NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE 83

BUS TRANSIT ACCESSIBILITY FOR THE HANDICAPPED IN URBAN AREAS

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

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SANDRA ROSENBLOOM
University of Texas at Austin

Topic Panel

STEPHEN E. BLAKE, *Transportation Research Board*
DONALD E. GLASCO, *Federal Highway Administration*
JOHN M. HARTZ, *Wisconsin Department of Transportation*
CAROL KECK, *New York State Department of Transportation*
R. IAN KINGHAM, *Transportation Research Board*
ANTHONY M. RACHAL III, *D.C. Department of Transportation*
PATRICIA E. SIMPICH, *Urban Mass Transportation Administration*
PATRICIA VAN MATRE, *Southern California Rapid Transit Authority*
WILLIAM L. VOLK, *Champaign-Urbana Mass Transit District*

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TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the National Academy of Sciences, or the program sponsors.

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PREFACE

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the engineering ideas of men faced with problems in their day-to-day work. Because there has been a lack of systematic means for bringing such useful information together and making it available to the entire highway fraternity, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize the useful knowledge from all possible sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series attempts to report on the various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which they are utilized in this fashion will quite logically be tempered by the breadth of the user's knowledge in the particular problem area.

FOREWORD

By Staff
Transportation Research Board

This synthesis will be of special interest to transportation administrators and others concerned with experiences in the removal of barriers to the use of bus transit by handicapped persons. Detailed information is included on factors influencing ridership and cost effectiveness.

Administrators, engineers, and researchers are faced continually with many highway problems on which much information already exists either in documented form or in terms of undocumented experience and practice. Unfortunately, this information often is fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem frequently is not assembled in seeking a solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of synthesizing and reporting on common highway problems. Syntheses from this endeavor constitute an NCHRP report series that collects and assembles the various forms of information into single concise documents pertaining to specific highway problems or sets of closely related problems.

Transit systems need information on the implementation of accessible service for handicapped persons. This report of the Transportation Research Board evaluates the effects of operational procedures, maintenance policies, and levels of accessible service provided. Experiences of various agencies in removing barriers to the use of bus transit by the elderly and the physically handicapped are analyzed to determine the influence of these factors on ridership response and cost effectiveness.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

BUS TRANSIT ACCESSIBILITY FOR THE HANDICAPPED IN URBAN AREAS

SUMMARY

Many transit systems provide accessible, fixed-route service for handicapped people, which means that buses on regular routes are equipped with lifts that enable a person in a wheelchair to board the bus. This synthesis is intended to assist transit systems in implementing such services in conformity with state or federal requirements or in response to goals and objectives of individual communities.

The experience of a transit system with wheelchair-lift-equipped (LE) buses is a result of (a) the physical, technical, and operational characteristics of the equipment involved and (b) the characteristics of buses and lifts including length and width of lift, lift attachments (grab bars, side flanges, etc.), location of lift on retrofits, and purchase and use of the kneeling feature of the bus. Design of bus interiors must consider location of furniture and poles; location, number, and type of wheelchair securement areas; total seating capacity; and special flooring. In addition, consideration must be given to the climate and terrain and to the ease of access to stops for both user and bus operator. Design or technical decisions on these items can affect ridership on accessible services, reliability and maintenance of lifts, and scheduling delays due to wheelchair boardings.

The level of accessible service provided, the operational procedures chosen, and the maintenance experiences and policies affect one another. They also affect ridership by both the handicapped and the nonhandicapped. Level of accessible service is determined by the number of LE vehicles in service, the number of routes with LE buses, and the frequency of LE buses on those routes. Operational procedures include the necessary scheduling changes, driving training, policies for stops where operation of wheelchair-lift equipment is not possible, policies for lift malfunction, and service refusal policies. Maintenance experience with lifts, in general, has not been good. Among the reported operating problems are difficulties with electrical and hydraulic systems, unintentional operation of the lift while the bus is in motion, and failure of the lift to cycle down or to stow. Some of these problems may have been solved by manufacturers; however, agencies planning to purchase lifts should contact other agencies that have recently purchased similar equipment to discuss the problems.

