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Barriers to Use of Transportation Alternatives by People with Disabilities

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16. Abstract

Implications of Americans with Disabilities Act of 1990 with regard to use of public transit and paratransit by people with disabilities are discussed in terms of physical, psychological, and communication barriers. Recent trends in amelioration of those barriers are described. A survey of several selected transit organizations who have been identified as innovative in their approach to removing barriers to access and use were surveyed by telephone and their experiences summarized. Technology to address physical and communications barriers is discussed with regard to ingress and egress from vehicles, securement of mobility aids, information transfer to sensory and cognitively disabled riders, and operational communications. Major findings are that physical barriers are being overcome, but initial resistance to even considering public transit remains. Not much was found to help those with cognitive disabilities use transit, except for some good training programs. Lifts have much improved through standards activities, but wheelchair restraints remain cumbersome and hard to use unless dedicated fittings on mobility aids are available. Occupant protection for those riding on their mobility aid remains controversial. A simple idea much underused is announcing stops and other route guidance information, and some gains have been made via GPS technology and computerization to automate this function.

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Executive Summary

Overview of the Americans with Disabilities Act

The Americans with Disabilities Act (ADA), passed in July 1990, was designed to eliminate discrimination against persons with disabilities in areas such as employment, public services, telecommunications and transportation.

In response to the passage of the ADA, transit providers have sought to improve their basic service operations, enhance existing services and develop innovative approaches for better serving customers with disabilities. The ADA requires transit agencies to provide equivalent and/or alternative services to persons with mobility, cognitive or sensory impairments. Indeed, when the ADA was passed, there were 43 million Americans with one or more disabilities; and it is anticipated that the number will grow as our population ages.

The obstacles facing the person with a disability who is seeking to use public transportation include the less obvious psychological barriers to independent transit use in addition to the physical barriers which more readily come to mind.

The ADA fundamentally changed the relationship between traditional fixed-route service and paratransit service. Traditional (or "conventional") mass transit service refers to fixed-route, fixed-schedule service. That is, the transit vehicle travels a route and schedule established by the transportation agency. Customers are picked up and dropped off at predesignated locations along the route at specified times.

Paratransit, on the other hand, is best characterized as a demand-responsive system (or, dial-a-ride). General public paratransit services are open to all riders, but such services are dwindling. Such services, where they exist, are not subject to the constraints and requirements affecting the ADA-mandated paratransit. According to the ADA, paratransit is no longer considered a substitute for accessible fixed-route service--rather, both are required. The ADA requires transit operators to provide complementary paratransit services that "shadow" all of the fixed-route systems.

Who Will Use Alternative Transportation?

Passage of the ADA also changed the way in which individuals are determined eligible for public paratransit service. Eligibility for paratransit under the ADA is not based solely on the existence of the applicant's disability. Rather, it will be based on the person's functional ability to use the fixed-route transit system once it is fully accessible.

Three issues must be considered in establishing an ADA-eligible disability:

(1) What is the nature of the disability and its severity?

(2) How long will it last?

(3) What is its permanent or long-term impact?

Fixed-route public transit would not be suitable for persons with disabilities that limited major life activities necessary for using such a system, even if it were "fully accessible" under ADA. The rank order of impairments most often cited under ADA (i.e., complaints about lack of access for a particular type of impairment) from most frequent to rare is :

- Back
- Neurological
- Emotional/Psychiatric
- Extremities (mostly amputation)
- Heart Disease
- Diabetes
- Hearing
- Vision
- Blood Disorders (including AIDS)
- Cancer
- Asthma

The impairments most likely to require paratransit service in order to provide reasonable accommodation are those which limit or preclude either traveling from a point of origin to the nearest stop on the fixed-route system and/or climbing inside the bus once at the stop. Thus most people who use either a manual wheelchair or a motorized chair or scooter would not need paratransit, although there may be obstacles between the stop and the person's point of origin that cannot be overcome or detoured around.

Barriers to the Use of Alternative Transportation Modes

Physical Barriers

The physical barriers to public transportation that most readily come to mind include such architectural obstacles as stairs, curbs, and doorways. However, in a broader sense, any feature of a mode of transportation which prevents a person from getting to accessible transportation, boarding the vehicle, riding in a safe and comfortable environment, and alighting from the vehicle at the appropriate time and place might be considered a physical barrier to travel.

Security concerns. Fear of crime and concern for safety appear to be key elements in the public's decision to use public transit. Although a given individual's fear of crime may be an exaggerated psychological barrier to public transit use, there are features of the physical environment that are basic to the perception of security for all passengers using public transportation. The visibility of protection efforts such as uniformed patrols, surveillance cameras, good lighting and facility design, as well as the proper maintenance of vehicles and facilities, are but a few of the measures that help to maximize transit security for all travelers.

Safety concerns. The capacity to alert customers to potential hazards in the physical environment is also essential to safe travel. Detectable warnings are standardized surface features applied to walking surfaces that may be helpful in warning visually impaired people of hazards in their line of travel. In a similar fashion, visual warnings may be used to alert hearing impaired persons of potential hazards, and prompt them to seek information or assistance while traveling.

Psychological Barriers

Obviously, there are other factors that may determine whether people with a mobility impairment will become mobile once accessible transportation is offered. These other barriers to the use of transportation may encompass a variety of personal, psychological, and social factors that limit the use of public transportation by some persons who would be classified as "able-bodied" as well as those persons with recognized disabilities. Some of these barriers are:

1. Fear of attack.
2. Fear of falling down.
3. Fear of becoming exhausted.
4. Fear of being stranded.
5. Fear of new ideas and/or new environments.
6. Fear of not being able to successfully complete a journey.
7. Fear of public places.
8. Fear of losing control.

Others especially associated with people with disabilities are:

1. Stigmatization as "disabled."
2. Lack of the social network and knowledge of places to go, what services may be offered, etc.
3. Failure to comply with social mores and proper conduct.
4. Lack of confidence in one's own physical, mental and emotional resources.
5. Inability to deal with the unexpected.

For the traveler who is emotionally disturbed or cognitively disabled, these barriers cannot be readily addressed with additional funding or changes in vehicle and facility design.

Barriers to Information Exchange

Barriers to the exchange of information was included as a separate category because the difficulties experienced by travelers who are disabled may result from any one, or a combination of, physical (or, sensory) deficits and cognitive deficits that prevent them from navigating to the intended destination. Access to usable information, sometimes characterized as an invisible barrier to independent travel.

The more obvious barriers result from hearing or vision impairments. In response to the need for technologies to overcome these obstacles, automated information and communication systems have been developed to enable or enhance communication with persons with disabilities. Techniques and devices to assist persons who are deaf and those with other hearing impairments typically rely on the use of visual information and technical devices that enhance the ability to hear. On the other hand, techniques for assisting persons who are blind or have low visual ability typically include devices that provide information verbally.

Although numerous technologies and policies have been developed to address the needs of persons with visual or hearing impairments, much less assistance is available to persons with cognitive disabilities. Cognitive impairments may include emotional disabilities, mental retardation, learning disabilities, brain injury, and other intellectual capacity limitations.

Recent Developments in Transportation for People with Disabilities

Engineering Alternatives

Under ADA regulations, buses (and many vans) operated by a public transportation authority to be considered in compliance will have a lift or deployable ramp of some design. The lift or ramp must also be able to accommodate ambulatory people who cannot use the customary able-bodied entrance to the vehicle. The vehicle will also have to have at least one or (for vehicles over 22 feet in length) two accessible locations designed for wheelchair or mobility aid

securement. The securement system (either automatic or attendant-attached) must restrain the mobility aid in such a way that any rider faces either forward or rearward, secured with a seatbelt occupant protection system. Somewhat paradoxically, if a mobility user elects to transfer to a conventional bus seat, there are no requirements under ADA for him or her to be provided with a seatbelt.

There are some new and emerging technologies to assist people with disabilities to access public transit or paratransit. Trip planning for people with sensory disabilities include tactile mapping, telecommunications devices, amplified telephones, faxes. Much of the time, one of the real challenges is in coordination of various agencies to implement "smart traveler" technologies. Identification of, and access to bus stops can be enhanced by providing "tactile paths," speech information equipment, and automatically triggered sound devices. Radio operated "verbal landmark systems," somewhat like the electronic tours being offered at some museums, are also in various stages of planning. Talking buses are now being proposed, they would work just like the automated tramway systems at Dallas-Ft Worth Airport and other similar facilities.

A real "sleeper" in engineering considerations is fare collection. Many of the present systems can be difficult for some kinds of disabilities, both physical (lack of dexterity in handling change or tokens) and mental. Off-vehicle fare collection by far is the most preferred by people with disabilities. These collection approaches vary from pre-payment passes to credit cards (read before and after the trip) to "smart cards."

Routing Alternatives

There are a variety of non-traditional routing options designed to increase transit ridership while holding down transit costs. These transit options may be grouped into three major categories:

1. route deviation services;
2. service routes (or, community buses); and
3. general public demand-responsive systems (also known as "paratransit" or "dial-a-ride" services).

Route Deviation Services

Using the fixed-route scheduled service as its basis, a route deviation service will deviate from the fixed route to pick up and drop off passengers upon request. After accommodating the request, the vehicle returns to the fixed route at the point at which it deviated.

Service Routes

Service routes (also known as community bus services) are designed to bring fixed-route buses as close as possible to the residences and destinations of the target population of users, thereby minimizing the walking distance for these individuals.

Paratransit Service

Paratransit is a complementary service that is provided whenever the existing fixed-route service is unable to, or not appropriate to, meet a customer's needs. Transit agencies may use accessible on-call services to satisfy the requirements set forth in the ADA. These services are typically viewed by transit agencies as short-term solutions as accessible buses replace conventional fixed-route vehicles.

Transfer to Other Systems or Modes

Even though a transit system may provide good service within its catchment area, often little or no consideration is given to transfer to another system or even transportation from the bus stop to the ultimate destination, except in long-established "transit regions" such as the Chicago area.

Enhanced Information Exchange and Communication Systems

Assisting Persons with Hearing Impairments

The techniques and devices developed for assisting hearing-impaired travelers include hearing-aid-compatible/amplified telephones, automated speech recognition, electronic information signs, and other assistant listening devices.

Automated speech recognition systems are being developed with computers that convert spoken words into text for presentation to persons who are deaf. Correspondingly, persons who are incapable of speech as a result of deafness can use computer keyboards to request information or respond to computer-generated text.

Electronic information signs are one of the most extensively utilized forms of alternative communication presently in use. Electronic readerboards can convey information and announcements to all sighted passengers, and are the best means of providing infrequent verbal information such as train delay.

Assisting the Visually Impaired Traveler

Technologies useful in transit to assist persons who are visually impaired include talking bus/train stops, talking signs, talking buses and trains, auditory pathways, and auditory maps.

Boxes mounted at bus or train stops may be used to announce route numbers and timetable information for visually impaired travelers at the touch of a button. Talking signs emit infrared signals that can be converted to audible information using a pocket-sized unit carried by individual travelers. The audible information is provided only when the unit is signalled, and directional infrared signals serve to guide the visually impaired customer to the sign.

Auditory maps and auditory pathways are recently emerging technologies that will also be useful for persons with impaired vision. Auditory maps are typically recorded on cassette tapes, and may be used to describe specific pathways, general neighborhood features, and other information about the transit system.

Tactile maps consist of a combination of Braille, raised symbols, and large print to transform printed maps into useful tools for the visually impaired. An audio signal may be used to indicate the location of the tactile map, and different textures are used to signal features of the environment. In addition, devices such as the Mowat Sensor, the Laser Cane, and the Soniguide have been developed to detect objects in the environment and provide information regarding surface texture and density.

Assistance for the Cognitively Challenged Transit User

In order to be of full service to all passengers, transit agencies must design materials such as maps, brochures, timetables, and other forms of information to be as straightforward and readily understandable as possible. In one survey, it was reported that 44 percent of the respondents had difficulty in understanding bus timetables, although only 3.4 percent of the population have learning disabilities.

Training and individual attention are essential to helping all customers feel confident and comfortable using public transportation. In addition, specialized mobility training can effectively shift moderately transportation handicapped travelers, such as mentally retarded persons, from paratransit to fixed-route services.

Travel training and facilitated travel. Travel training is a support service offered by some fixed-route or paratransit services that teaches people with disabilities the skills and confidence needed to use public transportation effectively. Facilitated travel provides for a travel monitor or companion (sometimes referred to as a "bus buddy") who accompanies the person with a disability along the travel route.

Community training. For persons with moderate to severe handicaps, community training has become an increasingly important part of their educational program. Through training conducted in simulated and *in vivo* conditions, students are taught to cross streets safely and to use public transportation.

Support Services and Promotional Programs

Service Enhancements

The service enhancements outlined below include suggestions for making transit travel more appealing for everyone. The prospect of traveling by public transportation appears complex and unpredictable to many potential users. In the past, systems have ignored the interests of special groups such as senior citizens, foreigners, illiterate persons, or people who are otherwise disabled. However, in their efforts to correct this situation, transit providers must be careful not to add another layer of complexity to the user's experience.

Trip Planning Services. Trip planning services provide a more personalized service in assisting customers with developing an itinerary for a desired trip (TRB, 1995). If a particular journey on a fixed-route system would be difficult or impossible given an individual's disability, trip planning services can provide information about alternative modes of travel, the availability of paratransit services, and alternative routes of travel.

Fare simplification. Fare simplification mechanisms include such things as vouchers, ID cards, transit passes, and other methods used by transit systems to simplifying the paying and collection of fares for travel.

Destination card programs. Destination card programs are an enhancement of fixed-route services that permit passengers to alert vehicle operators to their need for assistance. Destination cards are small forms filled out by riders or persons assisting riders, and contain information about the person's specific disability as well as information about the passenger's desired destination.

Smart maps. Computer-aided traveler information systems could be used to provide information tailored to diverse users and their specific needs. Recognizing the need for information presented in the form of spatial relationships (or, cognitive maps) and procedural instructions, it is suggested that the development of "smart maps" to convey information through customized route planning, auditory maps, and visual simulation.

Promotional Programs

Marketing programs may include information dissemination and other promotional efforts designed to increase ridership by persons who otherwise may be unaware of the availability of the services, or who are hesitant to use them because of a negative image. One group of potential users who are most likely to benefit from promotional efforts are senior citizens. When addressing the needs of a senior citizen population, not only the person's chronological age, but "cognitive age" and "life-style" choices must be considered. Promotion may be a key factor in recruiting riders among this group. Marketing efforts should emphasize independence, reliability, safety, and the variety of destinations offered by the transit service.

SURVEY OF SELECTED TRANSIT FACILITIES

A limited search of WEB sites and other resources turned up a number of transit operations that either have done or are doing seemingly innovative things in transportation of people with disabilities. Although some operations for one reason or another were unable to help us, we found six that were very willing to share their ideas with us.

The interview began by giving a brief description of the study and who is sponsoring it. The researcher then asked for general information, such as contact's position, telephone and fax number, email and general statistics on ridership. They were given information on the three types of barriers the study was interested in and asked what their organization did to combat these barriers.

