secondly, disabled and elderly people share many socio-economic characteristics. They are less likely than the total population to be employed and more likely to be relatively poor. They are more likely to be dependent on public transport. If they drive a car, elderly people experience various problems that are the results of aging and some of which are similar to problems experienced by people with some disabilities.

Elderly and disabled people should benefit from the improvements in road transport that ITS will bring for all travellers. Because of their rising numbers, any tests of ITS equipment should include elderly and disabled people in the sample to test the equipment. Indeed, in many cases, designing for the elderly and disabled population leads to equipment that is easier and safer for the whole population to use.

As well as benefiting from ITS as part of the total population, there is potential for ITS equipment to provide special features that are targeted to help elderly people or people with disabilities. Examples of ITS equipment with this potential include communication and dispatching systems to improve the operation of paratransit services for disabled people and devices carried by people with visual handicaps to trigger audio announcements of information

about public transport where the display is normally visual. The application of ITS to assist elderly and disabled travellers has been discussed by Suen and Parviainen (ref.1).

One study in Europe has shown that ITS equipment in a car has the potential to help elderly drivers compensate for some of the physiological effects of aging, and so better retain their mobility and delay the increase in accident rate for drivers over the age of about 75 that is worrying road safety administrations in many countries.

This paper, which has been written by Transportation Development Centre at the request of Industry Canada, outlines the demographics of the Canadian elderly and disabled populations and their transportation needs and problems. It indicates the current state of development of ITS technologies for accessible transport and the potential for future developments. It identifies Canadian expertise and activities in this area, and suggests the potential Canadian and international markets for ITS equipment for elderly and disabled people. Finally, it suggests niche areas for Canada to pursue in the world market.

A detailed study of the potential of ITS to increase the accessibility of transport is being conducted by Dr C G B Mitchell during his assignment to Transportation Development Centre (TDC), Transport Canada, as a Visiting Expert. This study will not be complete until December 1996, so this paper is based on preliminary results from Dr Mitchell, and is subject to revision or amplification.

2. BACKGROUND ON ELDERLY AND DISABLED PEOPLE

2.1 Numbers of elderly and disabled people

The adult population of Canada is expected to increase from 22.2 million in 1995 to 33.3 million in 2025, an increase of 50 percent. The number of persons aged 65 and over is expected to increase by 140 percent, from 3.2 million in 1995 to 7.8 million in 2025, when they will form 23.4 percent of the adult population of Canada. This trend is typical of developed countries (ref.2).

The population of adult Canadians with disabilities is expected to increase from 3.8 million in 1995 to 6.9 million in 2025. Of these adults with disabilities, 2.2 million in 1995 and 4.1 million in 2025 are expected to have transportation disabilities. By 2025, 12.3 percent of Canadian adults are expected to have transportation disabilities (Table 1).

TABLE 1
The present and forecast Canadian populations of elderly people and people with disabilities

Population, millions, (percent)

Year	Total adult population (aged over 15)	Persons aged 65+	Persons with disabilities	Persons with transportation disabilities
1995	22.2 (100 %)	3.2 (14.4%)	3.8 (17.1%)	2.2 (9.9%)
2025	33.3 (100 %)	7.8 (23.4%)	6.9 (20.7%)	4.1 (12.3%)

People with transportation disabilities tend to be more disabled than the population of people with disabilities, and are more likely to have multiple disabilities. These types and severities of disabilities are set out in Table 2. Mobility and agility disabilities occur most frequently.

TABLE 2
Disability characteristics of persons with disabilities and persons with transportation disabilities (Canada, 1995)

Population, thousands, (percent)

Disability	Persons with disabilities	Persons with transportation disabilities
Severity		
Mild	1,862 (48.8%)	555 (25.3%)
Moderately severe	1,256 (32.9%)	957 (43.6%)
Severe	695 (18.2%)	681 (31.1%)
Type of disability		
Mobility	2,271 (59.6%)	1,646 (75.1%)
Agility	2,067 (54.2%)	1,492 (68.1%)
Hearing	1,171 (30.7%)	681 (31.0%)
Seeing	558 (14.6%)	414 (18.9%)
Speaking	257 (6.7%)	201 (9.2%)
Other	1,137 (29.8%)	857 (39.1%)
Totals	3,813 (100 %)	2,193 (100 %)
Disabilities per person	1.96	2.41

The numbers of people with different types of disability do not sum to the total population because of multiple disabilities.

In 1995, an estimated 2.1 million people with disabilities drove personal vehicles, some 55 percent of all adults with disabilities in Canada and 11 percent of all drivers. An estimated 3.3 million adults with disabilities travelled as passengers in personal vehicles (some of whom also drove), representing about 86 percent of adults with disabilities. Of the remaining 14 percent, 6.4 percent considered themselves housebound, 1.5 percent who never travelled as a passenger and 6 percent were 'no response'. The numbers of elderly and disabled drivers will inevitably increase substantially as the population ages, probably to about 20 percent of all drivers.

In 1995 in Canada, an estimated 596,000 people with disabilities had difficulties taking short local trips. Similarly, 65,000 people had difficulty travelling by air, 60,000 by intercity bus, 12,000 by rail and 11,000 by ferry. These figures reflect both the numbers of people needing to take short trips or use the long distance modes of transport, and the difficulties posed by the particular mode. In terms of numbers of people affected, accessible local travel is the first priority.

The actual increase in the population with disabilities may in the event be a little less than the forecast figures quoted above. This is suggested by recent results from the US National Long Care Survey. The diseases associated with old age appear to be afflicting fewer elderly people;

when they do occur, it is later in life. The problems that doctors accepted as normal in a 65 year old in 1982 are now often not appearing until people are aged 70 or 75. On the other hand, there is no evidence of delay in the occurrence of the physiological effects of aging that make driving difficult (increased reaction time, poorer vision and difficulty in dividing attention between two or more tasks). Thus while future generations of elderly people may be less likely to experience the disabilities that make walking and use of public transport difficult, they are likely to continue to experience problems as drivers.

2.2 Transport needs and problems of elderly and disabled people

Elderly and disabled people travel less often than do able bodied people, even when work and business trips are omitted. Apart from employment, the range of activities for which elderly and disabled people travel is similar to that for the whole adult population. They travel more to health care than do the whole population.

The problems experienced by people with transportation disabilities depend on the mode of transport concerned. The greatest problems for users of local public transit are getting on/off the vehicle (52 percent of those who have difficulties using transit), standing in the vehicle while it is moving (49 percent) and getting to/locating the stop (33 percent) (ref.2). These are soluble by improvements to the design of the vehicles and the infrastructure of sidewalks, bus stops and transit terminals, and by operating transit to take account of the problems of elderly and disabled passengers. ITS devices are not likely to be involved directly in the solution of these problems, although the improvements to transit services that should result from the application of ITS to traffic management and public transport operation may help to alleviate them.

