Transit Cooperative Research Program
Sponsored by the Federal Transit Administration

RESEARCH RESULTS DIGEST

November 1998--Number 32

Subject Area: VI Public Transit

Responsible Senior Program Officer: Donna L Vlasak

Accessibility of Automated Fare Vending and Collection for Customers with Disabilities

This TCRP digest summarizes the results of TCRP Project J-7, Topic SA-9A, "Accessibility of Automated Fare Vending and Collection for Customers with Disabilities, " conducted by Daniel K. Boyle, Transportation Management and Design

CONTENTS

INTRODUCTION, 1
- Literature Search, 2
- Issues Related to Accessibility, 2
- Organization of This Report, 2

FARE RELATED ACCESSIBILITY ISSUES, 2
- Fare Vending, 2

SURVEY OF TRANSIT AGENCIES, 3
- Responding Agencies, 3
- Extent of Fare Related Accessibility Problems, 3
- Most Common Types of Fare Related Accessibility Problems, 3
- ADA Plans and Advisory Committees, 5
- Transit Agency Responses to Fare Related Accessibility Problems, 5
- New or Innovative Technologies, 5
- Summary of Survey Results, 6

THE BANKING INDUSTRY AND ATMs, 6
EXPERIENCE IN THE TRANSIT INDUSTRY, 7
CONCLUSIONS, 8
REFERENCES, 8

INTRODUCTION

This digest identifies issues of accessibility to automated fare collection and vending machines by transit customers, examines the extent to which these issues arise, and describes solutions that have been implemented or identified as promising.

Transit agencies throughout the country have introduced a variety of automated fare collection and ticket vending equipment, partially in response to increased labor costs and partially to offer a variety of fare media and payment options to transit customers. At the same time, the implementation of the Americans with Disabilities Act of 1990 (U.S. Public Law 101-336) set requirements for transit accessibility and has encouraged an increasing number of individuals with disabilities to use public transit. In some cases, automated fare vending and collection equipment may operate as barriers to these new or would-be transit customers.

Although United States Department of Transportation (USDOT) regulations incorporate ADA Accessibility Guidelines standards *(1)* relating to certain aspects of fare vending and collection, the regulations deal mostly with "reach ranges," or aspects of dimension such as minimum and maximum placement of certain design elements. Standards regarding communications disabilities, especially for persons with vision disabilities, have only been established in a general fashion. There exists in the current literature no comprehensive exploration of accessibility issues raised by the use of fare vending machines and automated fare collection systems, no understanding of the design applications that can facilitate use of such equipment, and little understanding of how difficulties with the equipment affect transit use by persons with disabilities.

The objectives of this study are to identify

accessibility related issues pertaining to bus and light rail fare collection and vending technology used by the transit industry, to determine the extent to which these issues arise among agencies using either fare vending or automated fare collection, and to note potential solutions that have been implemented or identified as promising future developments to address accessibility issues. Preliminary contact with a small sample of transit agencies and a literature review helped to identify issues related to accessibility by persons with various types of disabilities. This information was used in the development of a survey, which was mailed to more than 50 transit agencies in the United States and Canada. The survey results comprise the main findings of this study. Follow-up interviews with selected respondents elicited additional useful information regarding problems and solutions.

Literature Search

As noted in the original scope for this study and as confirmed by the results of a Transportation Research Information Services (TRIS) and Internet searches, little research has been devoted to the specific topics of the accessibility of fare collection equipment and fare vending machines USDOT *(2)* released a report on ADA compliance noting that accessible vending machines and farecard collection devices are among the accessibility features lacking at 80 percent of key stations identified by agencies operating rail systems in the United States. The primary problem lies in retrofitting older stations, since new rail systems must be fully accessible (St. Louis and Denver are cited as examples of new light rail systems that meet all ADA requirements). There still appears to be a focus on wheelchair accessibility to transit in the discussion of compliance.