Summary of Results

Physical barriers deal with inaccessibility, such as, steep steps, improper securements, inoperative equipment and unavailability of ramps. When asked for innovative ideas on removing this barrier, we received the following answers:

- Tulsa Transit deploys the lift for walk-ons who have a hard time climbing steps as well as, wheelchair users.
- SCAT contacts the tri county independent living center to report problems with accessibility to buildings. They also have wider lifts than required: 30 by 51.
- VIA coordinates a door to door service for paratransit and a training program to help passengers move from paratransit to fixed route transit. They also are involved with bus stop and infrastructure improvements.
- RTA equips their buses with a front hydraulic system that lowers the bus for easier access to the steps. All buses are equipped with lifts and they improve their transfer centers to be more accessible, i.e. having stops on both sides of the street so passengers don't have to cross busy intersections.
- Metro Transit contracts with the University of Oklahoma for improvement studies and has a well organized cooperation with the city to handle problems with accessibility. They work with the city to create curb cuts, ramps, and automatic doors at most public buildings.
- DART offers driver assistance with boarding on their fixed route and offers door to door service with package assistance for their paratransit riders.

Some "lessons learned" include initial work with building contractors for better access and wheelchair manufacturers for designs that better fit the lifts.

The second barrier is the *psychological barrier* which includes such things as fear of lifts or being stranded, trip lengths and attitudes of the drivers. The responses we received for combating this barrier are as follows:

- Tulsa Transit coordinates passenger training seminars designed to help familiarize the passenger with the routes and equipment.

- SCAT requires that drivers have disability awareness training. They also have training programs for the passengers. They allow people to come and examine the lifts so as to better familiarize themselves with it.

- VIA feels the best way to help break this barrier is to provide extensive training for the drivers. They want the drivers to be sensitive to the needs of disabled people. In doing so the drivers can calm any fears a passenger might have.

- RTA provides training not only for the passengers, but for the professionals who care for the passengers. This allows for another source of information and reassurance for the passengers.

- Metro Transit conducts periodic evaluations of drivers and sits in on routes to make new passengers comfortable and to answer any questions. They have a coordinator who will put new passengers on a route with an experienced driver.

- DART offers extensive driver training. They make every effort to not leave their paratransit riders behind. If the passenger is not at the designated pick up site the driver will call to make sure they still need a ride.

Most of the organizations would say that they need more training in order to fully deal with the psychological barrier.

The last barrier discussed in the interview is the *informational barrier*. Many times people with disabilities are unaware of their transit options. All the interviewees agreed that advertisement is the best way to let consumers know what is offered. Some of the ways this is achieved include:

- Newsletters and newspaper ads

- Customer hotlines offered in English and Spanish with rely service for the hearing impaired

- Presentations and brochures explaining services and equipment
- Advanced announcement of next stop
- Phone numbers printed on the sides of buses and vans
- Provide remote service locations for easier access

The interview was concluded by asking if there were any other remarks or comments in general about accommodating the disabled. The interviewees had nothing more to add, but were very helpful and friendly.

TECHNOLOGY TO REMOVE BARRIERS

Technology to remove barriers in the physical and psychological domains has advanced slowly through the years, but the pace has quickened with the advent of ADA. The major areas for technology development are:

- Ingress and egress from transit vehicles
- Securement of mobility aids and occupant protection
- Information transfer to those who are sensorily or cognitively disabled concerning route guidance, stop information, fare collection, and other operations
- Communications to improve scheduling and pickup/dropoff

Mobility Aid Lifts

There are two basic types: the platform lift and the rotary lift. Platform lifts in the personal vehicle market outsell rotary lifts by about a 10:1 ratio, and rotary lifts are almost unknown in transit applications. The device consists of a support structure typically installed in a doorway or special aperture in the vehicle body. The structure supports a folding platform which swings down from a vertical stowed position to a horizontal position at the level of the vehicle floor. The platform is always equipped with a *rollstop* which helps prevent the user from rolling off the platform until the platform is lowered to the ground. Operation of the lift may be electric or electrohydraulic.

In the middle to late 1970's, Texas A&M University developed the first definitive wheelchair lift standard under funding from the Veterans Administration (now the Department of

Veterans Affairs). More recently, the Society of Automotive Engineers Adaptive Devices Standards Committee has developed and published SAE J2093 and SAE J2092.

ADA *Accessibility Guidelines*, subpart 1192.23, specifies design requirements for bus and paratransit lifts which differ little from the personal lift standards and recommended practices cited above. The major differences lie in requiring handrails on each side, and complete interlock to prevent vehicle movement when the lift is deployed.

Similar language for lift requirements for rapid, light, commuter, and intercity rail cars are also found in the *Accessibility Guidelines*, but again a lift is a lift is a lift. One other requirement exists in the Guidelines that differs from specifications for personal vehicle lifts: the capability of providing ingress and egress for those people who do not use wheeled mobility aids, but require assistance in boarding or alighting. The lift must be capable of being ridden by a standee, one of the reasons for requiring a handrail on each side of the platform. Some of the newest transit vehicle designs that have been discussed on the CTAA web site have integrated lift/elevator systems built into what are otherwise stairwells. Buses are already available that are low floor and can "kneel" to provide access for a person using a mobility aid by deploying a short ramp.

The major consideration in lift design is provision for sufficient reliability and maintainability in transit operations. One of the major barriers to ingress and egress is an inoperative lift.

The platforms readily available from aftermarket manufacturers of internal lifts have dimensions of up to 32 inches wide, 51 inches long. This will accommodate almost all wheelchairs, but some of the larger scooters now on the market may not fit on such a platform. There are also externally mounted lifts which are considerably larger than internal units.

Baylor College of Medicine Wheelchair Restraint System

Baylor College of Medicine's research and development effort during the period 1994-95 was sponsored under the Transportation Research Board's IDEA Program. A team of researchers designed and tested an innovative concept for a wheelchair tiedown unit suitable for any kind of transit vehicle.

The state-of-the-art overwhelmingly is in the direction of 4-point "cargo" type straps, with or without 3-point occupant restraints or pelvic restraints. Wheelchairs often come equipped with seemingly automotive quality belts for retaining the user in the chair, but these belts are almost invariably not adequately anchored to be of much avail in a crash.

Pneumatically operated "bristles" provide the restraining force necessary to stabilize the wheelchair in the dynamic environment of a transit vehicle, without a residual force on the

wheelchair frame which could cause the chair to collapse. The design uses two stages of activation. In stage 1 the Teflon (R) bristles extend to their limit. Each bristle is independently extended by means of an inflatable bladder behind the bristle holding surface. The second stage then moves one or both of the bristle holding assemblies inboard to engage the wheelchair. During this second stage the bristles slide in and out freely to engage spokes, tubes, and other structures of the chair, forming a kind of mold of the engaged portions of the chair. When deployment and engagement is complete, the bristles lock in place by inflating elastomeric tubing placed next to the rows of bristles. The engaged "mold" is a relatively large area of containment which acts to keep stresses on the structure of the wheelchair as low as possible consistent with positive retention.

The practicality of the Baylor wheelchair tiedown was conclusively demonstrated. The device can quickly, and without modifications to the wheelchair, effectively capture the chair within one minute or less. There is no requirement for a transit vehicle operator to attach anything to the chair or even precisely align the chair for capture. The bristle mechanism prevents application of stress to even a foldable chair. Further design refinements are necessary to make the device suitable for sustaining the limit of 10 g's required for standard seating in a transit vehicle, but the design prototype came close, at least in static tests. Dynamic (crash) testing will be necessary after further design effort to verify performance of the Baylor wheelchair tiedown.

Oregon State University Securement System

This multi-phase project was performed under the auspices of the Federal transit Administration and Project ACTION of the National Easter Seal Society by Oregon State University researchers. The goal was to come up with a prototype design of a "universal" mobility aid securement system and compatible occupant restraint for use in transit vehicles.

This project involved determining state-of-the-art in wheelchair/mobility aid tiedown and user restraint, preliminary design of alternatives for the securement system, evaluation by user groups, prototype development, and dynamic testing of the design. One of the overriding considerations in this whole effort is how mobility aids have changed in the last few years. There is literally no such thing as a "standard wheelchair" either manual or powered, and certainly no such thing as a "standard scooter." Many if not most mobility aids are custom tailored for the individual user. In addition to sled tests of the design, a certain amount of "real world" use in an actual transit system was done, with very encouraging results.

The Oregon State University Securement System is designed to secure a mobility aid in the forward-facing direction. It has a capture mechanism mounted on the floor (it could probably be on a transverse wall as well) and what the project report describes as a "trailer hitch" on the back of the mobility device. This hitch or more properly interface unit must be attached to the mobility aid of any would-be rider.

The Cleveland Securement System

This project was a cooperative effort of the Cleveland (Ohio) Clinic Foundation, the Services for Independent Living, the Akron Metro RTA, LAKETRAN, and the Greater Cleveland RTA. The Cleveland Clinic did the R&D and also conducted the evaluations of the concept.

Ultimately three prototype units were built and installed in three different vehicles, one a fixed route type transit bus, and the other two paratransit type passenger vans. Volunteer riders with disabilities who used mobility aids rode the vehicles and made observations concerning their comfort and ease of use of the Cleveland Securement System.

The Cleveland Securement System consists of a docking latch mounted on the surface of a "modesty" wall located transversely in the transit vehicle. A mating receptacle attached to the wheelchair or scooter mates with the latch. The latch swings up to release, when the rider operates a cable operated release. The system includes both permanently mounted receptacles and temporary receptacles that could be mounted in a few minutes by the bus driver. The mobility aid securement location also has a stabilizer strap to the sidewall to stabilize the mobility aid in rear and side collisions, and an occupant protection belt for torso and pelvic restraint. These belts proved troublesome and conducive to mistakes in fastening properly, a not uncommon failing of almost all special restraint devices.

Riders all seemed to like the Cleveland Securement System, and found it easy to use. Docking into the latch took some practice, but securement in under 90 seconds seemed feasible.

Technology for Enhancing Information Transfer

What may be adequate information for the everyday commuter may be far from adequate for the first-time user even if he or she has no significant disabilities. For those who have sensory or cognitive disabilities, adequate information transfer becomes the cruicial difference between successful and unsuccessful use of a transit system. Recent work by the Texas Transportation Institute on bus stop design, on passenger information services, and on bus route guidance information design provides specific guidelines for accessible bus stops and signage for all aspects of a transit trip.
These reports specifically call out requirements and provide design information to comply with ADA.

Very often, simple solutions to the barriers disabled people face in using transit services can work exceptionally well, if given the chance and if adequately reinforced:

Calling Out Stops: A Simple Act, Often Forgotten

(By Jim Flemming, CTAA)

"...Calling out stops is more, however, than just another federal regulation imposed upon the public transportation field. It is the right thing to do, from both an economic and customer service perspective.

"Many people with visual disabilities have frustratingly come to the conclusion that much of the nation's fixed-route bus fleet, with few exceptions, is largely inaccessible to them. ...Preliminary estimates indicate that the average compliance rate for fixed-route bus operators in calling out stops is not more than 10 pecent to 15 percent nationally.

"...Yet, there is no information on how the industry is doing on the stop announcement issue because there is no national database on compliance rates, no reporting requirements for transit agencies on stop announcement compliance rates and no requirement that transit agencies track compliance rates on a regular basis.

"Little priority and few resources have been given to the stop announcement issue. Why has the commitment on the stop announcement issue at the national level lagged? Part of the answer, ironically, may be that compliance is a very straight forward and uncomplicated matter. And it makes economic and customer service sense.

"Economically speaking, calling out stops can save a transit agency money on its annual insurance premiums. *Community Transportation* talked to one transit agency that received a 5 percent discount on its premiums because calling out stops seriously reduced slip-and-fall accidents. Calling out stops is also a valuable customer service to passengers with and without visual disabilities.

"So why have transit agencies been unable or unwilling to enforce the stop announcement guarantee? The answer is not simple. Stop announcement compliance has been tied to the willingness and ability of transit agencies to enforce their disciplinary procedures. Many transit agencies have been reluctant to enforce stop announcement compliance by disciplining operators for fear that enforcement efforts will either get bogged down in lengthy appeals or tip the delicate balance of labor-management relations. Also, transit agencies will not enforce disciplinary procedures when there are no credible and qualified witnesses or if there is no reliable or objective monitoring or tracking system.

"...As the news of non-compliance among transit agencies in calling out stops has spread, many have come to believe that automated stop announcement systems will resolve the issue. Unfortunately, the vast majority of transit agencies today do not have automated stop announcement systems. ... Many operators still have to press a button to operate automated announcements, and (there have been) reports that some operators have turned off these systems because they consider automated announcements to be an annoyance and a distraction. ...it could take 15 to 20 years before the entire national bus fleet is equipped with automated stop announcement systems.

"Thus, a complex mix of factors -- the lack of management and supervisory support, labor-management entanglements, the non-enforcement of disciplinary policies and procedures, non-existent or unreliable monitoring and tracking systems, an operator culture or mind set resistant to calling out stops and a whole range of other systemic problems -- have all worked together to undermine compliance with the simple act of calling out stops and making other announcements.

"...New technologies currently are in the concept stage that would allow transit agencies to reliably and objectively monitor stop announcement compliance on existing fixed-route buses. If these two technologies could be combined, significant advances could be made in achieving compliance while making the job of the operator easier."

Communications for Scheduling

The most promising technology that could remove psychological barriers to use of transit by people with disabilities is Automated Vehicle Location and Mobile Data Systems (AVL). AVL is part of the Commercial Vehicle Operations (CVO) thrust within the U.S. DOT's Intelligent Trnasportation Systems initiative. With AVL applications an old story with many delivery and over-the-road commercial fleets, transit systems are adopting AVL to enhance dispatching for paratransit and route scheduling for fixed route systems. Now dispatchers know where every vehicle in the system is, and can communicate with drivers as needed to keep the system moving effectively.

Mobile Data Systems

MDS is a refinement of AVL for real-time communications bweteen driver and dispatcher, as a takeoff of ATIS, Advanced Traveler Information Systems. It is especialy suited to demand type scheduling, including route deviation. The driver gets the demand rider's address or location on a display at the driver's station. MDS could also facilitate fare collection, in accruing ride information and then billing riders on a periodic basis.

Geographic Information Systems

GIS provides custom maps in real-time to show both operators and riders where each other are. Routing changes based on ATMS provided information can facilitate efficient and timely operations, largely eliminating one of the most frequently heard complaints about transit and paratransit services: late pickups/arrivals, and no-shows. "Smart Maps" are very definitely in the near future for many if not most transit operators, as costs plummet and capabilities expand.

CONCLUSIONS

1. The trend toward mainlining as many disabled riders as possible toward fixed-route or route-diversion transit will continue, driven by both ADA and by improving technology.

2. Psychological barriers related to feelings of vulnerability at stops, inside some kinds of transit vehicles, and in "getting lost" in the system can still be formidible and may swamp advances in technology: would-be riders will not give the transit system a chance.

3. Great strides have been made in addressing people with either physical (mobility-related) or sensory disabilities; much remains to be done in dealing with those with cognitive impairments.