Seeing signs or notices is a problem for 20 percent of passengers who have difficulty using transit, obtaining information on routes or times for 17 percent and hearing announcements for 13 percent. These three problems could be alleviated by ITS equipment. Thirty-two percent of passengers who have difficulties with transit, find waiting at the stop difficult. This also could be reduced by ITS equipment to provide information on when the bus or train is predicted to arrive at the stop (which would be helpful to all transit passengers). Improvements to the display of information to transit passengers are already being implemented in Europe, and developed in Canada. It is possible that these improvements will prove to be commercially viable, in that they could increase ridership and revenue enough to cover any additional costs.

The conclusions for transit are that the physical design of vehicles and infrastructure, and the operation of the system, are the first priority for improving accessibility. But barriers that could be overcome by ITS will remain when the priority problems have been solved, and these barriers affect a substantial proportion of those who have difficulties using transit. Using ITS to reduce barriers for elderly and disabled transit passengers will help all passengers. In addition, ITS has a major role in improving the performance and efficiency of both mainstream public transit and specialized paratransit services. These improvements will be directly beneficial to elderly and disabled people, as well as helping all transit passengers.

Similar conclusions apply to the users of the other transport modes, including private cars. Additionally, in the case of car drivers, the physiological effects of aging make driving more difficult. ITS has a significant role in assisting elderly drivers. In the short term, systems such as enhanced vision, route guidance and emergency alert should improve safety and increase mobility. In the longer term, intelligent cruise control, collision warning, automatic lane following and, ultimately, the automated highway, should remove most of the barriers that

currently stop older people continuing to drive. There is also potential for using ITS to help pedestrians, particularly those with visual impairments. Again, this represents a stage of improvement that becomes more important after the basic infrastructure has been made accessible to pedestrians with disabilities.

2.3 Technologies and areas of application

The technologies that make up ITS can be listed as: Positioning/navigation; Sensors; Displays; User interfaces; Communications; On-board storage and processing of information; Controls; and System Integration/Intelligent Software.

In a presentation to the Canadian Advisory Committee on Accessible Transportation in April 1995, Sesto Vespa of Transportation Development Centre listed emerging ITS technologies of special use to elderly and disabled travellers as on-board replication of maps and signs, pre-trip electronic route planning, traffic information broadcast systems, on-board navigation systems, safety warning systems, obstacle detection, blind-spot monitoring, driver vigilance systems, enhanced night vision, head-up display and variable tint for windows and mirrors (ref.3).

The areas of application of ITS are usually listed as Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), Advanced Vehicle Control and Safety Systems (AVCSS), Advanced Public Transport Systems (APTS), Emergency Management (EM), Advanced Rural Transportation Systems (ARTS) and Commercial Vehicle Operations (CVO).

The ITS America/US DOT National ITS Program Plan (ref.4, March 1995) has revised these to seven 'User Service Bundles'. These are Travel and Transportation Management (TTM), Travel Demand Management (TDM), Public Transportation Operations (PTO), Electronic Payment (EP), Commercial Vehicle Operations (CVO), Emergency Management (EM) and Advanced Vehicle Control and Safety Systems (AVCSS). In this paper the previous classification will be used. Parviainen (ref.5) provides a 'technical primer' on ITS technologies.

CVO is a specialized topic for commercial vehicle operators, which is unlikely to interact with the needs of elderly and disabled people. ATMS is concerned with improving traffic management, mainly in major urban areas and along inter-urban corridors. The benefits it brings for all travellers will help elderly and disable people, but it does not usually interact with individual travellers, and will not be considered further in this paper. It is possible that traffic management centres could provide route guidance influenced by whether the driver is elderly or disabled, but this will be considered under navigation systems.

Vehicle control and safety systems (AVCSS) will almost certainly be developed to serve the whole population of drivers. It is important that elderly and disabled drivers are involved in their development, to ensure that AVCSS does not introduce unnecessary barriers to the mobility of this group. Furthermore, some aspects of AVCSS such as intelligent cruise control (ICC), collision warning or avoidance and vision enhancement have the potential for helping elderly drivers with aspects of driving that cause higher than average accident rates for them.

The main areas where the requirements of elderly and disabled travelers should influence the design of ITS equipment, and indeed lead to the development of specialized items of equipment, are ATIS for driver information from road-side and in-vehicle displays, APTS for passenger information and EM for emergency alert (Mayday) services. They also need to be involved in

the introduction of smart payment cards for transit fares, parking charges and tolls. There may well, in the further future, be scope for ITS in rural transport, for example in transport brokerage, paratransit operations for rural areas and ride sharing.

3. ITS TECHNOLOGIES FOR ACCESSIBLE TRANSPORT

3.1 Trip-planning information

The US ITS Program Plan considers the provision of multi-modal information for selecting the best transport mode, time and route as an integral part of transport demand management. A number of projects in Europe and North America are providing terminals in public places (airports, rail stations, shopping centres) for the provision of multi-modal trip planning information. BC Transit has implemented an automated telephone information system called BusLine to assist staff provide transit information to the public in Victoria, BC. In Europe, some travel information is available on television sets using Teletext. More needs to be done to provide easy access to pre-trip information for all travellers in the home, workplace or hotel. The European TIDE program includes one project, TURTLE, to display real time transit information at home using the existing Teletext system on television sets. A modem is being developed by Netscape to allow standard television sets to receive information from the Internet, using the remote controller as a keyboard (Sunday Times, 1 September 1996).

Equipment to provide electronic Yellow Pages is already available commercially, including hand-held portable data stores similar to personal organizers. There may well be scope for the inclusion of travel information in existing commercial services, and possibly for the inclusion of specialized information for elderly and disabled travellers. The role of information in accessible transport was outlined by Suen and Rutenberg (ref.6).

There is also a great need for specialized information on what accessible services are available, and for specific advice on how to make particular journeys for people with particular transportation disabilities. In Britain, an information service called TRIPSCOPE provides such advice to disabled travellers. This already uses a computerized data base, but it is clear that a greater use of information technology will be required for the two purposes of keeping information up to date and for increasing the speed with which questions can be answered.

3.2 Public transit systems

In North America and Europe. ITS technologies are being introduced to improve the efficiency, productivity and reliability of bus systems. In Canada this technology is currently in use in the bus services in Hull and Halifax. The technologies available include Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI) and communication between buses and a control centre (refs.7, 8). These allow the control centre to monitor operation of the system and to take action to minimize unreliability; they can also give buses priority at traffic signals. The same technology allows the display of the name of the next stop on-board the bus and, at a bus stop, the number and destination of the next few buses and the waiting times until they arrive. The information displayed at bus stops can also be announced audibly.

This technology, which is steadily coming into service in Europe, is intended to help all transit passengers. For example, RATP in Paris uses AVL, AVI, on-board and bus stop information displays for operational efficiency and passenger information, plus an on-board video camera and driver communications for safety and security. Safety and security are very important for

elderly and disabled travellers, and are improved by better communications. Because elderly and disabled people find it difficult to wait at bus stops, and also need warning of their destination stop, the improved passenger information should be particularly helpful to this group.