Hunter-Zaworski and Hron compiled a thorough bibliography for their 1993 study on improving bus accessibility *(3)*. A 1982 UMTA report addressed transit accessibility for persons with visual and hearing impairments *(4)*; many of its findings continue to be valid. The Smith-Kettlewell Rehabilitation Engineering Research Center *(5,6)* has produced several reports on its "Talking Signs" system developed to guide visually impaired persons through complex environments, including the BART/ MUNI Powell Street Station and two other above-ground MUNI stations, and has noted the potential applicability of this system to fare vending machines. "Verbal Landmarks" is another wayfaring aid using audible signage for visually impaired persons *(7)*. Project ACTION has conducted several research efforts on related topics, but neither the TRIS search nor the literature search conducted via the Internet (using Altavista because of its capabilities for field searching) yielded any studies addressing accessibility concerns specifically related to fare collection or fare vending equipment on bus or light rail.

Issues Related to Accessibility

To gain as much specific information as possible, the survey instrument asked about difficulties encountered by persons with particular types of disabilities. These included:

- visually impaired riders
- hearing-impaired riders
- wheelchair riders
- physically impaired riders
- riders with other disabilities (cognitive disabilities were mentioned under this category).

The survey instrument also contained separate questions regarding fare collection or fare collection equipment and fare vending equipment. At the outset, the project scope suggested that issues related to visually impaired passengers would be most common, but survey results revealed additional issues for wheelchair passengers, those with motor skill impairments, such as difficulty grasping coins or bills, and those with cognitive disabilities, particularly in terms of understanding how to use vending machines for systems with complex fare structures.

Organization of This Report

The next section of this report presents a more detailed discussion of accessibility issues related to both fare vending and fare collection equipment. Survey results are then presented in the following section. Subsequent sections include the experience of the banking industry making automated teller machines (ATMs) accessible to customers with disabilities and examples of problems and solutions at selected transit properties using automated vending machines. The concluding section summarizes findings and recommendations for further research.

FARE RELATED ACCESSIBILITY ISSUES

Fare Vending

Issues related to the accessibility of ticket vending machines (TVMs) include:

- general accessibility in terms of location
- ability to find the TVMs in a station
- height of the machines
- lack of raised characters on TVMs
- ease of using validator inserts or coin inserts
- complex sequences of buttons for any specific trip without tactile pathways
- lack of accessible instructions.

These issues primarily affect riders with visual or cognitive disabilities and riders in wheelchairs. The location of TVMs can cause problems for wheelchair riders if the location is difficult to access and for visually impaired riders who may have difficulty finding the TVM without a tactile pathway, a large-print map, or an audio description of locations within the station. Height of machines affects the ease of reaching buttons for those in wheelchairs. Visually impaired persons generally find raised characters to be of great assistance. Difficulty in using validator or coin inserts is a problem for riders with impaired motor skills, and the inserts can also be difficult for visually impaired riders to find. A complex sequence of buttons without tactile pathways has a negative impact on visually impaired customers and those with cognitive disabilities. The lack of accessible instructions makes it difficult for visually impaired persons to use the TVM.

Issues related to fare collection or fare collection equipment include:

- height and location of farebox
- inability to handle coins or pass
- exact fare requirements.

Interestingly, these issues are not specifically related to automated fare collection, but are more general in nature. Farebox height and location affects visually impaired riders and those in wheelchairs, for whom the farebox can be an impediment. The inability to handle coins or remove a pass is noted most often among riders with impaired motor skills; this inability would presumably extend to swiping fare cards, although this was not specifically mentioned in the surveys or by any of the agencies contacted. Exact fare requirements may be related to the previous issue, in terms of requiring riders to drop a number of coins into the farebox.

A survey instrument was designed to gather information on the nature and extent of problems regarding the accessibility of fare vending machines and fare collection equipment. The next section describes the selection process for transit agencies included in the survey and presents survey results.

SURVEY OF TRANSIT AGENCIES

This section summarizes the current state of the practice through presentation and analysis of survey results. The survey was mailed to the ADA Coordinator at 52 transit agencies in North America. The American Public Transit Association's (APTA) *Transit Fare Summary (8)* was consulted to select agencies for inclusion in this sample. All bus and light rail transit systems that indicated use of vending machines, fare validation machines, magnetic card coders, magnetic card readers, or swipe or other magnetic readers received a survey. The 1995 edition of the *Transit Fare Summary* was used to ensure that all systems surveyed had several years of experience with fare vending or fare collection equipment. Follow-up calls were made to agencies that had not returned the survey approximately one month after the requested date.