4. Off-vehicle or "cashless" fare collection through bar code readers or smart cards will offset some psychological barriers to transit use.

5. Route deviation strategies to providing responsive service to disabled people will be much enhanced by Mobile Data Systems technology arising from the Intelligent Transportation Systems national initiative.

6. Better design lifts and lowered-floor/kneeling vehicles are making it much easier for riders with or without wheeled mobility aids to use transit systems.

7. A number of transit systems are implementing training for drivers both to familiarize them with disabilities that they may encounter, but also how to interact with these customers. At the same time transit operations are also offering training to the disabled riders to help them use the alternatives available to them.

8. Much more needs to be done in "getting the word out" to disabled people that public transit will work for them; eligibility for paratransit is still and will remain an issue for many disabled people.

9. Wheelchair and mobility aid lifts, once crude offspring of tailgate lifts, have much improved in both design and in reliability. National and industrial standards now make lifts much more uniform and of better quality. Maintenance of lifts under transit conditions can still pose problems for operators.

10. Mobility aid tiedowns remain the biggest stumbling block to fast, easy accommodation for those who use wheeled mobility aids and do not readily transfer into a standard bus

seat. The most effective on the market are 4-strap cargo tiedowns, very complicated and cumbersome to attach.

11. Innovative tiedowns are on the way, but development is slow, probably because funding for such efforts is hard to come by. Only one tiedown currently in design does not require some kind of hardware on the mobility aid to achieve lockdown.

12. Occupant protection is a controversial subject, because able-bodied people are next to never provided with any kind of occupant restraint on a large transit vehicle (except for aircraft). Disabled people in a wheelchair or seated on a scooter are theoretically the same as any other rider seated on a transit seat. But many to most physically disabled people are helpless without their mobility aid, cannot independently transfer, and also cannot hold themselves in place to the same extent that an able-bodied person can. Presently, ADA requires the provision of occupant protection devices for people seated in secured mobility aids.

13. For many disabled riders, nothing would be more simple nor more helpful than the simple announcement of stops and transfer points by drivers. Automated methods of accomplishing the same thing, especially with the advent of GPS technology, will unburden the driver of performing this task, as the technology becomes more and more available.

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BARRIERS TO USE OF TRANSPORTATION ALTERNATIVES BY PEOPLE WITH DISABILITIES

Literature Review

Overview of the Americans with Disabilities Act

The Americans with Disabilities Act (ADA), passed in July 1990, was designed to eliminate discrimination against persons with disabilities in areas such as employment, public services, telecommunications and transportation. Specifically, Title II, Subtitle B prohibits discrimination by entities providing public transportation (Kaun, 1995). As such, the ADA provides legal recourse for persons with disabilities who feel that their civil rights have been violated when denied equal access to all forms of transportation.

By logical extension, the transportation regulations outlined in the ADA apply not only to vehicles and facilities, but to the overall level and quality of the transportation system providing services to the public. In response to the passage of the ADA, transit providers have sought to improve their basic service operations, enhance existing services and develop innovative approaches for better serving customers with disabilities. The ADA requires transit agencies to provide equivalent and/or alternative services to persons with mobility, cognitive or sensory impairments. Indeed, when the ADA was passed, there were 43 million Americans with one or more disabilities; and it is anticipated that the number will grow as our population ages (Hunter-Zaworski & Hron, 1993).

The obstacles facing the person with a disability who is seeking to use public transportation include the less obvious psychological barriers to independent transit use in addition to the physical barriers which more readily come to mind. Thus, accessibility *per se* is only one of the factors that must be taken into consideration when providing appropriate public transportation for travelers with disabilities. The user must also be able to functionally use the services. Realistically, the traveler with a disability must be able not only to board the vehicle, but successfully "navigate" to the intended destination. In their efforts to provide accessible public transportation for all passengers, transit agencies must also keep in mind the convenience and safety of their passengers with disabilities while making every effort to mainstream their travel with that of other transit users.

According to Rosenbloom (1996), the ADA fundamentally changed the relationship between traditional fixed-route service and paratransit service. Traditional (or "conventional") mass transit service refers to fixed-route, fixed-schedule service. That is, the transit vehicle travels a route and schedule established by the transportation agency. Customers are picked up and dropped off at predesignated locations along the route at specified times.

Paratransit, on the other hand, is best characterized as a demand-responsive system (or, dial-a-ride). General public paratransit services are open to all riders, but such services are dwindling (Rosenbloom, 1996). Such services, where they exist, are not subject to the constraints and requirements affecting the ADA-mandated paratransit. According to the ADA, paratransit is no longer considered a substitute for accessible fixed-route service--rather, both are required (TRB, 1995). The ADA requires transit operators to provide complementary paratransit services that "shadow" all of the fixed-route systems (Rosenbloom, 1996). This paratransit service must be comparable to fixed-route service in terms of the routing and scheduling available, and fares cannot be higher than twice the base fare charged for the fixed-route service. Moreover, customers cannot be generally refused service based on trip purpose or limited vehicle capacity. Within the provisions of the ADA, however, travelers may be asked to alter their travel plans by up to one hour, and often must arrange for service 24 to 48 hours before pickup, sometimes even longer.

It is likely that some transit systems will incur large expenses in complying with the requirements of the ADA. Provision of the most efficient and effective public transportation for all customers may require that fixed-route and paratransit services be developed and operated as one system. Thus, options and enhancements that better integrate fixed-route and paratransit services may have particular appeal.

Who Will Use Alternative Transportation?

Rosenbloom (1996) noted that passage of the ADA also changed the way in which individuals are determined eligible for public paratransit service. Eligibility for paratransit under the ADA is not based solely on the existence of the applicant's disability (Cerenio & Soper, 1993). Rather, it will be based on the person's functional ability to use the fixed-route transit system once it is fully accessible.

A *physical impairment* is defined by ADA (EEOC, 1992) as

"...any physiological disorder or condition, cosmetic disfigurement, or anatomical loss affecting one or more of the following body systems: neurological, musculoskeletal, special sense organs, respiratory (including speech organs), cadiovascular, reproductive, digestive, genito-urinary, hemic and lymphatic, skin, and endocrine."

A *mental impairment* is defined a few lines later as:

"...any mental or psychological disorder, such as mental retardation, organic brain syndrome, emotional and mental illness, and specific learning disabilities."

These disabilities or disorders are not otherwise catalogued, since such a listing could easily rival the *Merck Manual.* The emphasis in ADA is on *chronic* disorder; for example advanced pregnancy certainly disables a woman in many ways, but not with regard to accommodation under the provisions of ADA.

The Technical Assistance Manual (EEOC, 1992) goes on to state that the disability or disorder must also "substantially" limit one or more *major life activities.* These are activities that able-bodied or minded people can perform with little or no difficulty, such as walking, standing, breathing, self-care, etc. What matters for any disability is its *effect* on major life activities, not what it is *per se.*

Thus three issues must be considered in establishing an ADA-eligible disability:

(1) What is the nature of the disability and its severity?

(2) How long will it last?

(3) What is its permanent or long-term impact?

Fixed-route public transit would not be suitable for persons with disabilities that limited major life activities necessary for using such a system, even if it were "fully accessible" under ADA. The rank order of impairments most often cited under ADA (i.e., complaints about lack of access for a particular type of impairment) from most frequent to rare is (Kearney, 1995):

- Back
- Neurological
- Emotional/Psychiatric
- Extremities (mostly amputation)
- Heart Disease
- Diabetes
- Hearing
- Vision
- Blood Disorders (including AIDS)
- Cancer

- Asthma

The impairments most likely to require paratransit service in order to provide reasonable accommodation are those which limit or preclude either traveling from a point of origin to the nearest stop on the fixed-route system and/or climbing inside the bus once at the stop. Thus most people who use either a manual wheelchair or a motorized chair or scooter would not need paratransit, although there may be obstacles between the stop and the person's point of origin that cannot be overcome or detoured around. A person too weak with disease or disability may not be able to budge a manual chair for any distance, but may not be able to afford a 5-10,000 dollar power chair. They would have to resort to paratransit. A person unable to plan a trip and find their way to the requisite bus stop because of mental or emotional disabilities would also be a potential paratransit customer. A handbook prepared by KRW, Inc. (undated) provides specific guidance for making a decision regarding a person's eligibility for paratransit service based on disabilities.

Barriers to the Use of Alternative Transportation Modes

Physical Barriers

The physical barriers to public transportation that most readily come to mind include such architectural obstacles as stairs, curbs, and doorways. However, in a broader sense, any feature of a mode of transportation which prevents a person from getting to accessible transportation, boarding the vehicle, riding in a safe and comfortable environment, and alighting from the vehicle at the appropriate time and place might be considered a physical barrier to travel.

Anything that interferes with the provision of services (such as the length of trip time, the reliability of the service provided, the presence of security measures, or the insensitivity of employees to the needs of the traveler) could constitute a barrier to the use of transportation by some affected person. Thus, the essential elements of a truly accessible transit system include not only accessible vehicles and facilities, but services such as vehicle maintenance, proper training for transit employees, up-to-date information on the transit system and its emergency features, and the provision of a safe traveling environment. One barrier not always considered is the sheer availability of the accessible vehicle and its adaptive equipment. Inadequate or "deferred" maintenance can be a potent barrier to the use of alternative transportation, because the equipment just doesn't work, appears or is unsafe, is dirty, greasy or even missing. Makeshift wheelchair tiedowns, or the absence of occupant restraints are examples of poor maintenance.

Security concerns. Ingalls, Hartgen, and Owens (1994) found that fear of crime and concern for safety appear to be key elements in the public's decision to use public transit. Although a given individual's fear of crime may be an exaggerated psychological

barrier to public transit use, there are features of the physical environment that are basic to the perception of security for all passengers using public transportation (Benjamin et al., 1994). The visibility of protection efforts such as uniformed patrols, surveillance cameras, good lighting and facility design, as well as the proper maintenance of vehicles and facilities, are but a few of the measures that help to maximize transit security for all travelers (Balog et al., 1994). Efforts should be made to design transit stops and station layouts to increase visibility, while providing more limited access to areas such as rest rooms. In addition, transit providers should keep in mind the need for routes designed to decrease waiting time for passengers while providing a safe and comfortable environment in which travelers feel they have some measure of control in the event something should go wrong (e.g., availability of emergency telephones).

Safety concerns. The capacity to alert customers to potential hazards in the physical environment is also essential to safe travel. Detectable warnings are standardized surface features applied to walking surfaces that may be helpful in warning visually impaired people of hazards in their line of travel (Bentzen, 1994). In a similar fashion, visual warnings may be used to alert hearing impaired persons of potential hazards, and prompt them to seek information or assistance while traveling.

Psychological Barriers

Obviously, there are other factors that may determine whether people with a mobility impairment will become mobile once accessible transportation is offered. These other barriers to the use of transportation may encompass a variety of personal, psychological, and social factors that limit the use of public transportation by some persons who would be classified as "able-bodied" as well as those persons with recognized disabilities. Unfortunately, the term "accessibility" has been linked to our more common stereotypes of persons who have problems with locomotion or sensory deficits (Barber & Hajnrych, 1993), and little or no attention has been given to the myriad of other barriers to the use of public transportation.

The following is a list of fears which may constitute psychological barriers to travel, many of which were addressed in May (1992):

1. Fear of attack.
2. Fear of falling down.
3. Fear of becoming exhausted.
4. Fear of being stranded.
5. Fear of new ideas and/or new environments.
6. Fear of not being able to successfully complete a journey.
7. Fear of public places.
8. Fear of losing control.

As one can see, these are the sorts of worries that might (to some extent) plague any person, regardless of disability, at any time. However, for persons with disabilities, the magnitude of the fear is such that it can present an insurmountable obstacle to the use of otherwise fully accessible public transportation.

The following list of additional psychological barriers to the use of public transportation includes features that are not as likely to be experienced by the traveler who is not disabled:

1. Stigmatization as "disabled."
2. Lack of the social network and knowledge of places to go, what services may be offered, etc.
3. Failure to comply with social mores and proper conduct.
4. Lack of confidence in one's own physical, mental and emotional resources.
5. Inability to deal with the unexpected.

For the traveler who is emotionally disturbed or cognitively disabled, these barriers cannot be readily addressed with additional funding or changes in vehicle and facility design. Indeed, in considering any one of the psychological barriers listed above, one can readily see that "access" alone is not enough to mobilize everyone (McKenna & Lavery, 1993). The presence of any one of these factors may be viewed as a transportation handicap when it comes to the use of public transportation. As Doyle (1988) points out, the interaction of the person with the environment, and the way in which that person experiences the use of transportation, may constitute a transportation handicap, regardless of the nature and extent of any recognized disability.

Barriers to Information Exchange

Barriers to the exchange of information was included as a separate category because the difficulties experienced by travelers who are disabled may result from any one, or a combination of, physical (or, sensory) deficits and cognitive deficits that prevent them from navigating to the intended destination. Access to usable information, sometimes characterized as an invisible barrier to independent travel (Penner & Stark, 1993), can be a problem for all travelers. However, it is particularly troublesome for individuals who, because of age, level of literacy, mental, physical or sensory deficits, are unable to fully access available services. As a group, these passengers may have alternative communication needs that prevent them from understanding or being understood by others without assistance. In this sense, obstacles to effective communication can be as disabling to transit users as any physical or mental deficit.

The more obvious barriers result from hearing or vision impairments. In response to the need for technologies to overcome these obstacles, automated information and communication systems have been developed to enable or enhance communication with persons with disabilities. Techniques and devices to assist persons who are deaf and

those with other hearing impairments typically rely on the use of visual information and technical devices that enhance the ability to hear. On the other hand, techniques for assisting persons who are blind or have low visual ability typically include devices that provide information verbally. Certainly, information on transit routes, schedules, fares, stops, and emergency situations must be made available to all passengers. Likewise, it is important that all travelers are able to make inquiries and communicate their needs to transit personnel. However, these problems are often experienced by travelers who are not disabled as well, and will likely vary greatly with respect to the extent to which they can be corrected or overcome for each individual.

Although numerous technologies and policies have been developed to address the needs of persons with visual or hearing impairments, much less assistance is available to persons with cognitive disabilities. Cognitive impairments may include emotional disabilities, mental retardation, learning disabilities, brain injury, and other intellectual capacity limitations (Hunter-Zaworski & Hron, 1993). Often, the abilities of persons with cognitive impairments vary greatly, and result in a range of difficulties using public transportation systems. For persons with cognitive impairments, there may be few purely technological solutions to the barriers to transit use. Rather, personal interaction in the form of training and assistance may be key to solving the problems of individual transit users.

Recent Developments in Transportation for People with Disabilities

In meeting the requirements of the ADA, transit operators are required to make buses accessible, provide transportation options to persons with disabilities who do not have access to accessible buses, and provide transportation for travelers within the catchment area who are unable to use accessible buses. Thus, the ultimate goal is to make all forms of public transportation *usable* by everyone, regardless of disability. Transit systems are required to provide "paratransit" (or, complementary) services to users who either cannot use or cannot get to available accessible service. The following is a brief review of some of the alternatives to traditional transportation systems that are currently offered.