In Canada, the display of information on-board is already in service in the Montreal Metro using the Télécité Visual Communication Network (VCN) system. This is more advanced and allows more sophisticated displays than do the corresponding systems in Europe. Its extension to buses is being planned. It should be technically straightforward to install inductive loops in buses and metro cars so that people with hearing impairments can hear audio announcements directly through a hearing aid without interference from background noise (as is done already for some telephones).

At least two Canadian ITS projects were started to develop systems to broadcast real time transit information to hand-held display units or home-based computers. These systems would help elderly people by minimizing the time they need to wait at bus stops in inclement weather. At present both developments are blocked by lack of funding. The European DRIVE II Project PROMISE has developed portable and hand-held display and communication units. It is also possible to use urban cable systems to transmit similar information to a home-based computer or television set. The European TIDE Project TURTLE is specifically developing such a system. Saskatoon had a limited experiment to use the cable system to provide transit information (not real time) in the 1980s, but the system was not expanded due to lack of funding. Finally, the computer system that disseminates real time transit information could pass this to the internet, to be read on home computers or, using a special modem, television set.

Many Canadian transit operators have provided telephone information services that supply the times of the next two or three buses for each bus route using a specified bus stop. Most of these services supply schedule information, but two operators, in Hull (Société de transport de l'Outaouais) and Halifax, supply real time information derived from AVL systems. The widespead avialability of information by telephone has reduced the perceived requirement for the electronic display of information at bus stops.

European experience with "talking bus stops" that make voice announcements of transit information has shown them to cause local nuisance. Peek Traffic Ltd manufacture bus stop information displays that only make audio announcements when activated. This activation can be by a button or by a contactless device carried by a visually impaired person. A similar device could change the visual display of information to large print. A contactless device has been developed by the British RNIB (Royal National Institute for the Blind) 'React' project to operate a variety of equipment. London Transport are using React to trigger audio announcements of the bus services from particular stops at transit terminals. In the ROMANSE demonstration project in Southampton, contactless devices are being used to obtain audio announcements of real-time transit information from bus stop displays. In Canada the greatest use for such a device would be in transport terminals.

Elderly people find the time pressure of boarding, paying a fare and finding a seat before the bus starts a significant deterrent to transit use. Smart payment cards remove the need to pay a fare while boarding a bus and reduce this stress. Transit operators would like a contactless payment card to speed boarding; one Canadian company (Precursor Ltd) is developing smart payment cards for transit systems, but lack of standards is delaying widespread application. The Precursor smart card is being used by transit systems in Ajax and Burlington, Ontario. Société de Transport de l'Outaouais is working on the introduction of a smart card fare payment system.

The Ministry of Transport, Ontario, is conducting general studies to develop standards for a Universal Public Transport Card. The German Association of Public Transport Operators (VDV) already has in service a smart payment card for fares on all their members transit systems that also allows the purchase of railway tickets and the use of public telephones.

There is a more general role for a smart payment card that applies to all modes of transport (air, ferries, intercity bus, transit, taxis and car hire) and that carries personal information on the special requirements of a disabled traveller. This could be read at the time of booking and would supply the operators of all stages of a trip with the requirements of the individual traveller for assistance or storage space for a wheelchair. A common concern of disabled people making a multi-modal trip is that one of the later modes will not be accessible, or that help will not be available to transfer between modes or carry baggage, as necessary.

Community bus services, in which an accessible bus can be hailed at any point along its route, are already in service in Canada and are likely to become more widespread. A problem reported in Sweden, where these services originated, is that some passengers have difficulty recognizing the bus in time to hail it. This difficulty should be soluble by the use of a hand-held unit that informs the passenger of the approach of the bus, or the bus of the waiting passenger. This could also apply to hailing intercity buses on roads where passengers are picked up wherever it is safe to stop the bus.

3.3 Paratransit and taxi services

ITS has the potential to improve the performance and efficiency of the paratransit and taxi systems that provide specialized transport services for elderly and disabled people. The aspects of paratransit systems that are most likely to be improved are:

1) Telephone communications between passengers and the control centre. These are often overloaded, and in addition present problems for people with hearing or speech impairments.

2) Computer-aided dispatching. Dispatching software was first developed for taxi systems, and has only recently been developed for paratransit. Two Canadian companies, Trapeze Software Inc. and International Road Dynamics Inc., provide general paratransit dispatch systems (Trapeze and TransView). Trapeze has been found to give a 8 - 30 percent increase in productivity and can be regarded as a proven package, at least for medium and small paratransit systems. It is also being used to increase productivity by allocating trips that are expensive by paratransit to back-up taxis.

3) AVL. There is service experience of AVL on the 153 vehicles of the Houston METROLift paratransit service. Measured service performance and efficiency improved significantly. TransView is being upgraded to accept AVL inputs.

Computer dispatching of conventional taxi systems is now in general service and is able to improve productivity and the accuracy of pick-up times. The main improvements for taxi services used as part of the transport system for elderly and disabled people are likely to be telephone links that are easier for people with hearing impairments to use; data transmission links and smart card readers for taxis, to make it easy for elderly and disabled passengers to identify themselves and to pay their contribution to the fare; and systems to help passengers communicate with the driver. Data links and card readers are already in use in taxis in several Scandinavian cities, where they are used to validate credit card payments by able-bodied passengers as well as to operate the subsidized service for elderly and disabled people. A taxi

meter with a display that is easy to read, and that also talks, has been developed by Record Electronics Inc. for TDC to enable people with visual impairments to monitor the fare.

3.4 Car drivers

Studies in Europe have already shown that ITS equipment can partially compensate for the physiological changes that occur as people age and that make driving more difficult. The greatest potential improvement to road safety for elderly drivers is likely to be a system to enhance night vision without dazzling other drivers. This is likely to be initially achieved by the use of UV headlights, which is not an ITS system. In the longer term, it is possible that infra-red night vision equipment using a Head Up Display could supersede UV lights, but this is not likely for a considerable time. Systems to automatically dip a car's headlights when encountering on-coming traffic could help elderly drivers by reducing dazzle, but may prove not to be acceptable to drivers.

Route guidance/navigation systems have considerable potential to delay the age at which drivers become reluctant to go to new places or into crowded town centres. Emergency alert systems, in which GPS and cellular communications allow a driver to call assistance to the location of the vehicle, even if the driver does not know that location, increase the willingness of elderly drivers to drive at night, in unfamiliar areas and on major highways (the safest roads). These are coming into general service, either fitted by vehicle manufacturers as original equipment or retrofitted.

Systems that detect obstacles behind a car have potential to improve parking accuracy and reduce the risk of minor accidents caused by reversing into objects. They also reduce the risk of hitting a pedestrian who walks behind the car. A different application, from Delco Electronics, warns of children near or under a school bus. Although not tested by elderly drivers, detectors of obstacles beside a car are likely to reduce accidents during merging and lane changes. Equipment of this type has been developed in the European PROMETHEUS Program. If these encourage elderly drivers to continue to use highways, rather than the less safe local or secondary roads, they should reduce accidents and benefit the whole driving population.