Responding Agencies

A total of 23 agencies provided completed surveys, yielding a response rate of 44.2 percent. Seventeen were bus-only systems, and six operated both bus and light rail. Table 1 provides a breakdown of the 23 responding agencies. Eight agencies included in the survey use fare vending machines (including two agencies that also use automated fare collection). These are used for transactions on light rail (four systems), bus (three systems), or both modes (one system). All eight agencies offer automated fare vending as one option for the purchase of a single fare and/or multiple fares.

Thirteen systems use some sort of swipe, magnetic, or smart cards (two of these agencies also use fare vending machines). Four systems report no fare vending or automated fare collection equipment, despite their listing in the APTA summary. It is worth noting that two of these four systems reported problems with fare collection, suggesting that accessibility problems related to fare collection may not necessarily be caused by automated equipment such as swipe card readers.

Extent of Fare Related Accessibility Problems

Only six transit agencies indicated that riders or advocates for persons with disabilities had expressed concern regarding any aspects of fare collection or fare collection equipment. Nearly three-quarters of responding agencies (17 of 23) report no issues regarding fare collection. Of the 13 systems using swipe, magnetic, or smart cards, only three reported concerns regarding fare collection. Fare vending equipment elicited greater concern. The majority of agencies (five of the eight that use fare vending) indicated that the accessibility of fare vending equipment has been raised as an issue by riders or advocates for persons with disabilities. In all, nine of the 23 agencies reported that some aspect of fare vending and/or fare collection technology was of concern in terms of accessibility to persons with disabilities. Table 2 contains information on the extent of reported fare related accessibility problems.

Most Common Types of Fare Related Accessibility Problems

Problems reported by more than one transit agency include the following:

Table 1 Use of Automated Fare Vending or Fare Collection Equipment by Survey Respondents

Agency	City	Automated Fare Vending	Automated Fare Collection
Metro RTA	Akron, OH		
Pace	Arlington Heights, IL		
BATA	Brockton, MA		
NFTA	Buffalo, NY		
Calgary Transit	Calgary, ALB CAN		
CCCTA	Concord, CA		
Miami Valley	RTA Dayton, OH		
TANK	Fort Wright, KY		
Hamilton Street Railway Co	Hamilton, ONT		
CT Transit	Hartford, CT		
Knoxville Area Transit	Knoxville, TN		
Monterey-Salinas Transit	Monterey, CA		
New Jersey Transit	Newark, NJ		
Triangle Transit Authority	Raleigh, NC		
Metrobus	St. Cloud, MN		
SCVTA	San Jose, CA		
City of Scottsdale	Scottsdale, AZ		
King County Metro	Seattle, WA		
Spokane Transit Authority	Spokane, WA		
San Joaquin RTD	Stockton, CA		
Toronto Transit Commission	Toronto, ONT		
Foothill Transit	West Covina, CA		
WSTA	Winston-Salem, NC		

- The location of the farebox impedes maneuverability for wheelchair passengers.
- Passengers with impaired motor skills have difficulty in handling or physically depositing coins, tickets, or transfers.
- The height of the farebox or TVM affects the ability of wheelchair passengers to reach them to deposit or purchase their fare.
- TVMs are difficult or impossible for visually impaired riders to use (due to the lack of raised characters, tactile pathways, and/or accessible instructions or to the complexity of button sequencing required for a typical transaction).

Other reported problems related to fare collection include physical difficulty in showing a pass and resentment over having to present identification for a reduced fare. Other fare vending problems include the complexity of TVMs (and perhaps overall fare policy) for those with cognitive disabilities. General ergonomics and type of fare media offered are other problems that were mentioned by at least one agency. Figure 1 is an example of an older fare vending machine. The red buttons represent the fare to/from a particular station (listed alongside in gray). The transaction is reasonably complex, especially for the occasional rider.