Engineering Alternatives

Under ADA regulations (U.S. Access Board, 1994), buses (and many vans) operated by a public transportation authority to be considered in compliance will have a lift or deployable ramp of some design. The lift or ramp must also be able to accommodate ambulatory people who cannot use the customary able-bodied entrance to the vehicle. The vehicle will also have to have at least one or (for vehicles over 22 feet in length) two accessible locations designed for wheelchair or mobility aid securement. The securement system (either automatic or attendant-attached) must restrain the

mobility aid in such a way that any rider faces either forward or rearward, secured with a seatbelt occupant protection system. Somewhat paradoxically, if a mobility user elects to transfer to a conventional bus seat, there are no requirements under ADA for him or her to be provided with a seatbelt. Buses and vans must also allow maneuvering room for mobility aids, and slip-resistant flooring and steps to augment such mobility (and also help people who are ambulatory but disabled). Assist handles must be added to vehicles to assist those with walking or stability problems. Ingress/egress lighting will also be required to assist those with partial vision and anyone at night. A somewhat different kind of access provision is a means of requesting a stop at the location where the person with a disability is, which brings up interesting questions for people with visual disabilities: how do they know when to request a stop? No provision is made for people with auditory disabilities under these regulations.

A recent article by Hunter-Zaworski (1994) identifies some new and emerging technologies to assist people with disabilities to access public transit or paratransit. Trip planning for people with sensory disabilities include tactile mapping, telecommunications devices, amplified telephones, faxes. Much of the time, one of the real challenges is in coordination of various agencies to implement "smart traveler" technologies. Identification of, and access to bus stops can be enhanced by providing "tactile paths," speech information equipment, and automatically triggered sound devices. Radio operated "verbal landmark systems," somewhat like the electronic tours being offered at some museums, are also in various stages of planning. Talking buses are now being proposed, they would work just like the automated tramway systems at Dallas-Ft Worth Airport and other similar facilities. Some of these approaches will be discussed in more detail later in this review.

Conventional bus route guidance information was studied by TTI (NCTRP A-12; Koppa and Higgins, 1996) to make it accessible to the widest number of riders, including people who are elderly and/or disabled among us. Electronic information systems are rapidly becoming available and more are under development (Hunter-Zaworski, 1994). Some of these will incorporate automatic speech recognition, and satellite-based navigational technology that allows a rider to determine the exact whereabouts and arrival time of a vehicle.

A real "sleeper" in engineering considerations is fare collection. Many of the present systems can be difficult for some kinds of disabilities, both physical (lack of dexterity in handling change or tokens) and mental. Off-vehicle fare collection by far is the most preferred by people with disabilities. These collection approaches vary from pre-payment passes to credit cards (read before and after the trip) to "smart cards."

Routing Alternatives

There are a variety of non-traditional routing options designed to increase transit ridership while holding down transit costs. These transit options may be grouped into three major categories (Rosenblum, 1996):

1. route deviation services;
2. service routes (or, community buses); and
3. general public demand-responsive systems (also known as "paratransit" or "dial-a-ride" services).

Route Deviation Services

Using the fixed-route scheduled service as its basis, a route deviation service will deviate from the fixed route to pick up and drop off passengers upon request (Rosenblum, 1995). After accommodating the request, the vehicle returns to the fixed route at the point at which it deviated. There are several variations of route deviation possible, including site-specific deviation as well as client-specific deviation. Requests for deviations to reach a particular destination (site-specific deviation) can be required in advance or may be given to the driver when the individual boards the vehicle. In the absence of any requests to leave the advertised route, the vehicle operates a traditional fixed route making scheduled stops. Obviously, there are limitations on the extent to which a vehicle can deviate from the established route to provide this service. A route timetable will be difficult to impossible to meet unless the timetable has built-in flexibility that may render it almost meaningless. Typically, vehicles will deviate only on portions of certain routes, and these vehicles most often serve suburban and rural areas. Route deviation thus provides a low-cost alternative to paratransit service in low-density areas.

Service Routes

Service routes (also known as community bus services) are designed to bring fixed-route buses as close as possible to the residences and destinations of the target population of users, thereby minimizing the walking distance for these individuals. As an adjunct to fixed-route services, service routes feature more convenient bus stops and allow additional time in the schedule for drivers to assist passengers with boarding and disembarking. The vehicles used for service route operations are typically smaller than those used by fixed-route public transit systems, allowing them to service the narrower streets in residential and pedestrian-only areas (TRB, 1995). In addition, the service route is more flexible for the user since it does not require calling ahead for a reservation, thus allowing more spontaneous travel. With careful planning, service routes can be used successfully to replace low-use regular public transit routes and/or certain trips made by paratransit services.

Paratransit Service

Paratransit is a complementary service that is provided whenever the existing fixed-route service is unable to, or not appropriate to, meet a customer's needs (TRB, 1995). Transit agencies may use accessible on-call services to satisfy the requirements set forth in the ADA. These "dial-a-ride" services allow individuals who need to use accessible vehicles to call in advance and request that an accessible bus be placed on a particular route at the time they wish to travel. Individuals who need to make repetitive trips for work or school may place a standard reservation for an accessible bus on a specific route. These services are typically viewed by transit agencies as short-term solutions as accessible buses replace conventional fixed-route vehicles.

Paratransit services may also include accessible taxis and conventional paratransit van services. Accessible taxis are typically operated in general public services, but are accessible to persons who use wheelchairs. Paratransit van service is more cost-effective during peak travel times for grouped trips, whereas accessible taxis may be available for trips at any time during the day. The inclusion of these services as forms of paratransit is likely determined primarily by the extent to which they are subsidized as part of a public paratransit service.

Transfer to Other Systems or Modes

Even though a transit system may provide good service within its catchment area, often little or no consideration is given to transfer to another system or even transportation from the bus stop to the ultimate destination, except in long-established "transit regions" such as the Chicago area. The typical transit user, including travelers who are disabled, are confined to whatever system serves their catchment area. Travel to other, adjacent areas via other accessible transit providers may be extremely limited or simply not available.

Enhanced Information Exchange and Communication Systems

Assisting Persons with Hearing Impairments

The techniques and devices developed for assisting hearing-impaired travelers include hearing-aid-compatible/amplified telephones, automated speech recognition, electronic information signs, and other assistant listening devices (TRB, 1995). Transit stations are often noisy environments and people with hearing impairments may require assistance in obtaining information from transit personnel and/or announcements made in the station. The availability of at least one hearing-aid-compatible/amplified telephone is required by law where coin-operated and essential phones are necessary.

Automated speech recognition systems are being developed with computers that convert spoken words into text for presentation to persons who are deaf. Correspondingly, persons who are incapable of speech as a result of deafness can use computer keyboards to request information or respond to computer-generated text.

Electronic information signs are one of the most extensively utilized forms of alternative communication presently in use. Electronic readerboards can convey information and announcements to all sighted passengers, and are the best means of providing infrequent verbal information such as train delay (Bettger & Pearson, 1989). Video monitors can be programmed and updated regularly from a centralized computer and are the best means of providing information that is detailed and must be continually provided, such as schedules. Sophisticated electronic information systems are also being developed to provide arrival and departure information in "real-time," triggered by sensors installed at the approach to the station. Of course, both hearing-impaired and other passengers can benefit from these emerging technologies.

Assisting the Visually Impaired Traveler

Technologies useful in transit to assist persons who are visually impaired include talking bus/train stops, talking signs, talking buses and trains, auditory pathways, and auditory maps (TRB, 1995). Boxes mounted at bus or train stops may be used to announce route numbers and timetable information for visually impaired travelers at the touch of a button. Talking signs emit infrared signals that can be converted to audible information using a pocket-sized unit carried by individual travelers. The audible information is provided only when the unit is signalled, and directional infrared signals serve to guide the visually impaired customer to the sign.

Voice enunciator systems provide announcements in human voice, and may be triggered by approach vehicles to announce the arrival of a bus or train at the station. Computer-generated speech may also be used for delivering travel information, and touch-tone telephones provide easy access to schedules, fares, and other travel-related information. Messages may be delivered verbally and simultaneously displayed on signs at stops and on vehicles to assist persons with hearing impairments. These services will likely benefit all travelers, regardless of disability.

Auditory maps and auditory pathways are recently emerging technologies that will also be useful for persons with impaired vision. Auditory maps are typically recorded on cassette tapes, and may be used to describe specific pathways, general neighborhood features, and other information about the transit system (Hunter-Zaworski & Hron, 1993). Auditory pathways consist of a series of speakers positioned along the intended path which can be activated by a hand-held device carried by visually impaired travelers.

Tactile maps consist of a combination of Braille, raised symbols, and large print to transform printed maps into useful tools for the visually impaired. An audio signal may be used to indicate the location of the tactile map, and different textures are used to signal features of the environment. In addition, devices such as the Mowat Sensor, the Laser Cane, and the Soniguide have been developed to detect objects in the environment and provide information regarding surface texture and density (Hunter-Zaworski & Hron, 1993). When used with a long cane or guide dog to detect elevation changes,

these devices are enabling many visually impaired customers to enjoy safer independent travel.

Assistance for the Cognitively Challenged Transit User

In order to be of full service to all passengers, transit agencies must design materials such as maps, brochures, timetables, and other forms of information to be as straightforward and readily understandable as possible. In one survey, Barber and Hajnrych (1993) reported that 44 percent of the respondents had difficulty in understanding bus timetables, although only 3.4 percent of the population have learning disabilities. The use of symbols and colors, with limited textual explanation, are the best ways to increase understanding for most people, regardless of disability (TRB, 1995).

Training and individual attention are essential to helping all customers feel confident and comfortable using public transportation. In addition, specialized mobility training can effectively shift moderately transportation handicapped travelers, such as mentally retarded persons, from paratransit to fixed-route services (Starks, 1986). "Wayfinding" training (Taylor, 1991; Taylor & Taylor, 1993) teaches the cognitive and behavioral skills necessary to reach destinations in the environment. Mentally ill travelers often do not have the capacity to develop a cognitive map of the travel route. Without proper training, the person can easily become geographically lost--i.e., he or she does not associate current location with an understanding of the destination that is not in immediate perceptual range (Taylor & Taylor, 1993). Cognitive deficits such as poor attention and spatial difficulties combined with inadequate verbal skills and social incompetence can contribute to the person's feeling of being lost (Taylor, 1991). Becoming lost can then move a mentally ill person into a crisis state, and further compromise his problem-solving and coping skills. Crisis intervention training teaches the ability to respond to environmental demands in an adaptive manner, thereby lessening the intensity of potential crises.

Travel training and facilitated travel. Travel training is a support service offered by some fixed-route or paratransit services that teaches people with disabilities the skills and confidence needed to use public transportation effectively (TRB, 1995). In a similar vein, facilitated travel provides ongoing travel assistance for people with disabilities to travel by fixed-route transit. Facilitated travel provides for a travel monitor or companion (sometimes referred to as a "bus buddy") who accompanies the person with a disability along the travel route.

For many travelers with mental disabilities, travel training can teach skills in wayfinding, including finding the way to and from the transit stop, recognizing the correct stop and the correct vehicle, and how to pay the fare. Instruction can also be provided on appropriate behavior while on board the vehicle, recognizing landmarks and the correct place to alight, and how to deal with unexpected situations. Travel training can be particularly effective for persons with cognitive and developmental disabilities, and is

most effective in enabling these passengers to make successful daily journeys to and from the same destination (such as school or work).

Community training. For persons with moderate to severe handicaps, community training has become an increasingly important part of their educational program. Through training conducted in simulated and *in vivo* conditions, students are taught to cross streets safely and to use public transportation (Welch, Nietupski, & Hamre-Nietupski, 1985). Welch et al. taught young adults with moderate to severe handicaps to use a prosthetic picture-prompt card to travel to and from their vocational training site. The card assists the individual in determining whether he is on time to catch the bus and directs him in following a problem-solving procedure in the event that he missed the bus. The results of the Welch et al. study were quite encouraging, suggesting the effectiveness of such devices to teach otherwise complex problem-solving behaviors. An added advantage of the device is that it provides the student with a means of control, and its use can be phased out as the person needs less assistance in travel.

Support Services and Promotional Programs

Service Enhancements

The service enhancements outlined below include suggestions for making transit travel more appealing for everyone. The prospect of traveling by public transportation appears complex and unpredictable to many potential users. In the past, systems have ignored the interests of special groups such as senior citizens, foreigners, illiterate persons, or people who are otherwise disabled. However, in their efforts to correct this situation, transit providers must be careful not to add another layer of complexity to the user's experience.

Trip Planning Services. Trip planning services provide a more personalized service in assisting customers with developing an itinerary for a desired trip (TRB, 1995). If a particular journey on a fixed-route system would be difficult or impossible given an individual's disability, trip planning services can provide information about alternative modes of travel, the availability of paratransit services, and alternative routes of travel. Details about schedules and fares, as well as bus stop locations, accessible paths for wheel chair users, vehicle and equipment operations, and driver assistance can be accessed in advance. By offering personal assistance in planning travel, transit providers can encourage persons who are unfamiliar with transit travel to feel more confident.

Fare simplification. Fare simplification mechanisms include such things as vouchers, ID cards, transit passes, and other methods used by transit systems to simplifying the paying and collection of fares for travel (TRB, 1995). In addition to improving security and enabling users to track their travel for reimbursement purposes, these fare simplification mechanisms may be of special assistance to persons with disabilities who might have problems (physical or mental) handling money. Electronic

ID card systems can hold comprehensive detailed information on individuals and their capabilities and need for assistance. Often these cards require no physical contact between the user and transit personnel, while providing information on regular trip origins and destinations.

Destination card programs. Destination card programs are an enhancement of fixed-route services that permit passengers to alert vehicle operators to their need for assistance (TRB, 1995). Destination cards are small forms filled out by riders or persons assisting riders, and contain information about the person's specific disability as well as information about the passenger's desired destination. Upon boarding the vehicle, the rider hands the completed card to the driver, who then recognizes the person's need for assistance and can provide the appropriate written or verbal information to enable the rider to exit the vehicle at the correct stop.

Smart maps. Southworth (1996) maintains that computer-aided traveler information systems could be used to provide information tailored to diverse users and their specific needs. Recognizing the need for information presented in the form of spatial relationships (or, cognitive maps) and procedural instructions, Southworth suggests the development of "smart maps" to convey information through customized route planning, auditory maps, and visual simulation. Walk-through maps would give the transit user a simulated preview of the prospective trip, while hand-held transit maps could provide information vital to certain user groups (such as visitors, newcomers, and travelers who are disabled). The intent is to improve current information systems based on transit users' needs and the cognitive processes involved in wayfinding.

Promotional Programs

Marketing programs may include information dissemination and other promotional efforts designed to increase ridership by persons who otherwise may be unaware of the availability of the services, or who are hesitant to use them because of a negative image (TRB, 1995). One group of potential users who are most likely to benefit from promotional efforts are senior citizens who are no longer able or willing to drive. Census projections estimate that seniors will make up about 13 percent of the total population by the year 2000, and one-half of this population will be over the age of 75 (Kihl, 1992).