Simulator tests have shown that collision warning systems do prevent drivers attempting to turn across traffic when the gap available is insufficient. They were judged particularly helpful at night. They also reduced the average length of the gap required and should increase junction capacity. There is considerable development still to be done on both the ergonomics and the technical aspects of such systems. They should have an acceptable gap length that can be adjusted to suit individual drivers and they should include some display to warn a driver of the need to complete their turning manoeuvre quickly.

A package of existing technology (UV lights, route guidance/navigation, traffic information, obstacle detection and emergency alert) has the potential to increase the mobility of elderly drivers and to extend their safe driving life. When it is available, intelligent cruise control should reduce the risk of elderly drivers failing to comply with right of way signs or red traffic signals (a common fault for elderly drivers). In the longer term, automated lane following, collision warning and/or avoidance, and ultimately the automatic highway, should remove most of the barriers that at present cause old people to stop driving.

Disabled drivers already have vehicle conversions available with zero-force steering, brake and accelerator controls, that can be driven from a wheelchair. These vehicles have various items of ITS or high-tech equipment to operate secondary controls, lock external doors and operate a

wheelchair lift. There are potential problems with electro-magnetic interference and the compatibility of such systems, but these can be identified and corrected by well-established methods.

3.5 Pedestrians

Elderly and disabled pedestrians have problems with crossing roads because they walk more slowly than able-bodied people. Traffic signals often do not allow long enough for such pedestrians to cross the road safely. Increasing the crossing time generally would reduce junction capacity. In Britain, experience is being obtained from a limited number of crossings where people-detectors are used to extend the time of the pedestrian crossing phase while a slow-moving pedestrian is on the crossing. The same detectors are able to cancel a pedestrian phase if there is no pedestrian waiting to cross. Francher et al (ref. 9) suggests flashing warning lights on mid-block pedestrian crossing signs that are triggered by detecting a pedestrian on or approaching the crossing.

Gowda and Meadors (ref. 10) suggest that visually impaired pedestrians could be helped by portable ITS equipment incorporating GPS and a topographical map, and a cellular phone for communication with a Traffic Management Centre. Developments since the 1960s of acoustic devices to warn blind pedestrians of obstacles have not proved useful. The main problem for a visually impaired pedestrian appears to be the complex one of spatial location and route finding, rather than detecting and avoiding local obstacles. Equipment has been developed in USA that links GPS, a digital map and voice synthesis to provide location and route guidance.

Another class of ITS equipment for visually impaired people is talking signs at points such as bus stops, ticket dispensers, barriers and escalators. These are detected by hand-held receivers and are being used in subway stations and transit terminals. The European TIDE Project OPEN is using them to help visually impaired people to find their way in the underground systems of London and Paris, and they are also being used at a station in San Francisco. They have the potential to be used generally in urban streets to provide location, guidance and warnings.

4. CANADIAN ACTIVITIES IN THE AREA OF ITS AND ACCESSIBLE TRANSPORT

4.1 The National Inventory of IVHS programs

The National Inventory of IVHS programs and related activities in Canada (ref. 11) includes about 17 projects that have the potential to increase the accessibility of transport systems (Table 3). These cover the provision of information to transit passengers, the broadcasting of transit information, dispatching systems for taxi and paratransit services, a system for communication between taxi drivers and passengers, smart payment cards, information systems for drivers, in-vehicle visual message display and audio announcements, vehicle location and an emergency alert system. Projects that provide information or services that would assist elderly and disabled travellers have been included, even if the project description does not specifically identify this market. Projects aimed at providing essential basic services, such as digital maps, have been excluded. Inevitably the identification of projects is somewhat arbitrary, and it is likely that additional projects have started since December 1994.

TABLE 3
Projects listed in the national inventory of IVHS activities in Canada that have the potential to increase the mobility of elderly and disabled travellers

Project ID	Title	Description	Responsible organizations	Project type
33	Saskatchewan real-time dispatch system "TransView"	Real time dispatch system for small to medium services using GPS, 2-way data coms and central software	International Road Dynamics Inc. TDC	Full-scale application
37	Portable public transport data display	Pocket sized real-time display unit which communicates to users of public transport	Transcom International Manitoba Dept Industry, Trade & Tourism	Models development
38	Real-time transit data broadcast	Test broadcast of real-time transit data on FM subcarrier	Transcom International Manitoba IT&T; TRB	Field test prototype
60	Met.Toronto transport data processing system	Real time data collection, processing and dissemination - info on traffic and transit conditions	Ministry of Transport, Ontario Teleride Sage Ltd	Field trial
65	Universal public transport card	Feasibility of a contactless fare payment/validation card	Ministry of Transport, Ontario	R & D, standards
102	Cabmate	Computerized taxi and black car dispatching system	Gandalf Mobile Systems Inc.	Full scale application
108	Smart fare payment and data collection	Fare payment system using smart cards and ID cards (Ajax Transit)	Precursor Ltd; Ministry of Transport, Ontario; Ajax Transit; Burlington Transit, ON	Full scale application
109	ATIS for use in accessible taxis	Communication between taxi driver and passengers with hearing/ speaking problems	Rutenberg Design Inc. TDC	Feasibility study
111	Metro Toronto information production system (MTIPS)	Real time traffic and transit data acquisition, processing and dissemination system to support Travel Guide	Teleride Sage Ltd Ministry of Transport, Ontario	Field trial
112	Travel Guide	Demonstrate feasibility of hand-held vehicle navigation device	Teranet Land Info Services Inc. Navigation Technologies Inc.	Field trial
115	Advanced traveller information system	Studies of ATIS to include multiple trips	A M Kahn, Carleton University NSERC Research Grant	R & D studies
205	Visual communication network in Montreal Metro	System installed on 3 lines to make automatic announcements of station stops (Montreal Metro)	Télécité Inc.	Full scale application
214	Vehicle location and data transmission system for 300 buses	Design AVL and system to transmit data to two control centres for a fleet of more than 300 buses	Genitec Télécommunications Inc. STRSM	Full scale application
225	Vehicle location system	Unit containing GPS plus cellular com system and/or VHF, UHF	S2RK Advanced Technology Inc.	Full scale application
228	Design of vocal and visual comm system on board buses and metros	Signs and announcements of upcoming stations and stops. Signs at main transfer points	Société de transport de la CUM	Feasibility study
233	Visual Communication Network on board buses	Apply to buses VCN used in Montreal Metro	Société de transport de l'Outaouis; Télécité Inc.	Field trial
234	On bus computer fare collection system	Smartcard for fare management system and data collection	Société de transport de l'Outaouis	Full scale application

4.2 TDC activities related to ITS and accessible transport

TDC has a continuing research and development program on accessible transportation. This focuses on the adaptation of the Canadian transportation system to the needs of elderly and disabled travellers. It covers access to all modes of transportation and also safety considerations, travel planning information, and communication and orientation in terminals and vehicles.