Table 2 Extent of Fare Related Accessibility Problems

Category	Agencies Reporting a Problem	Agencies Reporting No Problems	Total Number of Agencies Reporting
Fare Vending	5	3	8
Fare Collection	6	17	23
Fare Vending or Fare Collection	9	14	23

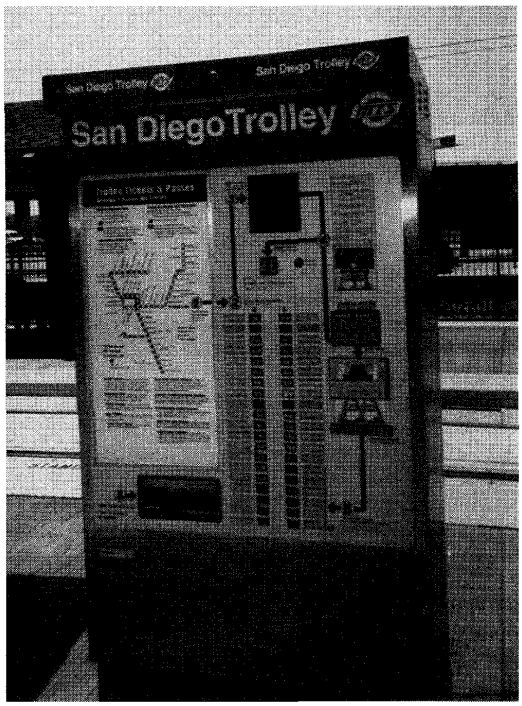

Figure 1. An older fare vending machine at the Old Town Station in San Diego requires a relatively complex transaction

ADA Plans and Advisory Committees

All transit agencies have prepared ADA compliance plans, and nearly half of the agencies responding to this question on the survey indicated that their ADA plan addressed aspects of fare vending or fare collection. TVM accessibility received the greatest attention in ADA plans, but one agency reported that its ADA plan called for operators to assist passengers who have difficulty in depositing the fare. Nearly all agencies have an advisory committee that considers ADA-related issues and can serve as a resource for bringing problems to the attention of the transit agency.

Transit Agency Responses to Fare Related Accessibility Problems

Seven of the nine agencies that reported fare related accessibility problems have implemented or are planning to implement changes in equipment design or procedures, as noted in Table 3. Three agencies focused on TVMs, with actions including a request for proposals for new design options, implementation of ergonomic design criteria, and a retrofit of older TVMs in service on the system. TVM-related design changes include voice instruction, terminal display instruction, raised tactile characters on buttons, braille, and a tactile path to guide passengers through the fare purchase process Other actions taken in response to fare related accessibility problems were to modify farebox mounts to allow the front wheel of a wheelchair to roll under the farebox, to issue a request for proposals for new fareboxes, to introduce smart cards, and to make changes to fare policies. Among the fare policy changes reported were making fare media available for sale through the mail and eliminating surcharges for on-board fare purchase for passengers with disabilities. While no agency mentioned individual or group training specifically, it does appear that use of fare vending and fare collection equipment is incorporated into broader training on how to use the transit system.

Two agencies reported that they encourage their operators to assist riders who have difficulty putting coins in the farebox, and operators at one of these agencies are concerned about handling money. This was the only example among respondents of a less than fully successful solution to a fare related accessibility issue. No agency reported any unanticipated side effects as a result of changes in equipment design or procedures, although there is the possibility that current riders with disabilities may be adversely affected when an agency switches to a new type of equipment.

New or Innovative Technologies

Smart cards, voice instruction, and magnetic swipe cards were the most commonly reported examples of new or innovative technologies being used elsewhere in the transit industry or in other industries to facilitate the accessibility of fare vending and fare collection. Contactless or proximity smart cards record a boarding and deduct the appropriate fare without direct contact between the card and the farebox. These hold considerable promise in addressing issues related to motor skill impairments that make it difficult for passengers to handle money or even to remove a pass, but some agencies are concerned that a smart card system requires an understanding of the transit system's fare structure that goes beyond simply dropping coins in a farebox. Voice instruction is being implemented at several transit properties

Table 3 Responses to Fare Related Accessibility Problems

Category	Number of Agencies
Vending Machine Design/Retrofit	3
Farebox Design	2
Fare Policy Changes	2
RF Smart Cards	1
Technology Committee	1
Total Systems Responding	7

as an option for visually impaired passengers at TVMs. Another TVM enhancement mentioned as an innovation is credit card acceptance for fare purchases. Magnetic swipe cards, of course, are increasingly common throughout the transit industry.

One agency pointed out that the use of web sites to make route and schedule information available electronically could create a problem for visually impaired riders. This issue obviously goes beyond the transit industry, but could surface as an ADA issue.