When addressing the needs of a senior citizen population, Kihl reminds us to consider not only the person's chronological age, but "cognitive age" and "life-style" choices. Promotion may be a key factor in recruiting riders among this group. Marketing efforts should emphasize independence, reliability, safety, and the variety of destinations offered by the transit service. While avoiding any indication of condescension or negative connotations associated with being old or elderly, promotional messages can be particularly effective if delivered by a fellow senior citizen. The quality, dependability and safety of the transit system may be particularly important to this group,

while flexibility and innovation are essential to meeting the needs of all customers, particularly those residing in rural communities.

Implications for Providing Alternative Transportation

The paratransit requirements of the ADA recognize the importance of public participation in implementing program goals (Balog, Schwarz, & Simon, 1994). People with disabilities, older citizens, and people from rural communities may be particularly reliant on a public forum in which to express their needs. Communication with the public is essential to maintaining system efficiency, and rider surveys can provide valuable feedback on the services that are currently provided as well as proposed service changes.

In the past, paratransit service may have been viewed as an adjunct to the social services provided for special groups, such as persons who are elderly and/or disabled. Hence the concept of paratransit as a "separate, but equal" form of public transportation. However, one of the goals of the ADA is to move people with disabilities more into the mainstream of activities. Public transit operators who provide paratransit service in order to comply with the ADA need to focus on paratransit as a supplementary form of public transit (Koffman, 1994). Coordination of efforts among policy makers, members of the community, and system providers is the key to increasing system efficiency and reducing costs. By informing people of the services that are available and encouraging them to use fixed-route systems, duplication of services can be kept to a minimum and the goals of the ADA met.

SURVEY OF SELECTED TRANSIT FACILITIES

A limited search of WEB sites and other resources turned up a number of transit operations that either have done or are doing seemingly innovative things in transportation of people with disabilities. Although some operations for one reason or another were unable to help us, we found six that were very willing to share their ideas with us. The following few pages (Exhibit 1) provide the format for the structured interview used with these operations.

EXHIBIT 1

TELEPHONE INTERVIEW ON BARRIERS TO THE USE OF TRANSIT BY PEOPLE WITH DISABILITIES

Date:_____

Transit Facility or Organization:

Contact: _____
Title_____
Telephone_____FAX_____
e-mail_____

INTRODUCTION TO PROJECT:
The Texas Transportation Institute is working on a small study sponsored by the Southwest Region University Transportation Center to take a look at barriers to the use of transit by people with physical, sensory, and mental disabilities as defined under the Americans with Disabilities Act (ADA) of 1990.

We are calling you because your organization has been identified as one doing some innovative things to accommodate disabled people. We want to follow up and learn a little more about successes you have had, and lessons that have been learned.

A few general statistics, if you have them:

1. Ridership per month:

2. How many buses in fleet:

3. How many buses equipped to be ADA accessible:

EXHIBIT 1

4. Numbers of disabilities accommodated (per time period)_____: on fixed route or modified fixed route operations

   A. Wheelchair or similar mobility aid_____

   B. Inability to use stairs/stepwells_____

   C. Blind_____

   D. Deaf (if applicable)_____

   E. Cognitive_____

   F. Other_____

5. Paratransit Operations?

6. How many paratransit vehicles:_____

7. How are they equipped?

8. Numbers of disabilities accommodated (per time period)_____: with paratransit operations

   A. Wheelchair or similar mobility aid_____

   B. Inability to use stairs/stepwells_____

   C. Blind_____

   D. Deaf (if applicable)_____

   E. Cognitive_____

   F. Other_____

Any other commentary on operations, plans, etc.

EXHIBIT 1

There are at least 3 types of barriers to the use of transit by people with disabilities. They are

PHYSICAL
PSYCHOLOGICAL
INFORMATIONAL

Physical barriers include such things as inaccessibility, steps too steep, mobility aid securement, inoperative access equipment, stops with no sidewalks, etc.

There are lots of ideas for removing physical barriers in the various ADA-related guidebooks and publications, but what are you especially proud of in your system? Any ideas that have worked for you that you would like to share with us?

What have been some "lessons learned" or things you might have done differently with 20/20 hindsight in eliminating physical barriers?

EXHIBIT 1

Psychological Barriers include such things as fear of lifts, fear of stranding, fare collection policies, attitude of drivers (perceived or real), trip lengths, etc.

Such concerns are not much dealt with in the ADA literature, but you have probably encountered them among patrons or would-be patrons. Any successful strategies that you have used to overcome psychological barriers?

Again, have there been any "lessons learned" in dealing with psychological barriers?

EXHIBIT 1

Finally, there are *information barriers*. One thing we hear over and over is that people with disabilities are unaware of what transit can offer them. Have you tried any special strategies in (a) telling about your services and (b) proving specific information on accessibility, scheduling, timetables, and route guidance?

Are there any other items that might be interest to other operators facing ADA compliance that you would like to share?

Close Interview

We interviewed the transit facilities to get their perspective on barriers that disabled people face when using public transit between February and April 1998.

The interview began by giving a brief description of the study and who is sponsoring it. The researcher then asked for general information, such as, contact's position, telephone and fax number, email and general statistics on ridership. They were given information on the three types of barriers the study was interested in and asked what their organization did to combat these barriers.

Summary of Results

Physical barriers deal with inaccessibility, such as, steep steps, improper securements, inoperative equipment and unavailability of ramps. When asked for innovative ideas on removing this barrier, we received the following answers:

- Tulsa Transit deploys the lift for walk-ons who have a hard time climbing steps as well as, wheelchair users.

- SCAT contacts the tri county independent living center to report problems with accessibility to buildings. They also have wider lifts than required: 30 by 51.

- VIA coordinates a door to door service for paratransit and a training program to help passengers move from paratransit to fixed route transit. They also are involved with bus stop and infrastructure improvements.

- RTA equips their buses with a front hydraulic system that lowers the bus for easier access to the steps. All buses are equipped with lifts and they improve their transfer centers to be more accessible, i.e. having stops on both sides of the street so passengers don't have to cross busy intersections.

- Metro Transit contracts with the University of Oklahoma for improvement studies and has a well organized cooperation with the city to handle problems with accessibility. They work with the city to create curb cuts, ramps, and automatic doors at most public buildings.

- DART offers driver assistance with boarding on their fixed route and offers door to door service with package assistance for their paratransit riders.

Some "lessons learned" include initial work with building contractors for better access and wheelchair manufacturers for designs that better fit the lifts.

The second barrier is the *psychological barrier* which includes such things as fear of lifts or being stranded, trip lengths and attitudes of the drivers. The responses we received for combating this barrier are as follows:

- Tulsa Transit coordinates passenger training seminars designed to help familiarize the passenger with the routes and equipment.

- SCAT requires that drivers have disability awareness training. They also have training programs for the passengers. They allow people to come and examine the lifts so as to better familiarize themselves with it.

- VIA feels the best way to help break this barrier is to provide extensive training for the drivers. They want the drivers to be sensitive to the needs of disabled people. In doing so the drivers can calm any fears a passenger might have.

- RTA provides training not only for the passengers, but for the professionals who care for the passengers. This allows for another source of information and reassurance for the passengers.

- Metro Transit conducts periodic evaluations of drivers and sits in on routes to make new passengers comfortable and to answer any questions. They have a coordinator who will put new passengers on a route with an experienced driver.

- DART offers extensive driver training. They make every effort to not leave their paratransit riders behind. If the passenger is not at the designated pick up site the driver will call to make sure they still need a ride.

Most of the organizations would say that they need more training in order to fully deal with the psychological barrier.

The last barrier discussed in the interview is the *informational barrier.* Many times people with disabilities are unaware of their transit options. All the interviewees agreed that advertisement is the best way to let consumers know what is offered. Some of the ways this is achieved include:

- Newsletters and newspaper ads
- Customer hotlines offered in English and Spanish with rely service for the hearing impaired
- Presentations and brochures explaining services and equipment
- Advanced announcement of next stop

- Phone numbers printed on the sides of buses and vans
- Provide remote service locations for easier access

The interview was concluded by asking if there were any other remarks or comments in general about accommodating the disabled. The interviewees had nothing more to add, but were very helpful and friendly.

Tabulations of Responses to Survey

General Statistics

Transit System	Ridership per month	Buses in fleet	# of buses ADA accessible
DART	not available	864	30%
Metro Transit	not available	not available	not available
RTA	2100 monthly	80+ fix route	100%
SCAT	30000 monthly	200 fix route	77% fixed 100% para
Tulsa Transit	not available	93	100%
VIA	2.5 million monthly	500	not available

Disability Statistics

Transit System	Fixed Route Ridership	# of Paratransit Vehicles	Paratransit Ridership
DART	not available	200 vans	56400 per month
Metro Transit	minimal	6 vans	1800 per month
RTA	200-500 daily	30	700 daily
SCAT	3000 per month	52	11300 per month
Tulsa Transit	not available	30 vans	not available
VIA	not available	125	75000 per month

Physical Barriers - Transit system's response to removing physical barriers

Transit System	Response
DART - Dallas, TX	Offers driver assistance with boarding on the fixed route Offers door to door service with package assistance for the paratransit route
Metro Transit - Norman, OK	Has a well organized cooperation with the city to handle problems with accessibility
RTA - Corpus Christi, TX	Equips buses with a front hydraulic system that lowers the bus for easier access to the steps.
SCAT - Akron, OH	Equips buses with a wider lift Contacts the tri county independent living center to report problems with accessibility
Tulsa Transit - Tulsa, OK	Deploys the lift for walk-ons who have a hard time climbing the steps
VIA - San Antonio, TX	Involved with bus stop and infrastructure improvements Coordinates a door to door service for the paratransit route

Psychological Barrier - Transit system's response to removing psychological barriers

Transit System	Response
DART - Dallas, TX	Offers extensive driver training They make every effort not to leave their paratransit riders behind. If the passenger is not at the designated pick up site the driver will call to make sure they still need a ride.
Metro Transit - Norman, OK	Conducts periodic evaluations of drivers and sits in on routes to make new passengers comfortable and to answer any questions. They have a coordinated who will put new passengers on a route with an experienced driver.
RTA - Corpus Christi, TX	Provides training not only for the passengers, but for the professionals that care for the passengers
SCAT - Akron, OH	Requires that drivers have disability awareness training Offer training programs for the passengers. They allow people to come and examine the lifts in a simulation environment.
Tulsa Transit - Tulsa, OK	Coordinates passenger training seminars designed to help familiarize the passenger with the routes and equipment
VIA - San Antonio, TX	Provides extensive training to the driver They want the drivers to be sensitive to the needs of the disabled.

Informational Barriers - Transit system's response to removing informational barriers

Transit System	Response
DART - Dallas, TX	General information is sent to all applicants Rely service for the hearing impaired
Metro Transit - Norman, OK	Phone numbers are printed on the sides of the buses The United Way and the Chamber of Commerce give the number to people who call
RTA - Corpus Christi, TX	Operator assistance in English and Spanish Brochures are printed in larger font
SCAT - Akron, OH	Provides brochures explaining the various services, lifts and equipment they offer Give presentations to explain services
Tulsa Transit - Tulsa, OK	Print newsletters and advertise in the newspaper Rely service for the hearing impaired • TV commercials
VIA - San Antonio, TX	Presentations on services provided Announce stops ahead of time

TECHNOLOGY TO REMOVE BARRIERS

Technology to remove barriers in the physical and psychological domains has advanced slowly through the years, but the pace has quickened with the advent of ADA. The major areas for technology development are:

- Ingress and egress from transit vehicles
- Securement of mobility aids and occupant protection
- Information transfer to those who are sensorily or cognitively disabled concerning route guidance, stop information, fare collection, and other operations
- Communications to improve scheduling and pickup/dropoff

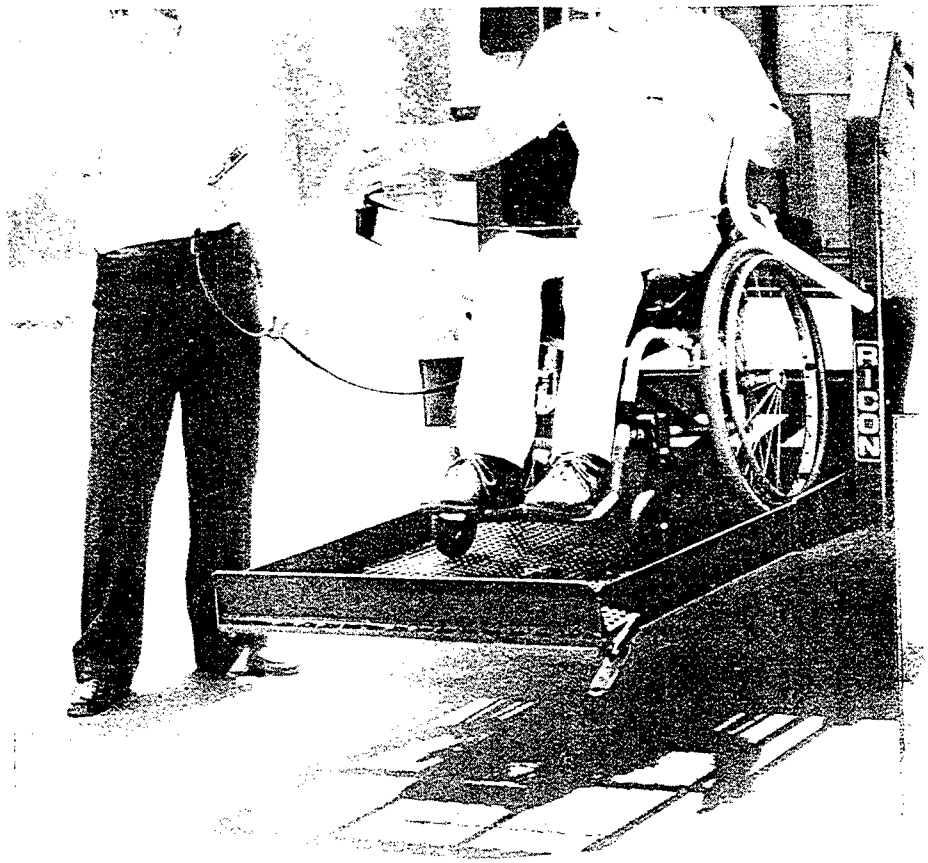
Each of the subsections that follow will discuss these major areas of emerging technology.