The TDC Transportation Accessibility R & D program for 1995 includes projects on transit buses, charter coaches, taxis, air transport, car drivers, wheelchair security and payment cards. Several of these projects specifically include ITS. These are summarized in Table 4, together with projects that have started since the 1995 program was agreed.

Details of five of these projects are provided in Appendix A. In addition to the projects listed in Table 4, TDC has expertise on ITS for many other applications and, through its participation in the work of ITS Canada and ITS America, keeps in touch with development work on ITS in North America. Current TDC projects include demonstrating the application of ITS to the automatic clearance of heavy goods vehicles through Canada-US border crossings, implementing a system to automate the management of taxis and limousines at a major airport, and developing International Traveller Information Interchange Standards. These provide a good base of expertise from which to examine the application of ITS to travel by elderly and disabled people.

TABLE 4
Transportation Development Centre projects on ITS and accessible transport

Title	Objective	Description	Contractor
Taxi meter	Complete development, test and demonstrate an easy-view, "talking" taxi meter	An existing prototype of a easily read, talking, display slave unit to taxi meter was put in production.	Record Electronics Inc.
Intelligent transit bus system	To adapt the existing Visual Communication Network for subway cars to transit buses	Develop VCN linked to GPS for AVL and control communications for fleet management	Télécité Inc. (same as project 233, Table 3)
Mag-card payment	Complete development, test and demonstrate an automated fare payment system for paratransit and taxis (Burlington Transit)	An existing prototype magnetic card payment system is being enhanced and taken to production	Precursor Ltd (similar to project 108, Table 3)
HandyLINE demonstration	To improve special transit services through application of computerized telephone information systems	Developed HandyLINE automated telephone info system that uses touch tone and computer generated voice for access to data	BC Transit; Oracle Communications Inc
HandyQ	To automate paratransit trip request/ booking/ vehicle assignment for demonstration at Calgary Handi-Bus	Saves staff costs by providing client access to the Trapeze scheduling software without need for human agents	Oracle Communications Inc; Trapeze Software Inc; Calgary Handi-Bus
TransView smart scheduler	To develop and demonstrate smart enhancements to the TransView paratransit scheduling and dispatching system	The smart system will allow the paratransit service to be automatically rescheduled daily or as required. Uses AVL data from GPS and transmits via data radio.	IRD Inc. Saskatoon Transit; Saskatchewan Abilities Council (similar to project 33, Table 3)
Translaid demonstration	To develop a communication system to simplify check-in for travellers with hearing, speech or visual impairments, or language difficulties.	Translaid allows the user to conduct audio-visual dialogue with the ticket agent in eight languages. Covers ticketing, flight info, baggage and seating.	Rutenberg Design Inc. and ON/Q Corporation
Info-Centre	To develop a prototype information kiosk for test and demonstration at Dorval Airport	The info-kiosk provides information to all travellers, including hearing, speech and vision impaired	Rutenberg Design Inc. and ON/Q Corporation

Currently, TDC also has two projects to explore the potential for applying ITS to meet the needs of elderly and disabled travellers. There is also one project on in flight communications for hearing impaired passengers. This is not discussed further, as it does not relate to road transport.

5. CANADIAN EXPERTISE IN THE AREA OF ITS AND ACCESSIBLE TRANSPORT

In Canada, expertise in accessible transport is available in Transportation Development Centre, a number of consultants who have worked regularly on accessibility projects for TDC, provincial ministries of transport, several transport operators and a number of industrial companies which can provide manufacturing, engineering design and ergonomic skills. There has been little involvement of academic organizations in the topic. This expertise has developed as a result of the long-term research program on accessible transportation that has been planned and managed by TDC on behalf of Transport Canada. Expertise in ITS is more widely spread. Expertise on the combined topics of accessibility and ITS is limited to a few officers at TDC, the Ministry of Transport, Ontario and several manufacturers and consultants. In Table 3 the only university based project is item 115 by Mr A M Khan of Carlton University. Appendix C lists contacts in Canada related to ITS and accessibility.

The accessible transport program of TDC has involved working with consultants, transport operators, provincial governments and industry to develop accessible vehicles and equipment to assist accessibility. These products have been subject to extensive ergonomic evaluation and testing during field trials and demonstration services. People with disabilities have been involved in the research projects from their initial definition, through the tests and service demonstrations to the final reporting and dissemination of results. From this experience over many years has evolved knowledge of the needs and problems of disabled travellers and of the technical solutions likely to be appropriate, together with contacts in the disabled community, in industry and among transport operators. This range of contacts and depth of knowledge is a necessary requirement for progress in this field.

Of the ITS technologies that are likely to be of particular assistance to elderly and disabled people, Canada has particular expertise in the fields of telecommunications, navigation technologies and software, including routing software. Development by TDC and its contractors has tended to concentrate on the areas of ATIS and paratransit dispatching. The ATIS systems have included pre-trip information, information kiosks, communications during check-in or when contacting a paratransit service, and real-time information. The design of these products has been developed on the basis of ergonomic testing. Two paratransit dispatching systems have been developed, Trapeze QV by Trapeze Software Inc. for Ministry of Transport, Ontario and TransView by IRD Inc. for TDC.

The range of ITS projects listed in the National Inventory of IVHS programs is extensive and largely covers the topics required for accessible transportation. It appears to be somewhat weak on projects for the display of real time public transport information at bus stops and transit terminals, and on the platforms of Metro systems, probably because of the widespread existing telephone information services. Smart payment cards are reasonably represented in the inventory. An interesting area is the broadcasting of real time transit and traffic information to portable and home-based terminals; three manufacturers are listed as active on two projects, but in fact both have been stopped by lack of funding. There is recognition of the potential value of hand-held data storage units, such as personal organizers, as providers of specialized information for elderly and disabled people. Proposals to develop units of this type, such as one put forward by Parviainen & Associates in 1995, have not been successful in attracting funding.

6. CANADIAN AND INTERNATIONAL MARKETS

Hickling Corporation has developed market estimates of ITS for seniors and people with disabilities (ref. 12). This identified the numbers of seniors and people with disabilities for whom particular types of ITS would be applicable. It showed that ATIS would be relevant to 59 million people with disabilities and 18 million seniors in North America. ITS to assist car drivers would be relevant to 18 - 23 million seniors and 7 - 40 million people with disabilities, depending on the system. APTS would apply to about 9 million people with disabilities and 18 million other seniors, but systems related to specialized paratransit services would only apply to about 1 million people. This report did not estimate the actual market for ITS among seniors and people with disabilities, only the number of people to whom ITS might be relevant. The European DRIVE II project EDDIT established that elderly drivers would be willing to pay reasonable prices for ITS equipment that helped them drive more easily and more safely.