Only four agencies noted automated vending technologies used in other industries that could be adapted to the transit industry. Two cited smart cards and proximity cards in general. One respondent indicated that a particular manufacturer's smart card system is available in a watch made by Swatch, and would be ideal for some passengers on a contactless smart card system. Another respondent reported a demonstration project in progress by Bell Canada in Ontario that allows smart card or magnetic card changeup over phone lines.

Summary of Survey Results

A majority of transit agencies responding to the survey report that they have experienced no problems related to automated fare vending or fare collection for customers with disabilities. However, five of the eight systems that currently use automated fare vending through TVMs have received complaints from riders or advocates for persons with disabilities. Thus, survey results suggest that automated fare vending creates more problems for riders with disabilities than does automated fare collection.

Moreover, automated fare vending machines, such as TVMs, create particular problems for those with visual impairments, although riders with cognitive disabilities are also affected. There is some evidence of continued problems with creating access to the TVMs for the physically handicapped, especially for the wheelchair patron. However, ADA guidelines outline specific requirements for maximum height of buttons, depending on whether the wheelchair approaches from the side or the front of the machine. Compliance with the ADA regulations in the design and, if necessary, retrofit of TVMs should remove any accessibility problems for patrons in "standard" wheelchairs (30 in. wide by 48 in. long). Some states may have stricter requirements that address access by nonstandard (wider or longer) wheelchairs; one agency suggested the need for flexibility in designing for wheelchair patrons to anticipate current nonstandard designs that may become increasingly prevalent in the future.

Several agencies have implemented solutions to TVM related access problems for customers with disabilities. Solutions have included voice instruction, terminal display instructions, raised tactile characters on buttons, braille, a tactile path to guide passengers through the fare purchase process, and sale of fare media by mail.

THE BANKING INDUSTRY AND ATMs

One of the closest parallels to fare vending machines exists in the banking industry, with the proliferation of ATMs over the past decade. Project team members spoke with representatives of three major banks headquartered on the West Coast to identify any experiences related to the accessibility of ATMs that may be relevant to the transit industry.

The provisions of ADA apply to the banking industry as well as to the transit industry, and so the height of ATMs and the placement of buttons are all governed by these regulations. Banks have upgraded their entire ATM networks using various approaches. One bank installed braille labels on all ATM components and produced an instructional brochure in braille. Another includes raised letters and numbers as well as braille on all ATMs, even those at drive-through locations; the rationale is that a visually impaired person could use a drive-through ATM as a passenger. Extended hours at bank branches mean that a teller is usually available (ATM usage drops sharply after dinnertime and does not begin to rise until the morning rush hour). One bank representative indicated that the bank receives more comments from the disabled community related to the height of the teller counter than to ATMs.

Consistency of ATM design is a concern in making ATMs usable for visually impaired customers. One bank reported that all of its machines in California have a standard layout to access various functions, but that ATMs out of state do not share this standard design. This problem has also arisen when two banks merge. The situation is comparable to a transit agency using two or more generations of ticket vending machines that have design differences. Visually impaired customers tend to memorize the sequence of buttons to press for various types of transactions, but they may not be able to use the same sequence on different machines; this problem is mitigated by the tendency to use a single "home" machine most often.

The banking industry experience suggests that the accessibility of ATMs for customers with disabilities has not been a major issue. Compliance with height and reach guidelines, use of raised letters and numbers and/or braille, a relatively short and straightforward sequence of buttons that can readily be memorized for the most common transactions, and the availability of a teller during regular (extended) banking hours appear to have minimized any problems associated with usage of ATMs by customers with disabilities.

A remaining issue is the use of audio instructions for bank customers with visual impairments. There is a real safety concern regarding broadcasting financial transactions via audio. One bank representative, however, suggested that the "handwriting is on the wall" regarding audio systems and that banks will eventually face additional regulations in this regard unless the industry takes a proactive approach to meet the needs of all of its customers. This observation

could apply equally well to the transit industry, particularly in relation to automated fare vending.

EXPERIENCE IN THE TRANSIT INDUSTRY

Information in this section is based on follow-up discussions with staff members of the Metropolitan Transit Development Board (MTDB) in San Diego, California and New Jersey Transit (NJT) in Newark. Both agencies have experience with automated fare vending machines, although the primary use of these machines at NJT is for commuter rail fares.