Mobility Aid Lifts

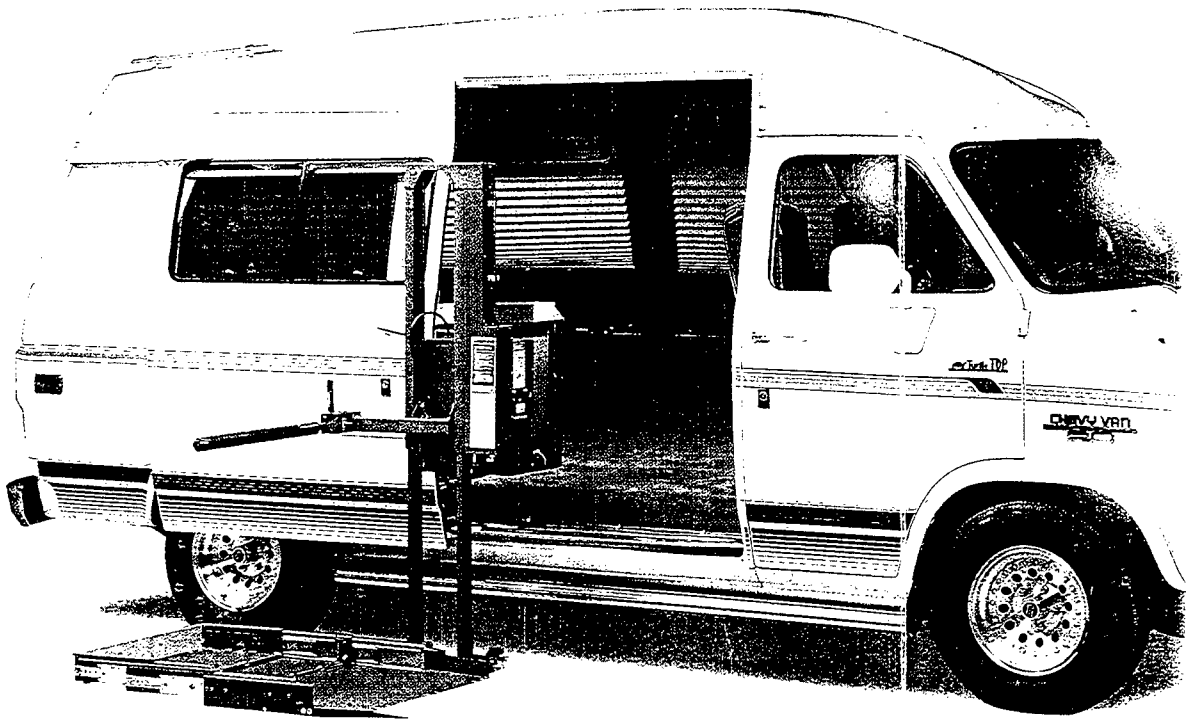
The earliest wheelchair lifts were 1950's adaptations of tailgate lifts long used on moving vans and delivery vehicles. These crude lifts were equipped with (some) redundancy to become person-rated and given pendant controls which might or might not be operable by the lift user. By the late 1960's the modern varieties of wheelchair lifts had evolved. There were and are two basic types: the platform lift and the rotary lift. Platform lifts in the personal vehicle market outsell rotary lifts by about a 10:1 ratio, and rotary lifts are almost unknown in transit applications. Exhibit shows a typical transit-type semiautomatic platform lift. The device consists of a support structure typically installed in a doorway or special aperture in the vehicle body. The structure supports a folding platform which swings down from a vertical stowed position to a horizontal position at the level of the vehicle floor. The platform is always equipped with a *rollstop* which helps prevent the user from rolling off the platform until the platform is lowered to the ground. Operation of the lift may be electric or electrohydraulic. Some lifts are equipped with two handrails, some with only one. One variety, which is designed to stow in a box *under* the vehicle, has no handrails.

A rotary lift (Exhibit 2) is designed for swing-out of the rider from the vehicle on a hinge-like swivel. The rider is then lowered to the ground next to the vehicle. Platforms tend to collapse or slide together to conserve space inside the vehicle. The chief advantage of a rotary lift is the comparatively small "footprint" required for the lift when it is deployed out from the vehicle, typically less than half that required by a platform lift. They are, however, more costly and complicated than platform lifts.

EXHIBIT 2



Transit Platform Lift
(Ricon Corp.)



Rotary Lift
(Braun Corp.)

Rear post Swing-A-Way® lift (L800UE shown) provides clear path access for front seat passengers. The optional extended platform is shown.

In the middle to late 1970's, USAF Lt. Colonel Dean Duncan, then with Texas A&M University, developed the first definitive wheelchair lift standard under funding from the Veterans Administration (now the Department of Veterans Affairs). This standard, adopted by the VA as VAPC-A-7708-3, "VA Standard Design and Test Criteria for Safety and Quality of Automatic Wheelchair Lift Systems for Passenger Motor Vehicles," has remained in force since 1977 (VAPC, 1977). More recently, the Society of Automotive Engineers Adaptive Devices Standards Committee has developed and published SAE J2093 and SAE J2092, Design Considerations and Testing of Wheelchair Lifts for Entry to or Exit from a Personally Licensed Vehicle (SAE, 1998)." Although all this activity was carefully confined to *personal* vehicles as opposed to *public* or *transit* vehicles, the lifts built for public transit or school districts or health care facilities are for the most part beefed-up versions of the lifts sold for private use, usually by the same manufacturers.

ADA accessibility Guidelines (Architectural Barriers Board, 1994), subpart 1192.23, specifies design requirements for bus and paratransit lifts which differ little from the personal lift standards and recommended practices cited above. The major differences lie in requiring handrails on each side, and complete interlock to prevent vehicle movement when the lift is deployed.

One manufacturer's specification based on 49CFR Part 38 calls out the following requirements (Braun Corp., 1995):

> "The wheelchair lift shall be of modular steel construction. The bolt-together frame design shall provide rigidity for proper lift alignment and lift operation. The lift shall have been tested to a minimum static load of 2400 lbs. The lift shall have 800 lbs rated lift capacity. The base plate shall be of a welded box design to provide flexural rigidity to minimize lift deflection when placed under load.
>
> "The power supply shall be a 12 volt electric hydraulic system operating two single-acting cylinders. The hydraulic power pack system shall be of modular design allowing for easy removal and field replacement, if needed. There shall be no power-down operation. The operation of the unit shall provide a smooth, jerk-free ride in both up and down directions. The power operation of the hydraulic cylinders shall be of a pull-type design for smooth lifting operation and improved synchronous arm movement. The pivot pins in the trunnion (knuckle) of the pivot arms shall be of stationary design. This design spreads the load over a 300 per cent larger area than the rotating pivot pins, greatly increasing the wear characteristics and eliminating the elongation of the pivot pin holes.
>
> "The flow-controlled gravity-down shall be regulated by external pressure/temperature compensator valves, allowing for easy in-field replacement if needed. Internal cylinder-mounted pressure compensator valves are not permitted.

"The switching system used to regulate platform movement shall be activated by a single arm-mounted cam lever. The switch box for lift operation shall be of a one-hand operation design made of durable ABS plastic. Color-coded rocker switches shall be required and be permanently stamped with the appropriate function legends.

"A manual back-up system shall be provided to ensure operation of the lift in case of electrical failure. The back-up system shall provide a reliable means of manually raising and lowering the lift while occupied. The back-up system shall fold and unfold the platform. The backup pump shall be integrated with the hydraulic power pack system such that no hydraulic lines or fittings are required for fluidic transfer.

"The platform shall be of steel construction and the surface shall be of see-through grating allowing for improved visibility and safer use in inclement weather. The platform shall have a wheelchair passageway width of 30 inches and a length of 51.75 inches, requiring a 55.5 inch vertical clear door opening. The sides of the platform shall be a minimum of 4.25 inches high, measured at platform surface to assure lateral security of the wheelchair.

"The platform shall be automatically folded and unfolded and fully automatic in operation. The platform shall allow both inboard and outboard facing of wheelchair and mobility aid users. No part of the entrance ramp to the platform shall exceed a slope of 1:8 as specified by ADA. The outer approach edge of the ramp commonly referred to be ADA as the threshold shall not exceed 0.5 inch in height and shall have a slope no greater than 1:2.

"The rollstop shall be automatic in operation and a minimum of 8 inches high measured from the platform surface. The automatic rollstop (ARS) shall be power activated and not activated by complex mechanical linkage. The ARS must be activated in the full up position before there is any vertical movement of the outer edge of the lift platform. The ARS must not deploy until the outer end of the platform touches the ground. Rollstops which require vertical platform movement to engage are not acceptable. The use of an ARS that can be disengaged by the lift operator when the platform is above the ground plane is not acceptable. The ARS shall exceed all ADA requirements. The outer boundaries of the platform shall be clearly marked for proper placement of the wheelchair.

"Dual handrails shall be provided to add security and convenience. These handrails shall be 1.25 inch minimum diameter, minimum 30 inches in height, minimum of 8 inches in length, and withstand a 100 lb force in any direction including vertical.

"All lift components shall be finished with a baked-on powder coating, which will meet a salt spray test of 1000 hours, to provide corrosion resistance and a long service life.

While the foregoing reflects one manufacturer's implementation of the ADA requirements, and go somewhat beyond requirements into product design, it is characteristic of the state-of-the-art in the technology of mobility aid lifts. Other manufacturers meet ADA (and the other two lift standards) with designs which differ from Braun's.

Similar language for lift requirements for rapid, light, commuter, and intercity rail cars are also found in the *Accessibility Guidelines*, but again a lift is a lift is a lift. One other requirement exists in the Guidelines that differs from specifications for personal vehicle lifts: the capability of providing ingress and egress for those people who do not use wheeled mobility aids, but require assistance in boarding or alighting. The lift must be capable of being ridden by a standee, one of the reasons for requiring a handrail on each side of the platform. Some of the newest transit vehicle designs that have been discussed on the CTAA web site have integrated lift/elevator systems built into what are otherwise stairwells. Buses are already available that are low floor and can "kneel" to provide access for a person using a mobility aid by deploying a short ramp.

The major consideration in lift design is provision for sufficient reliability and maintainability in transit operations. One of the major barriers to ingress and egress is an inoperative lift. Most lifts are not particularly complicated (although their control logic can be, e.g., the Crow River Vangater II) but they do see considerable wear and tear and require periodic maintenance: lubrication, adjustment, and repair. Most motor pool or bus garage mechanics are not familiar with these units, and require both shop manuals and training/experience in maintaining or repairing them. Most lift manufacturers are really small businesses, and their service documentation can leave something to be desired.

The platforms readily available from aftermarket manufacturers of internal lifts have dimensions of up to 32 inches wide, 51 inches long. This will accommodate almost all wheelchairs, but some of the larger scooters now on the market may not fit on such a platform. There are also externally mounted lifts which are considerably larger than internal units (Exhibit 3).

EXHIBIT 3

Externally Mounted Lift for
Extra Large Platforms
(Braun Corp.)

Baylor College of Medicine Wheelchair Restraint System

Baylor College of Medicine's research and development effort during the period 1994-95 was sponsored under the Transportation Research Board's IDEA Program (Krouskop, 1995). Dr. Thomas A. Krouskop and a team of researchers designed and tested an innovative concept for a wheelchair tiedown unit suitable for any kind of transit vehicle.

The work was based on a need arising from several considerations about existing design wheelchair tiedowns:

(1) Current design restraints take too much time to fasten or unfasten and they invade the personal space. Tie-down times were estimated in the range of 30 seconds (very short) to up to 5 minutes, including time for the positioning of the chair.

(2) ADA requirements call for either front or rear facing in a minimum 30 x 48 inch footprint with either a two- or four- point tiedown. Free play can be no more than 1.5 inches. Although passenger restraint is required on many paratransit operations, they are optional on most buses, if for no other reason than belts are never required for able-bodied passengers. Wheelchair lift platform sizes restrict the size wheelchair that needs to be accommodated by any tiedown to 30 x 48 inches.

(3) All resources say that the driver should be removed from active participation in the tiedown process. For liability considerations the driver may or should verify adequate tiedown, but drivers are often neither able or willing to take an active role in tiedown operation. Their job is to drive the bus, not act as an attendant.

The project team reviewed other on-going work on either developing wheelchair tiedowns or in the writing of standards for wheelchair tiedown design. The state-of-the-art overwhelmingly is in the direction of 4-point "cargo" type straps, with or without 3-point occupant restraints or pelvic restraints. Wheelchairs often come equipped with seemingly automotive quality belts for retaining the user in the chair, but these belts are almost invariably not adequately anchored to be of much avail in a crash. Sheet metal screws into tubing will not hold under the dynamics of the typical crash.

Design Approach

The basic concept is shown in Exhibit 4. Pneumatically operated "bristles" provide the restraining force necessary to stabilize the wheelchair in the dynamic environment of a transit vehicle, without a residual force on the wheelchair frame which could cause the chair to collapse. The design uses two stages of activation. In stage 1 the Teflon (R)

EXHIBIT 4

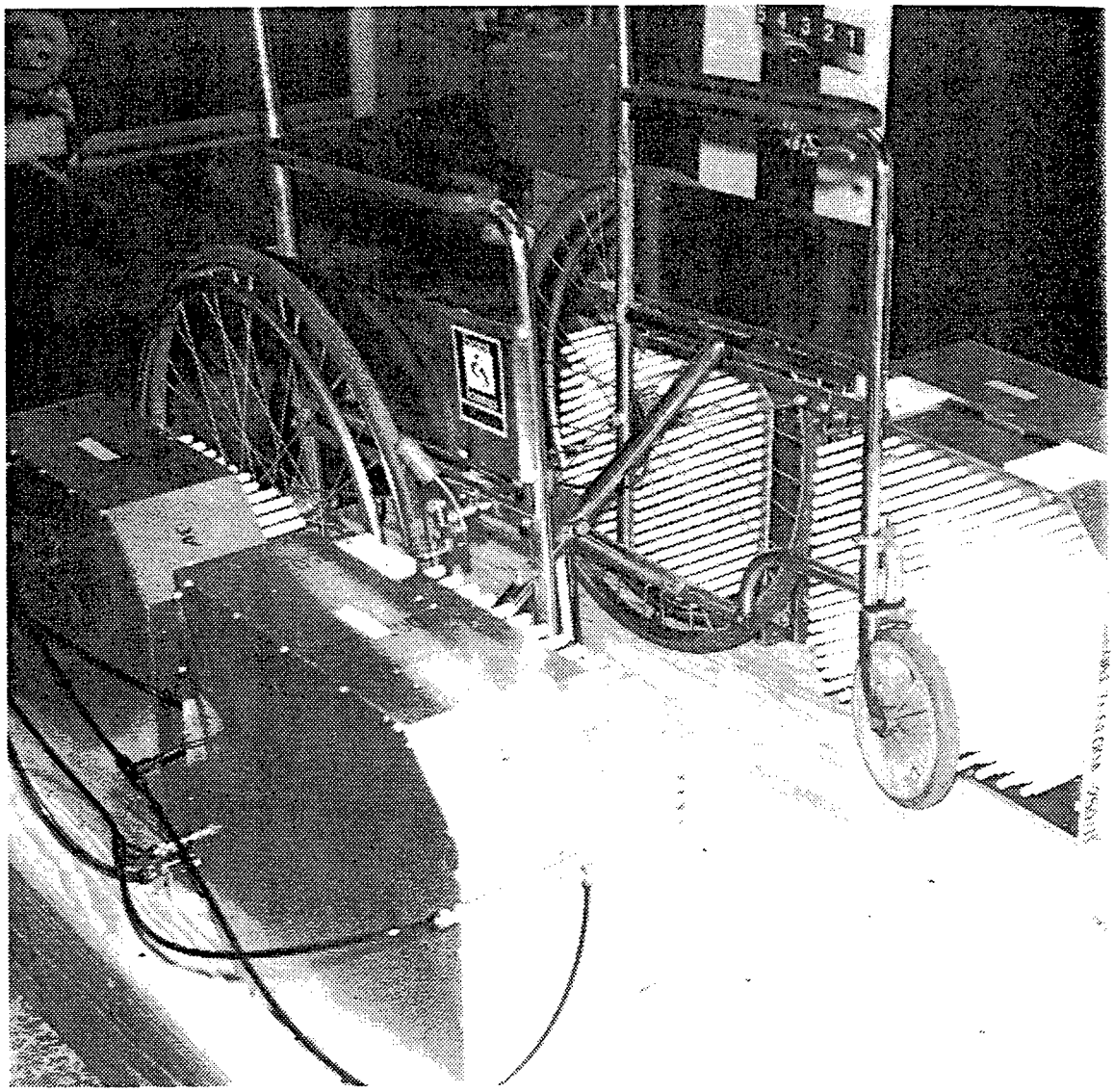


FIGURE 1 Prototype wheelchair restraint

(Baylor College of Medicine)

bristles extend to their limit. Each bristle is independently extended by means of an inflatable bladder behind the bristle holding surface. The second stage then moves one or both of the bristle holding assemblies inboard to engage the wheelchair. During this second stage the bristles slide in and out freely to engage spokes, tubes, and other structures of the chair, forming a kind of mold of the engaged portions of the chair. When deployment and engagement is complete, the bristles lock in place by inflating elastomeric tubing placed next to the rows of bristles. The engaged "mold" is a relatively large area of containment which acts to keep stresses on the structure of the wheelchair as low as possible consistent with positive retention.