The IVHS America Strategic Plan (ref. 13) estimated the expenditure on ITS deployment over a 20 year period as shown in Table 5. However, the readiness of consumers to purchase advanced travel information is currently being debated (ref. 14).

TABLE 5
Distribution of 20-year ITS deployment expenditure, millions of dollars (US)

ITS sub-system	Public sector costs	Consumer costs	Total
ATMS	24,941	0	24,941
ATIS	1,996	102,362	104,358
AVCSS	4,320	46,250	50,570
CVO	4,986	21,775	26,761
APTS	2,855	0	2,855
Planning and engineering	340	0	340
Total	39,438	170,387	209,825

The biggest market of ITS systems for elderly and disabled people is likely to be for equipment developed for the general population, that happens to be appropriate for elderly travellers and, particularly, for elderly drivers. Given that people with disabilities now account for some 2.1 million drivers of personal vehicles in Canada (about 11 percent of all drivers), it is likely that people with disabilities are likely to provide at least 10 percent of the market for ITS equipment for use in private vehicles. In the USA, 13 percent of all drivers are aged 65 or over. These percentages would imply that the market for ITS equipment for elderly and disabled travellers will be about $17 billion (US) over a 20 year period. Since the percentage of drivers who are elderly or disabled will increase as the population ages, it is likely that this sector of the market for ITS equipment will in reality be larger than $17 billion (US).

Much of the equipment for supplying information to transit passengers in USA is being installed to serve elderly and disabled people as a result of the Americans with Disabilities Act. This equipment is included in the total for APTS in Table 5.

European experience is showing that there is a market for systems to display real-time transit information. This market is not as large as the markets for traffic management systems and ATIS for car drivers, but is significant. Transit information is of value to all travellers, but possibly of greater value to elderly and disabled travellers. Pressure from this group may well lead to the introduction of more general information displays.

It may well prove to be difficult to make commercially viable products that are intended specifically for elderly and disabled people. It is relatively easy to ensure that equipment intended for the whole population is suitable for elderly and disabled people, but this group must be considered from the start of the development of a new product.

7. NICHE MARKETS FOR CANADA TO PURSUE

It is possible that there are specialized ITS products designed to meet the needs of elderly and disabled people which could be regarded as niche markets for Canada to exploit. Niche markets are likely to be for products which satisfy the following criteria:

- Canada has the technical expertise to develop the product
- Canada has the industrial strength to manufacture and market the product
- There is a Canadian market for the product
- There are few or no competitive products.

Markets in Canada, northern USA and northern Europe may be relatively easy to exploit for equipment that is designed to overcome problems caused by the extreme winter climate.

Areas where Canada has technical and industrial strength include telecommunications and communications in general between vehicles, road-side, control centres and passengers. Canada has considerable experience of communication equipment that is easier to use for people with impaired hearing, speech or vision. Canada has links with US manufacturers of hand-held data storage and display units, which have considerable potential for application to the special needs of elderly and disabled people and have been proposed for this role by Parviainen & Associates.

TDC does not know of any existing Canadian systems that broadcast travel information direct to portable receivers, as is done by RDS FM radio in Europe. Three manufacturers, Transcom International Ltd, Teleride Sage Ltd and Teranet Land Information Services Inc., are listed in the National Inventry of IVHS programs (ref. 11) as being active in two project for the development of such systems. At present both projects are stalled through lack of funding, and Teranet are no longer involved. Another somewhat similar proposal, for a 'Personal Mobility Manager for elderly and disabled travellers' by Rutenberg Design Inc., has also failed to attract funding for initial development. There appears to be potential for a family of devices, starting with a hand-held data storage and display unit (similar to a personal organiser) and extending through more complex versions including some combination of telephone, real time data receiver, GPS and digitised map. These could offer 'Yellow Pages' travel and touring data, real time traffic and transit information, communications, emergency alert, location and guidance.

While there is certainly value in seeking niche markets for ITS products, the major benefit of ITS in making transport accessible will be through assistive technology for all drivers (which will be particularly useful to elderly drivers), through the progressive automation of the highway-vehicle

system, and through the provision of much better information to travellers, both by public transport and by car. These systems will be developed for all travellers, not specifically for elderly and disabled people. The development of any ITS equipment needs to take account of the requirements of elderly and disabled people, since by the year 2025 they will comprise more than a quarter of the total population and perhaps twenty percent of all drivers, and provide a corresponding percentage of the market for ITS equipment. As well as drivers of private vehicles, ITS has the potential to help public transport users and pedestrians.

The following list of development activities and products covers the things that need to be done to make ITS useful for elderly and disabled people, and to overcome problems experienced by many people. The products could well provide niche markets for Canada to exploit.

General

1. **Make the ergonomic evaluation of any ITS equipment used by the public a routine part of the design process.** Include elderly and disabled drivers and travellers in these assessments (by 2025 these groups will make up about 25% of the market for ITS equipment).

2. **Develop ergonomic guidelines for the design of ITS equipment to be suitable for elderly and disabled people.** This should be done co-operatively by ITS Canada, ITS America, ERTICO and VERTIS in liaison with committees on international standards. ITS Canada could well lead this co-operation, because Canada has a strong ergonomic skill base and is independent in relation to the major vehicle and equipment manufacturers. Standards have been drafted in Europe by CEN TC278 for many technical aspects of ITS. Work on general human factors aspects of ITS is in progress in CEN TC278/WG 10, ISO TC204 and ISO TC22/WG8. It seems likely that it will take some years for these bodies to produce guidance for industry. For this reason, quickly produced guidelines specifically relating to elderly and disabled users, which are needed now, would help to make ITS equipment easier to use.

3. **Develop a family of hand-held information storage and display equipment.** This range could start with a personal organiser/electronic yellow pages carrying travel and touring information (special accessible information for elderly and disabled people); more complicated versions could include some combination of telephone, receiver for real-time data, GPS and digital map. These could provide real time traffic and transit information, communications, emergency alert, location and guidance.

4. **Introduce to North America the British Royal National Institute for the Blind contactless 'React' transponder to activate various types of equipment, including making video displays talk when required.** An example could be a modification to information display systems in transport terminals and possibly at bus stops to trigger audio announcements from visual information displays or to change the size of the text displayed when required by a person with impaired vision. This is targeted specifically at the elderly and disabled population and therefore would be expected to have a smaller market. However, similar technology has many applications such as controlling access to private car parks or secure buildings.

Car drivers

5. **Set up, in co-operation with the USA, long-term trials of the use of ITS by elderly drivers.** Fit out a number of cars with ITS and vision enhancement equipment now available and find out how elderly drivers use this over a period of, say, a year. Note ergonomic problems and the effect of the equipment on where and when elderly people drive (and possible on safety - reports of near misses, for example). The equipment could include route guidance, traffic information, rear obstacle detection, emergency alert (mayday) and UV-Lights (which Volvo should have in production soon). A European project, TELSCAN, for the fourth framework research program is intended to conduct a trial of this type in Europe.