MTDB in San Diego is the parent organization of San Diego Trolley, the operator of the light rail system. MTDB has a Trolley Access Advisory Committee that addresses light rail access issues. The committee is composed of members of the disabled community and meets on a bi-monthly basis *(9)*.

Fare vending machines are located at each trolley station, and are the sole means of fare purchases at the stations (except during special events). Several issues have arisen and been addressed in recent years related to access to the fare vending equipment. MTDB has worked with committee members to solve problems and ensure ready access.

Staff members have categorized fare vending access issues as related either to reach or to visibility. Reach issues have been addressed by ADA access guidelines that require the highest point of access to be no more than 54 in. from the ground if the fare vending machine can be approached from the side or 48 in. if it can be approached only from the front *(1)*. Visibility issues have been more challenging, in terms of how to make fare vending equipment accessible to visually impaired customers. In MTDB's experience, the majority of visually impaired customers are not legally blind but do require some assistance in using the machines.

Design features that make it easier for visually impaired customers to use fare vending machines include high contrast surfaces that are not flush with the machine and the tactile ability to locate various entry points. Raised letters and numbers have been fairly effective. Braille is somewhat less effective because only a small percentage of the visually impaired population can read braille *(10)*. The machines feature a tactile path that guides the customer through the process of purchasing a fare. Newer machines also have audio capability to provide additional guidance to visually impaired riders.

One example of the benefits of working closely with the disabled community through an advisory committee arose in relation to the types of fare purchases offered. The advisory committee expressed a strong preference for visually impaired persons to have the ability to purchase any type of fare, not just the discounted fare for the elderly and disabled, through the ticket vending machines. This strong preference to be treated as part of the mainstream may not have occurred to system designers in the absence of consultation.

Figure 2. Newer fare vending machine at the Old Town Station provides an audio option and tactile pathways to guide customers through the transaction.

Addition of an audio component to the fare vending machines has resolved some issues but raised others, such as privacy. Committee members wanted headphones to be available at the machines so that the purchase of a high-value ticket or pass would not be broadcast to all within earshot. After some discussion, it was agreed that providing headphones was not MTDB's responsibility, although the machines have been designed with a universal headphone jack. Figure 2 shows a newer fare vending machine similar in design to ATMs. The screen at the center presents a number of choices, selected with buttons to the left and right of the screen. An audio option is available at the upper left, and headphone plugs are provided for privacy (the passenger must provide the headphones). A tactile pathway guides the customer through the transaction.

Provision of an accessible system map was a final key issue. A fare vending machine assumes a certain amount of knowledge about the transit system, and the fare machines include a map with all of the light rail stops and the corresponding fares. To make the map usable for visually impaired riders, a minimum letter height of five-eighths of an inch was required. Space limitations precluded placement of an accessible map on the vending machine itself. Additionally, a tactile dimension was needed, meaning that the map could not be under glass. Durability concerns led to the choice of metal as the map material, which becomes very hot in the southern California sun. Ultimately, MTDB and the advisory committee jointly reached the decision that an accessible map could not be provided, and that the audio system would be sufficient.

MTDB's experience with fare vending machines may

or may not be typical of the transit industry, but it represents the wide variety of issues that can and do arise related to accessibility. The joint efforts of the agency and the Trolley Access Advisory Committee provide a model for cooperation in identifying and solving accessibility issues in a nonconfrontational manner.

In discussions with personnel from NJT, the issue was raised of whether accessibility problems related to fare vending machines could become more pronounced in the future. NJT offers fare vending as one option for purchase of fare media. Due to the complexity of the commuter rail fare structure, the fare vending machines have not been made accessible to visually impaired riders. Other provisions, such as no surcharge for on-board ticket purchase, availability of fare media by mail, and the ability to purchase fare media from ticket agents at the major stations, lessen the impact of inaccessible fare vending machines. The concern is that, as transit agencies move to fully automated fare vending, the alternative of purchasing a fare from a ticket agent will no longer be available. In this situation, accessibility issues related to fare vending machines could become more prominent in the absence of a back-up alternative. This concern is borne out by recent experience in south Florida. Advocates for the disabled community filed a discrimination complaint against Tri-County Commuter Rail Agency when TVMs replaced ticket agents at rail stations.