To satisfy another design constraint associated with current buses, a sliding mechanism was designed to permit this tiedown system to be stored as part of a folding passenger seat. When the tiedown is to be used, the passenger seat bottom is raised and the tiedown is slid into the aisle to provide sufficient maneuvering room for the wheelchair. Once positioned," the modules along the aisle move toward the wheelchair to reduce the box travel required for capture. The concept, in mockup form, was fit checked in several Houston Metro lift buses and found to be suitable as regards the space constraints of the transit vehicle.

Static Tests

A limited series of static tests of this concept were conducted in the summer of 1995. The test setup is shown in Exhibit 5. An E&J Premier manual wheelchair braced with plywood to resist folding was used in these tests. The dummy used was a 50th percentile anthropometric dummy used in crash tests. By means of a hydraulic actuator, pull forces were exerted on the chair and dummy in the forward direction, simulating a deceleration. Pull force was increased in increments of 250 lbs until release of the chair (loss of tension on the pull chain) occurred. Over four separate pull tests, the applied force on the chair to point of slippage varied from 890 lbs to 1214 lbs, with an average value of 1025 lbs, a deceleration loading of 8 g's. The design goal was 10 g's, so further design refinement will be required.

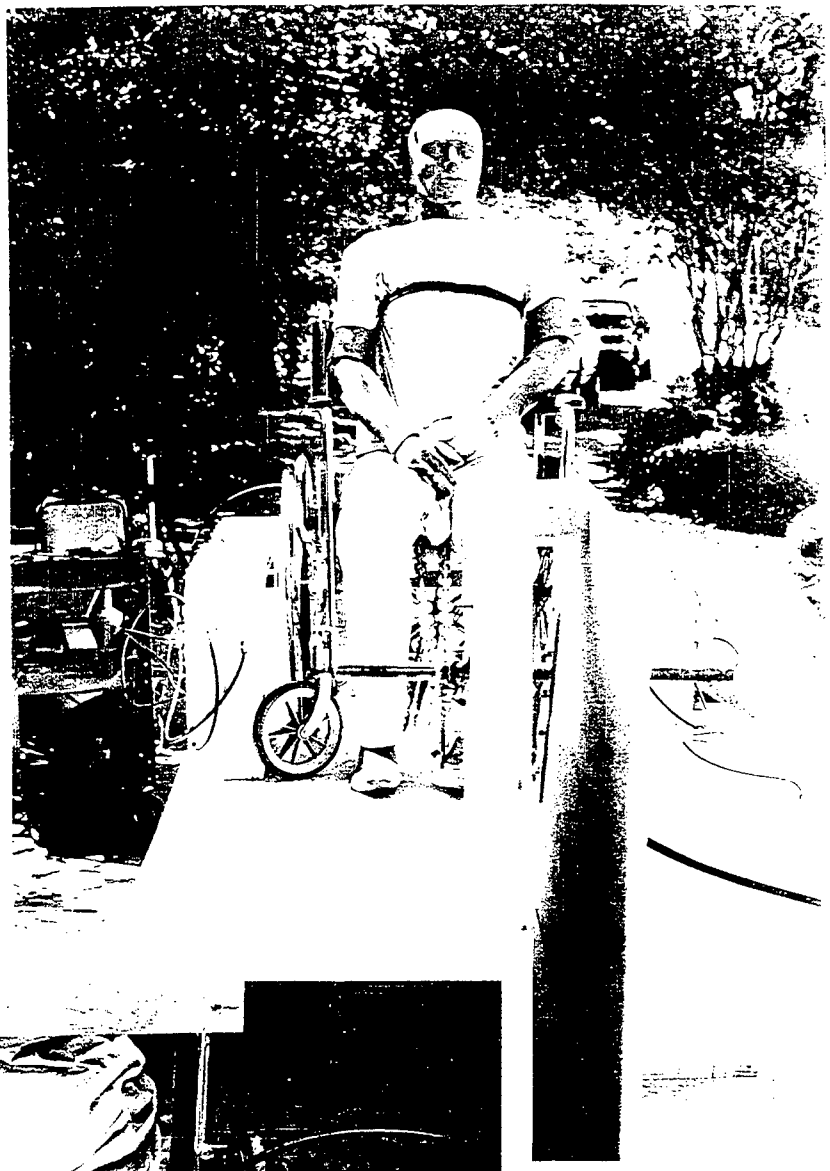
The tiedown resists movement of the captured wheelchair to a certain threshold, and then allows the chair to "comb" through the assembly, thus dissipating a great deal of energy. Some damage resulted to the wheelchair around the hubs of the main wheels, but not to the point of rendering the chair unusable. Movement of the captured wheelchair in excess of 0.79 inch makes wheelchair occupants uncomfortable, although at high g-loadings unless they are belted in, they will not still be in the wheelchair anyway.

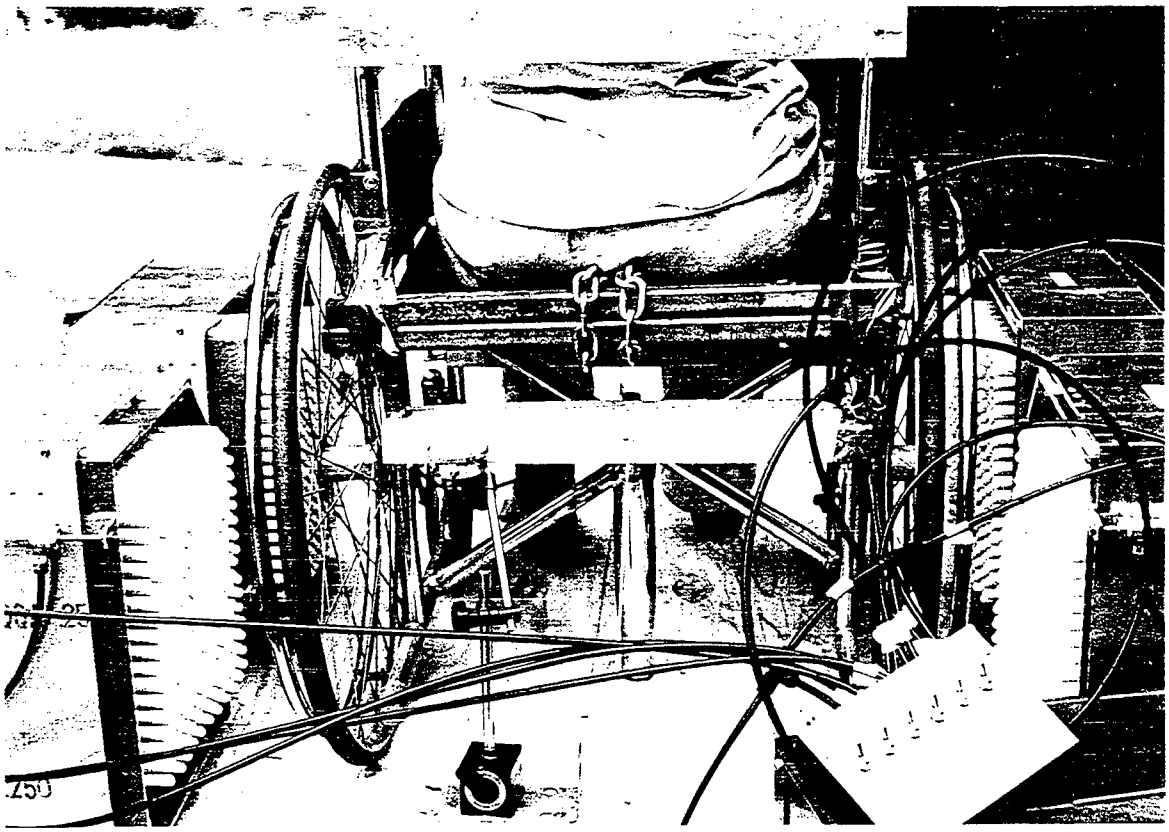
Status of the Concept

The practicality of the Baylor wheelchair tiedown was conclusively demonstrated. The device can quickly, and without modifications to the wheelchair, effectively capture the chair within one minute or less. There is no requirement for a transit vehicle

EXHIBIT 5

Static Load Test Setup
(Baylor College of Medicine)





Rear View, showing "Bristles"
(Baylor College of Medicine)

operator to attach anything to the chair or even precisely align the chair for capture. The bristle mechanism prevents application of stress to even a foldable chair. Further design refinements are necessary to make the device suitable for sustaining the limit of 10 g's required for standard seating in a transit vehicle, but the design prototype came close, at least in static tests. Dynamic (crash) testing will be necessary after further design effort to verify performance of the Baylor wheelchair tiedown. At the present time (May 1998) a proposal is pending with the National Research Council to continue work on the concept.

Oregon State University Securement System

This multi-phase project was performed under the auspices of the Federal transit Administration and Project ACTION of the National Easter Seal Society by Oregon State University researchers under the direction of K. M. Hunter-Zaworski (1992). The goal was to come up with a prototype design of a "universal" mobility aid securement system and compatible occupant restraint for use in transit vehicles. Some ground rules for this development effort were:

- On fixed route vehicles, securement has to be rugged to withstand wear and tear from the general public, and must be capable of being placed out of the way when not in use

- Fixed route drivers are neither trained or oftentimes able to assist with operation of securement devices; a rider of such vehicles can be assumed to be capable of using a suitable securement system by themselves or with minimal assistance. In contrast a paratransit or special route driver is both trained to render assistance to disabled riders and expected to do so

- Time constraints on fixed route vehicle operations are very tight and preclude most conventional types of securement

- Special route or paratransit vehicles are much more flexible in every way for integrating securement devices for mobility aids: cheaper, not ridden by the general public, and not under such rigid time constraints

- Dynamic criteria for smaller paratransit type vehicles (typically passenger vans) are much more stringent than for large transit vehicles: masses are much smaller and acceleration/deceleration profiles much higher, egress under emergency conditions is much more difficult from a lighter, smaller vehicle

Project Activities

This project involved determining state-of-the-art in wheelchair/mobility aid tiedown and user restraint, preliminary design of alternatives for the securement system, evaluation by user groups, prototype development, and dynamic testing of the design. One of the overriding considerations in this whole effort is how mobility aids have changed in the last few years. There is literally no such thing as a "standard wheelchair" either manual or powered, and certainly no such thing as a "standard scooter." Many if not most mobility aids are custom tailored for the individual user. In addition to sled tests of the design, a certain amount of "real world" use in an actual transit system was done, with very encouraging results.

Description of the Securement System

The Oregon State University Securement System is designed to secure a mobility aid in the forward-facing direction. It has a capture mechanism mounted on the floor (it could probably be on a transverse wall as well) and what the project report describes as a "trailer hitch" on the back of the mobility device. This hitch or more properly interface unit must be attached to the mobility aid of any would-be rider. It consists of two D-shaped rings mounted 14.5 inches apart (laterally). The rings are 4 inches high. The user backs into the capture mechanism which automatically latches. When the rider wishes to leave the vehicle, he or she pushes a release switch. The driver or operator also has a release switch if the rider cannot reach or operate the switch.

The hitch structure is tailored to the particular design mobility aid, but always culminates in the same two D rings mounted 14.5 inches apart. On foldable wheelchairs, the hitch is in parts, a bar with the rings that snaps into two brackets on the wheelchair structure. Presumably a bystander or the driver would have to install this bar to allow the disabled person to ride the transit vehicle. The entire interface assembly weighs only 3.5 lbs and is said to not pose any mobility obstacles because of protruding parts, etc.

The latches on the securement mechanism are similar to those used for power door latches (and probably similar to that use in the Constantin EZ Lock. The latches are on a rectangular box which surmounts a pedestal in such a way that both transverse and longitudinal movement (with respect to the chair) is possible. This concept is somewhat like that used in certain applications in the space program for docking. The unit is shock mounted on rubber cylinders to help absorb energy in the event of a crash.

The Cleveland Securement System

This project was a cooperative effort of the Cleveland (Ohio) Clinic Foundation, the Services for Independent Living, the Akron Metro RTA, LAKETRAN, and the Greater Cleveland RTA (Reger and Adams, undated). The Cleveland Clinic did the R&D and also conducted the evaluations of the concept. The project had the following goals:

1. Compare the Cleveland Securement System as developed with several other commercially available wheelchair securement units (one the ubiquitous 4-strap tiedown with three-point occupant restraint marketed by Q'Straint, Kinedyne, and others; the other the older wheelclamp units made by Braun and others which are suitable only for spoke-wheel conventional wheelchairs).

2. Improve the design of the Cleveland Securement System as a result of the evaluation effort.

3. Develop mobility aid securement selection guidelines for public transit authorities.

Ultimately three prototype units were built and installed in three different vehicles, one a fixed route type transit bus, and the other two paratransit type passenger vans. Volunteer riders with disabilities who used mobility aids rode the vehicles and made observations concerning their comfort and ease of use of the Cleveland Securement System.

The Cleveland Securement System consists of a docking latch mounted on the surface of a "modesty" wall located transversely in the transit vehicle. A mating receptacle attached to the wheelchair or scooter mates with the latch. The latch swings up to release, when the rider operates a cable operated release. The system includes both permanently mounted receptacles and temporary receptacles that could be mounted in a few minutes by the bus driver. The mobility aid securement location also has a stabilizer strap to the sidewall to stabilize the mobility aid in rear and side collisions, and an occupant protection belt for torso and pelvic restraint. These belts proved troublesome and conducive to mistakes in fastening properly, a not uncommon failing of almost all special restraint devices.

Riders all seemed to like the Cleveland Securement System, and found it easy to use. Docking into the latch took some practice, but securement in under 90 seconds seemed feasible.