6. **A system to broadcast map corrections direct to a vehicle's navigation system, at least at the beginning of a day's driving and possibly on a continuous basis to reflect accidents and incidents.** One problem with navigation systems that has already been observed in Europe is the difficulty of keeping the system map updated with changes to the road network, let alone day-by-day changes when roads are closed for maintenance or other purposes. Dynamic route guidance systems take account of traffic and delays in selecting routes, but involve much more computing than do conventional guidance systems. This has caused development problems.

   The market for this system would only develop when in-vehicle navigation systems are in widespread use. It would also depend on the supply of information about changes to the road system. By the time navigation systems are in widespread use, it is likely that large urban areas and inter-urban highways will be equipped with ITS to automatically record disruption to traffic caused by accidents and incidents. These could be the source of information on short-term changes to the road system.

Public transport users

7. **Extend smart payment cards** to make a single card cover public transport operators in many towns plus railways and public telephones (as is done already by the German Association of Public Transport Operators VDV). This could be further extended to include air travel and major hotel chains, and in addition carry, on a voluntary basis, information on passenger requirements (need wheelchair space, need staff assistance, prefer non-smoking room or seat, prefer to travel back to engine, etc). Cards such as those issued by airlines to frequent flyers already carry this type of information. The card would need to be able to operate as a proximity card for paying bus fares and an inserted card for use with telephones and, possibly, bank automatic machinery (ATMs).

8. **Develop equipment for a communication system between passenger and bus to help a passenger hail a Community Bus.** This is targeted specifically at the elderly and disabled population and therefore would be expected to have a smaller market. However, it could well be applicable to hailing long-distance buses, which could increase the market. No such system is known to be under development.

9. **A system that provides information on the predicted arrival times for buses at specified local bus stops, and other transit, travel and 'Yellow Pages' information, using cable to a home computer or television, the internet or broadcasts to a portable receiver.** Many transit companies provide information by telephone on the time of the next bus from a selected stop. Usually this is schedule information, but it is

now becoming possible to supply real-time information, based on bus locations. Transit information was supplied to televisions by cable as a limited demonstration in Saskatoon in the 1980s. The system that supplies real time transit information could pass it to the internet for display on a PC with, typically, updates once a minute. Netscape is developing equipment to display information from the internet on a normal household television.

10. **Look for other low cost ways to use ITS to help disabled people.** One possibility is the use of inductive loops in transit vehicles, to enable people with impaired hearing who use a hearing aid with a "T"-switch to hear announcements transmitted from the loop direct to their hearing aid, without interference from other conversations and background noise. This is a specialized application of existing technology, which is in use in telephones and at some ticket desks. Development would be needed to ensure that electrical interference did not block or distort the loop signals. Provided this application worked technically, it could provide a selling point for Canadian systems that display and announce real-time information in buses, metros and trains.

It is almost certain that further ideas for niche products will be suggested in the next few years. Where the product appears to be commercially viable, its development should be encouraged. Federal policy is generally not to become involved in the development of commercial products. In the field of specialized equipment or services for elderly and disabled people, it may well be that government assistance with development and field trials is the only way to bring new products to the market. Government assistance cannot create a market for a product that is not viable commercially, but it can overcome initial barriers that would prevent a viable product being developed.

Taking account of the requirements of elderly and disabled people means, firstly, ensuring that equipment is easy and safe to use by this group of people. This will almost certainly make it easier and safer for the whole population to use. Secondly, it means seeking ways of extending standard equipment to cover the specialized requirement of elderly and disabled people. An example would be adding an additional, optional, data base of accessible facilities to a standard hand-held data storage and display unit. Thirdly, it means seeking ways to use existing technology to perform a service specifically for elderly or disabled people. Using a contactless transducer to trigger audio announcements for a visually impaired person from a visual display of information would be a typical example.

8. CONCLUDING REMARKS

By the year 2025, 23 percent of the Canadian population will be aged 65+, 21 percent will be disabled and 12 percent will have a specific transportation disability. Disabled drivers already account for about 11 percent of all drivers, and by 2025 the proportion of drivers who are elderly or disabled will be approaching 20 percent. Elderly and disabled people form a significant part of the market for ITS equipment, probably about 25 percent of the total, and this equipment must be designed to take account of their requirements and abilities.

ITS equipment has the potential to improve the accessibility of public transport by the provision of pre-trip information and of real time information during a journey. The use of smart payment cards and, eventually, cards that provide details of traveller requirements to transport operators should also reduce barriers to travel. ITS equipment is already in use in bus transit systems to

improve service reliability and provide real time information to travellers. These ITS services should help all travellers as well as improving accessibility for people with disabilities.

ITS also has considerable potential to help pedestrians. Talking signposts, audio announcements on request from visual displays and hand-held location and guidance systems should help pedestrians with visual impairments.

The numbers of elderly and disabled car drivers will increase substantially over the next 20 years. In the near future, ITS equipment such as vision enhancement, route guidance and emergency alert has the potential to partially compensate for the physiological effects of aging and improve the safety and mobility of elderly drivers. In the longer term, developments such as intelligent cruise control, collision warning, automated lane following and, ultimately, the automatic highway, have the potential to remove most of the barriers that currently prevent elderly people continuing to drive.

The first priority is for ITS equipment to be designed to take account of the requirements of elderly and disabled people, and to include these groups in the ergonomic assessment of any ITS equipment intended for use by the public. It may well be possible to increase the market for standard ITS equipment by offering optional ways of extending its function to directly cover the specialized requirements of elderly and disabled people. Offering specialized data on accessible facilities as an optional addition to a general travel information service ("Yellow Pages") would be an example. Finally, there could be niche markets for specialized equipment intended specifically for elderly and disabled people, but there could well be difficulty in achieving commercial viability for these specialized products.

While specialized products are undoubtedly useful for elderly and disabled travellers, it is more important to ensure that mainstream ITS equipment helps these groups rather than creating new barriers for them. Long-term trials of existing ITS equipment in cars used by elderly drivers would be valuable, to examine the ergonomic design of the equipment and the ways in which it affects drivers behaviour.. As automatic control systems for automobiles become available, they should be checked for ergonomic suitability for elderly and disabled drivers. The standards organisations ISO and CEN are working on the general human factors aspects of ITS, but this will take some time to come to fruition. In the interim, ergonomic guidelines specifically relating to elderly and disabled people, based on existing information, are needed to ensure that current ITS equipment is easy for elderly and disabled people to use

Research during the 1980s established guidelines for the design of physically accessible transport services. Unless a continuing research program maintains expertise on ITS and accessibility, there is a risk that the changes to road transport, and particularly to driving, that ITS will bring over the next twenty to thirty years, could unintentionally introduce new barriers to travel rather than improve accessibility.