CONCLUSIONS

Findings regarding the accessibility of automated fare vending and collection for customers with disabilities are summarized below.

- **Fare vending machines can be difficult for visually impaired customers to use.** Issues include the lack of raised characters and accessible instructions, difficulty in locating key entry points on the machines, and the absence of tactile pathways to help navigate through the complex sequence of buttons. The complexity can also cause difficulties for those with cognitive disabilities. Changes in ticket vending machine design, retrofit of existing machines, and additional options for purchasing fare media are strategies that have successfully addressed these issues.
- **Wheelchair access is addressed by ADA guidelines.** Compliance with ADA should solve all issues related to wheelchair access to fare vending machines.
- **Automated fare collection equipment does not pose special problems for customers with disabilities.** Fare collection problems are primarily related to wheelchair access to and maneuverability around the farebox. Issues related to the ability to handle magnetic swipe cards also apply to cash and pass usage.
- **Transit agencies have successfully implemented solutions to access problems related to fare vending machines.** Audio instruction systems, accessible terminal display instructions, raised tactile characters, provision of tactile pathways to guide passengers through the fare purchase process, and sale of fare media by mail are among the successful solutions.
- **Technological innovations in fare collection offer the promise of solving accessibility issues.** Proximity smart cards would address concerns regarding farebox access and difficulty in handling coins or passes
- **Access problems related to fare vending machines may intensify as agencies move toward fully automated fare vending.** When fare vending machines are the only option for fare purchase, their shortcomings may be magnified. The banking industry experience suggests that teller availability has helped to minimize accessibility problems related to ATMs However, MTDB's experience with the use of fare vending machines as the only option available to purchase fares at light rail stations indicates that this does not automatically intensify access problems Anecdotal evidence from other light-rail properties supports the MTDB finding, but this may emerge as an issue at certain agencies.
- **Clear benefits are obtained by working closely with the disabled community.** The MTDB experience demonstrates that cooperative efforts produce positive results for all concerned.

Future research would usefully focus on fare vending issues as transit agencies move toward increasingly automated fare sales. Heavy rail and commuter rail systems need to be included in the scope of future projects, since many of these systems have long experience with automated fare vending.

REFERENCES

1. Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities, *Federal Register*, July 26, 1991, especially Sections 4.2.5, Forward Reach, 4.2.6, Side Reach, 4.30.4, Raised and Brailled Characters and Pictorial Symbol Signs, and 4.34, ATMs.
2. United States Department of Transportation, *Implementing the Americans with Disabilities Act (ADA), A Report on the Department of Transportation's Accomplishments: ADA and Related Laws; Special Report Commemorating the 6th Anniversary of the ADA*, July 12, 1996.
3. Hunter-Zaworski, K. and M. Hron, *Improving Bus Accessibility Systems for Persons with Sensory and Cognitive Impairments*, Washington, D.C., Federal Transit Administration, DOT-T-94-04, August 1993.
4. Crain-Revis Associates, Inc. and The Washington Consulting Group, *Handbook Describing Low-Cost Concepts and Techniques to Make Public Transportation More Accessible for Visually and Hearing-Impaired*

Persons, Washington, D.C., Urban Mass Transportation Administration, DTM 60-81-72903, April 1982.

5. The Smith-Kettlewell Eye Research Institute, *Proceedings of a Symposium on Consumer, User Agency, Researcher, and Commercial Experience with Talking Signs and Related Technologies*, San Francisco, California, June 27, 1995.
6. Crandall, W. et al., *Transit Accessibility Improvement through Talking Signs Infrared Remote Signage: A Demonstration and Evaluation*, San Francisco, California, The Smith-Kettlewell Eye Research Institute, 1995.
7. Bentzen, B.L and P. Mitchell, Audible Signage as a Wayfinding Aid: Comparison of "Verbal Landmarks" with "Talking Signs," *Accessible Design for the Blind*, Berlin, Massachusetts, September 10, 1993.
8. American Public Transit Association, *1995 Transit Fare Summary*, October 1995.
9. Metropolitan Transit Development Board, *Short Range Transit Plan: FY 1997-2003*, July 1996.
10. Coburn, N. et al., *Guidelines for Improvements to Transit Accessibility for Patrons with Disabilities*, Washington, D C., Federal Transit Administration, DOT-T-9304, September 1992.