For some reason, developers had a goal of trying to hold a mobility aid under g loadings of 30. For a 200 lb rider in a 200 lb mobility aid (some weigh considerably more) this works out to 12,000 lbs. A static load test determined that the latch could approach 15 g's. This would probably be adequate for large transit vehicles.

Technology for Enhancing Information Transfer

What may be adequate information for the everyday commuter may be far from adequate for the first-time user even if he or she has no significant disabilities. For those who have sensory or cognitive disabilities, adequate information transfer becomes the cruicial difference between successful and unsuccessful use of a transit system. Recent work by the Texas Transportation Institute on bus stop design (Fitzpatrick, et al 1996), on passenger information services (Weatherby and Higgins, 1998), and on bus route guidance information design (Koppa and Higgins, 1996) provides specific guidelines for accessible bus stops and signage for all aspects of a transit trip. These reports specifically call out requirements and provide design information to comply with ADA. Although Weatherby and Higgins mention the importance of interaction between the transit vehicle operator and the riding public, such interaction can be even more important when accommodating a person with sensory or cognitive disabilities.

Very often, simple solutions to the barriers disabled people face in using transit services can work exceptionally well, if given the chance and if adequately reinforced. The following essay was written by Jim Flemming and appeared on the CTAA web site cogently expresses the simplest solution to riders getting lost prior to boarding and during the trip (Flemming, 1998).

Calling Out Stops: A Simple Act, Often Forgotten

By Jim Flemming

Almost unperceptively, close to eight years have elapsed since the signing of the Americans with Disabilities Act (ADA). With little more than 24 months left before celebrating the 10th anniversary of the ADA, some members of the disability community are beginning to identify the areas where real progress has been made and those where substantial work remains.

The Federal Transit Administration (FTA) reports that 68 percent of the nation's approximately 50,000 fixed-route buses are lift-equipped today, a far cry from 1990. However, the act of putting a lift on a bus does not by itself make that bus accessible. Progress toward making public transportation services fully accessible is undeniable and worthy of celebration. Disability advocates and transit professionals acknowledge, nevertheless, that more work needs to be done in certain areas. Take, for example, the ADA civil rights guarantee of making stop and other related announcements on fixed-route vehicles.

The following account is based on information provided by the American Council of the Blind (ACB) -- a national advocacy organization for people with visual disabilities -- which has assumed a proactive role in making fixed-route public transportation services fully accessible to the blind community.

ACB's efforts have been directed at overcoming one of the most important barriers experienced by blind and visually impaired persons in using fixed-route bus and many rail services -- compliance with the ADA mandate of calling out stops and making other related announcements. Announcing stops, routes and destinations is the accessibility equivalent to people with visual disabilities and those who cannot read of the lift for people with mobility impairments.

Calling out stops is more, however, than just another federal regulation imposed upon the public transportation field. It is the right thing to do, from both an economic and customer service perspective.

The Problem and the Response

Many people with visual disabilities have frustratingly come to the conclusion that much of the nation's fixed-route bus fleet, with few exceptions, is largely inaccessible to them. ACB's own preliminary estimates indicate that the average compliance rate for fixed-route bus operators in calling out stops is not more than 10 pecent to 15 percent nationally.

The impact of a largely inaccessible fixed-route bus and rail system on the lives and travel experiences of blind and visually impaired persons and others with disabilities is unmistakable and clear. Those who use these services are put at great risk since getting off at the wrong stop can pose serious safety hazards for blind and visually impaired riders. Those who get on the wrong bus because of an operator's failure to announce the bus route and destination risk becoming disoriented, lost, injured or worse by getting off at an unfamiliar stop.

For scores of people with visual disabilities, however, a largely inaccessible fixed-route bus fleet means that they remain separated from the community, and all too often they are left with little choice but to depend on more costly paratransit services. The vast majority of blind and visually impaired persons in this country today qualify, under the ADA, for paratransit services because of the inaccessibility of fixed-route vehicles. This significantly slows down or even halts national and local efforts by disability groups and transit agencies to transition blind and visually impaired persons onto fixed-route services. It also means that new blind and visually impaired applicants for ADA paratransit services automatically qualify because there is a consistent pattern of noncompliance in calling out stops in fixed-route vehicles, even though they may otherwise be considered functionally capable of using fixed-route services. FTA estimates that the entire national bus fleet is expected to be fully lift-equipped shortly

after the year 2000. Yet, there is no information on how the industry is doing on the stop announcement issue because there is no national database on compliance rates, no reporting requirements for transit agencies on stop announcement compliance rates and no requirement that transit agencies track compliance rates on a regular basis.

A Matter of Priorities

Little priority and few resources have been given to the stop announcement issue. Why has the commitment on the stop announcement issue at the national level lagged? Part of the answer, ironically, may be that compliance is a very straight forward and uncomplicated matter. And it makes economic and customer service sense.

Economically speaking, calling out stops can save a transit agency money on its annual insurance premiums. *Community Transportation* talked to one transit agency that received a 5 percent discount on its premiums because calling out stops seriously reduced slip-and-fall accidents. Calling out stops is also a valuable customer service to passengers with and without visual disabilities.

So why have transit agencies been unable or unwilling to enforce the stop announcement guarantee? The answer is not simple. Stop announcement compliance has been tied to the willingness and ability of transit agencies to enforce their disciplinary procedures. Many transit agencies have been reluctant to enforce stop announcement compliance by disciplining operators for fear that enforcement efforts will either get bogged down in lengthy appeals or tip the delicate balance of labor-management relations. Also, transit agencies will not enforce disciplinary procedures when there are no credible and qualified witnesses or if there is no reliable or objective monitoring or tracking system.

Indeed, many transit agencies have no monitoring system in place and, if they do, it may not provide the kind of consistent, reliable information on compliance rates that would be needed to identify both compliant and non-compliant operators.

As we all know, people are often resistant to change. Bus drivers are no different. The prevailing fixed-route operator culture also has often generated a mind set that is resistant and even antagonistic to the idea of calling out stops. Many operators say they have little management and supervisory support and now have to perform multiple functions which makes it difficult to call out stops on a consistent basis.

Operators complain that they are routinely ridiculed by riders when stops are called out and in some neighborhoods they have reported instances of being physically assaulted when stops are called out (it happened in Boston!). Operators go on to say that most riders know where they are going and do not listen to stop announcements anyway. Many operators have indicated that they know who their riders are -- especially their

blind riders -- and therefore know where blind persons need to get off. Operators complain of malfunctioning public address systems and the fact that their announcements can not be heard by bus passengers.

Automation an Answer?

As the news of non-compliance among transit agencies in calling out stops has spread, many have come to believe that automated stop announcement systems will resolve the issue. Unfortunately, the vast majority of transit agencies today do not have automated stop announcement systems. FTA reports that only 2 percent to 4 percent of the nation's 50,000 fixed-route buses are equipped with such systems, thus leaving it up to operators to audibly call stops for 96 percent to 98 percent of the fleet. Those who have ordered such systems still have to contend with the problem of operator compliance for those older buses that are still on the street. Many operators still have to press a button to operate automated announcements, and ACB has received reports that some operators have turned off these systems because they consider automated announcements to be an annoyance and a distraction. ACB estimates that it could take 15 to 20 years before the entire national bus fleet is equipped with automated stop announcement systems.

A Simple Act Often Forgotten

Thus, a complex mix of factors -- the lack of management and supervisory support, labor-management entanglements, the non-enforcement of disciplinary policies and procedures, non-existent or unreliable monitoring and tracking systems, an operator culture or mind set resistant to calling out stops and a whole range of other systemic problems -- have all worked together to undermine compliance with the simple act of calling out stops and making other announcements.

Except in a relatively few communities, the pattern of non-compliance is about the same as it was when the ADA was signed into law. The severity of the compliance issue on the stop announcement guarantee has been flagged on two other fronts. First, the American Public Transit Association (APTA) several years ago conducted a survey of its members on ADA compliance issues and found that the problem of noncompliance with respect to the ADA stop announcement guarantee ranked second only to difficulties in implementing the ADA as a result of federal cutbacks in transit operating subsidiaries. Second, a number of class action lawsuits filed in recent years against transit agencies have included allegations of widespread non-compliance by fixed route operators in calling out stops...

Emerging Solutions

The systemic barriers on the stop announcement issue are not insurmountable. They can be overcome by implementing a broad-based strategy which includes the following elements:

- Regulatory Changes: Some advocates and transit professionals believe that the current DOT regulations need to be reexamined to determine whether changes should be made that will hasten compliance. A few of the issues that have been identified concern the possible need for:

  - Requiring that transit agencies report on an annual basis to FTA stop announcement compliance rates based on reliable and objective data.

  - Requiring that transit agencies comply with specific requirements for maintaining public address systems and repairing such systems within a prescribed time frame.

  - Clarifying the regulations to indicate that blind and visually impaired persons would qualify for ADA paratransit services if operators of fixed-route vehicles failed to call stops and make other announcements consistently.

  - Defining the role of technology in achieving compliance.

- Training and Technical Assistance: The National Easter Seal Society's Project ACTION has provided support through its recent funding of ACB's national stop announcement training program for operators and supervisors. This innovative program has demonstrated that it can achieve full compliance as well as significant increases in compliance rates when the program principles and practices are applied on a consistent basis by transit agencies. One transit agency (in Cleveland, Ohio) used as a pilot site for testing the model achieved 100 percent compliance in calling out stops by applying the program principles developed by ACB.

- The Role of Technology: High tech solutions on the stop announcement issue are widely known to transit professionals and disability advocates. However, there is a need to identify and develop new low-tech approaches that are cost effective and, at the same time, make the job of the fixed-route operator who must audibly call stops easier while monitoring stop announcement compliance. Relatively low-cost technology exists today in the form of hands free public address systems that relieve the operator of having to pick up a microphone and manipulate the familiar goose-neck microphone.

New technologies currently are in the concept stage that would allow transit agencies to reliably and objectively monitor stop announcement compliance on existing fixed-route buses. If these two technologies could be combined, significant advances could be made in achieving compliance while making the job of the operator easier.

Conclusion

The success of current and past efforts to promote the use of fixed-route public transportation services through the legitimate emphasis on consumer training, travel training and various initiatives aimed at transitioning individuals onto fixed-route vehicles may largely depend on whether fixed-route vehicles are truly accessible.

Recognizing the tremendous strides made to-date in making such services accessible, the time is at-hand for building upon those successes by providing the resources for a coordinated approach to implementing the ADA stop announcement civil right guarantee.

Communications for Scheduling

The most promising technology that could remove psychological barriers to use of transit by people with disabilities is Automated Vehicle Location and Mobile Data Systems (AVL). AVL is part of the Commercial Vehicle Operations (CVO) thrust within the U.S. DOT's Intelligent Trnasportation Systems initiative. With AVL applications an old story with many delivery and over-the-road commercial fleets, transit systems are adopting AVL to enhance dispatching for paratransit and route scheduling for fixed route systems. Now dispatchers know where every vehicle in the system is, and can communicate with drivers as needed to keep the system moving effectively. The three basic technologies are:

- Signpost: fixed route operators set up receivers along the routes which relay vehicle data and location to a central dispatch center

- Land-based Radio (LORAN): receivers and transmitters are set up a central location and in each vehicle, thus providing dedicated two-way radio (also data transmission) for a complete system

- Global Positioning System (GPS): transit vehicles carry a GPS receiver and transmits location and other information to a central dispatch station.

Although each of these not necessarily mutually exclusive technologies have advantages and disadvantages, more than 58 transit operations use or soon will use AVL. Signpost AVL, with the advent of cheap GPS receivers, is being rapidly supplanted by GPS approaches. Either Signpost or GPS facilitate automated in-vehicle stop announcing system. Looking a little further ahead, AVL can interface with Advanced traffic management Systems to facilitate right-of-way for transit vehicles that have gone off schedule.

Mobile Data Systems

MDS is a refinement of AVL for real-time communications bweteen driver and dispatcher, as a takeoff of ATIS, Advanced Traveler Information Systems. It is especialy suited to demand type scheduling, including route deviation. The driver gets the demand rider's address or location on a display at the driver's station. MDS could also facilitate fare collection, in accruing ride information and then billing riders on a periodic basis.

Geographic Information Systems

GIS provides custom maps in real-time to show both operators and riders where each other are. Routing changes based on ATMS provided information can facilitate efficient and timely operations, largely eliminating one of the most frequently heard complaints about transit and paratransit services: late pickups/arrivals, and no-shows. "Smart Maps" are very definitely in the near future for many if not most transit operators, as costs plummet and capabilities expand.

CONCLUSIONS

1. The trend toward mainlining as many disabled riders as possible toward fixed-route or route-diversion transit will continue, driven by both ADA and by improving technology.

2. Psychological barriers related to feelings of vulnerability at stops, inside some kinds of transit vehicles, and in "getting lost" in the system can still be formidible and may swamp advances in technology: would-be riders will not give the transit system a chance.

3. Great strides have been made in addressing people with either physical (mobility-related) or sensory disabilities; much remains to be done in dealing with those with cognitive impairments.

4. Off-vehicle or "cashless" fare collection through bar code readers or smart cards will offset some psychological barriers to transit use.

5. Route deviation strategies to providing responsive service to disabled people will be much enhanced by Mobile Data Systems technology arising from the Intelligent Transportation Systems national initiative.

6. Better design lifts and lowered-floor/kneeling vehicles are making it much easier for riders with or without wheeled mobility aids to use transit systems.

7. A number of transit systems are implementing training for drivers both to familiarize them with disabilities that they may encounter, but also how to interact with these customers. At the same time transit operations are also offering training to the disabled riders to help them use the alternatives available to them.

8. Much more needs to be done in "getting the word out" to disabled people that public transit will work for them; eligibility for paratransit is still and will remain an issue for many disabled people.

9. Wheelchair and mobility aid lifts, once crude offspring of tailgate lifts, have much improved in both design and in reliability. National and industrial standards now make lifts much more uniform and of better quality. Maintenance of lifts under transit conditions can still pose problems for operators.

10. Mobility aid tiedowns remain the biggest stumbling block to fast, easy accommodation for those who use wheeled mobility aids and do not readily transfer into a standard bus seat. The most effective on the market are 4-strap cargo tiedowns, very complicated and cumbersome to attach.

11. Innovative tiedowns are on the way, but development is slow, probably because funding for such efforts is hard to come by. Only one tiedown currently in design does not require some kind of hardware on the mobility aid to achieve lockdown.

12. Occupant protection is a controversial subject, because able-bodied people are next to never provided with any kind of occupant restraint on a large transit vehicle (except for aircraft). Disabled people in a wheelchair or seated on a scooter are theoretically the same as any other rider seated on a transit seat. But many to most physically disabled people are helpless without their mobility aid, cannot independently transfer, and also cannot hold themselves in place to the same extent that an able-bodied person can. Presently, ADA requires the provision of occupant protection devices for people seated in secured mobility aids.

13. For many disabled riders, nothing would be more simple nor more helpful than the simple announcement of stops and transfer points by drivers. Automated methods of accomplishing the same thing, especially with the advent of GPS technology, will unburden the driver of performing this task, as the technology becomes more and more available.

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