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APPENDIX A

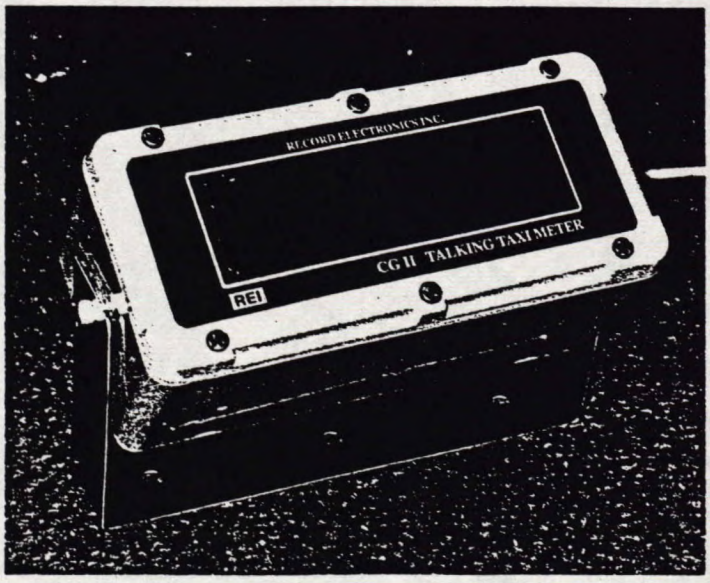
The Transportation Development Centre programme on accessible transportation

Taxi meter

Objective To undertake the final development, testing, and demonstration of an easy-view, "talking" taxi meter to assist visually and hearing impaired passengers.

Description An existing prototype of a talking (smart speaker) easily read display that functions as a slave unit to a regular taxi meter was brought to the production stage. The work included consumer and ergonomic studies.

Results Marketing to the taxi industry is under way and prospects are encouraging.



Contractor: Record Electronics Inc. (REI), Calgary, Alberta
Schedule: November 1994–March 1995

Funding: National Strategy for the Integration of Persons with Disabilities	$89 900
REI	$17 100
Total	$107 000

Project number: 8623
File number: 1450-103-111-17
Report: Fact sheet pending
TDC contact: Ling Suen

Intelligent transit bus system

Objective To adapt the Visual Communication Network (VCN), developed for use in subway cars, to transit buses.

Description The project is developing a version of the VCN that can be integrated with GPS technologies to provide the automatic vehicle location and two-way control centre communications necessary for a broad range of fleet management and data gathering functions. Such a VCN would not only make information more accessible for all passengers, but would also improve system management and productivity, cost-effectiveness, and safety.

Results Conceptual design requirements have been defined and work is proceeding on mechanical design, taking into account industrial and ergonomic considerations and human factors. The construction of an initial prototype model for installation on a demonstration bus is under way.

Contractor: Télécité inc., Montreal, Quebec
Schedule: November 1994–July 1996
Funding: TDC $120 000
Energy R&D Program $100 000
Télécité inc. $230 000
Other federal and provincial departments $300 000
Total $750 000
Project numbers: 8530, 8531
File number: 1450-103-71-5
Report: Pending
TDC contact: Trevor N. Smith

Mag-card payment

Objective To undertake the final development, testing, and demonstration of an automated fare payment system for paratransit bus and taxi services. Automating the payment of fares would eliminate the need for bills and coins for elderly and disabled passengers and streamline accounting of subsidies by public agencies.

Description The work involves taking an existing prototype of a magnetic-card fare payment system to the production stage. A number of enhancements, including voice capability and brighter, more easily-read alphanumeric displays, are being developed and tested. The work will also enhance the existing fare account data base to enable central dispatchers to monitor account status, authorize trips, record valid pending fare payments, verify payments, and record total distributed charges.

Progress to date The system is now being tested by the City of Burlington, Ontario, in its transit operations.

Contractor: Precursor Ltd., Toronto, Ontario
Schedule: December 1994–March 1996
Funding: Precursor Ltd. $25 000
National Strategy for the Integration of Persons with Disabilities $87 000
Total $112 000
Project number: 8630
File number: 1450-103-111
Report: Fact sheet pending
TDC contact: Ling Suen

HandyLine demonstration

Objective To improve the quality and cost-effectiveness of special transit services through the application of computerized telephone information systems.

Description The project developed HandyLine – a prototype automated telephone information system that uses touch-tone technology and computer-generated voice communication to allow callers to interact with a computerized data base. (The technology is based on the Integrated Transportation Information System developed by Oracle Communications Inc. of Burnaby, B.C., in earlier TDC-sponsored work.) HandyLine was implemented in Vancouver for B.C. Transit's paratransit service for disabled travellers.

Results The principal benefits to be derived from the application of an automatic telephone information system to special transit operations are functions such as trip confirmation, trip cancellation, and semi-automatic trip booking, which clients can access at their convenience.

The project recommended that more consideration be given to user-friendly ergonomic designs, to improve user acceptance of the new technology.

Contractor: BC Transit, Vancouver, British Columbia
Schedule: January 1990–December 1993
Funding: Transportation of Disabled Persons Program $182 145
BC Transit $94 000
Total $276 145
Project number: 7400
File number: 1450-103-102
Report: TP 11656E, *Evaluation of HandyLine – Vancouver's automated paratransit information system*, TransVision Consultants, 1993
Video also available in both official languages: *The HandyLine Demonstration; Le projet de démonstration HandyLine*
TDC contact: Ling Suen

Translaid demonstration

Objective To develop a communication system to simplify check-in procedures for travellers with hearing, speech, or visual impairments, or with language difficulties.

Description Translaid, a communication system for transportation terminals, allows the user to conduct an audio-visual dialogue with the ticket agent, who controls the communication via a conventional computer. The dialogue can be conducted in eight languages and covers ticketing, flight information, baggage handling, and seating. In this project the system was refined, and both hardware and software were modified, following a human factors study to determine the ergonomic, technical, and operational requirements.

Results Now ready for the marketplace, Translaid was recently installed at Canadian Airlines' check-in counter in Terminal 3 at Toronto's Pearson International Airport. The feedback from check-in agents and international travellers is being monitored to determine whether the system could be further improved.

U.S. Air, United Airlines, and other carriers have expressed interest in the system, and are awaiting the results of the Canadian Airlines demonstration.

Contractors: Rutenberg Design Inc., Kanata, Ontario
On/Q Corporation, Montreal, Quebec

Schedule: March 1994–January 1995

Funding:

National Strategy for the Integration of Persons with Disabilities	$75 000
On/Q Corporation	$20 000
Total	$95 000

Project number: 8467
File number: 1450-103-44-4
Report: Fact sheet available
TDC contact: Ling Suen

APPENDIX B
Bibliography of Canadian publications on Intelligent Transportation Systems and accessible transport

Publications before 1991

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Publications dated 1992

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APPENDIX C
Names and addresses of Canadian persons and organisations with expertise relating to ITS and accessible transportation

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Talking easy view taxi meter
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Translaid - translation & communication device and Info Centre communication kiosk
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Transporter - personal receiver for real-time bus arrival information at stops
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