Handicapped ridership on most routes with LE buses has been low, but some of the factors affecting ridership are changing. As service becomes more widespread, reliable, and frequent, ridership may increase. Although increased ridership under better conditions cannot be assured, it is clear that poor service deters wheelchair ridership.

The cost effectiveness of accessible transit service depends on how and when various cost items are counted and how and when ridership counts are made. The crucial factor in comparing the cost of accessible service per passenger served to the cost arising from the alternatives is how costs and ridership response are estimated for the alternatives.

Lift-equipped, fixed-route transit service addresses the needs of only a small number of handicapped travelers, principally wheelchair users. Lifts do not meet the problems of many other handicapped travelers—such as information needs (before and during travel), difficulties waiting at stops or standing in a moving vehicle, difficulty in paying fares, and mental disorientation. Many measures would remedy these and other problems, at least in part, but they are not without cost. However, it is not known what the costs are or how many travelers would be aided.

CHAPTER ONE

INTRODUCTION

BACKGROUND AND PURPOSE OF SYNTHESIS

More than 90 transit systems in the United States currently provide accessible, fixed-route transit service to handicapped people. This type of service means that buses on regular routes are equipped with lifts that enable a person in a wheelchair to board the bus. Many of the systems provide these services because of mandates and sanctions from the U.S. Department of Transportation (DOT) (these mandates have recently been changed). However, some of these systems began the purchase of accessible equipment and the delivery of accessible services before DOT mandates were issued. This was in response to community pressures, local and state laws, court orders (Milwaukee), or out-of-court settlements (Austin and Los Angeles). A number of communities will continue to provide at least some fixed-route service with lift-equipped (LE) buses even though DOT regulations have been changed.

Several states, including California and Michigan, have state laws mandating wheelchair lifts on all vehicles purchased. Some communities, including Los Angeles and Seattle, have chosen to provide LE buses on all fixed routes as a response to objectives of handicapped groups. Many transit systems, like the Detroit South Eastern Michigan Transportation Authority (SEMTA), still wish to continue using some LE buses on some of the fixed routes. Other systems wish to compare the full costs of providing for the handicapped LE buses on fixed routes with alternative transportation options in their communities. Implementing accessible transit services in urban areas, therefore, is not merely a question of meeting DOT regulations.

The purpose of this synthesis is to assist localities in implementing DOT regulations and to assist transit systems in considering or implementing either limited or full-system accessible services. The synthesis provides information on the key areas of operation and service in which resources should be concentrated and in which modification of rules and procedures could be considered. The objectives are to:

- Alert transit systems to changes needed in routing, scheduling, maintenance, and training programs to accommodate accessible vehicles, and the cost of such changes.
- Alert transit systems to complementary changes required in other service systems and by other providers.
- Assist transit systems in determining the most effective way to provide safe and reliable services.
- Assist agencies and transit systems in reducing the costs of implementing accessible services by avoiding pitfalls.

To the greatest extent possible, published research reports, evaluations, and project-reported data were used in the preparation of this report. Because the information is limited in the rapidly changing field of bus transit accessibility, some research and firsthand surveying were undertaken.

Only the experiences and practices of urban bus systems or the bus components of multimodal transit systems are dealt with here. The problems facing urban bus systems as they implement accessible service in LE vehicles are of great overall interest, and solutions to those problems have wide applicability. In addition, accessibility can be considered only for the large, heavy-duty transit coaches more than 35 ft (11 m) long, which are traditionally used in urban systems. The issues raised by DOT accessibility requirements for rail systems are very different from those for bus systems in both scope and direction, and it would have been difficult to adequately survey and evaluate the accessibility experiences of multiple modes (light rail, heavy rail, etc.) and report the findings in a detailed and useful way.

FEDERAL LEGISLATION AND REGULATIONS

The Congress of the United States, through several major statutes, has made it national policy that elderly and handicapped travelers shall have the same right to transportation services and the same access to transportation facilities as the general public (Section 16 of the Urban Mass Transportation Act of 1964, as amended, the Architectural Barrier Act of 1968 [PL–90–480], and Section 165[b] of the Federal Aid Highway Act of 1973, as amended). The DOT has issued a series of regulations designed to implement the important components of federal legislation.

Section 16 of the Urban Mass Transportation Act of 1964

In April 1976 and September 1977 the Urban Mass Transportation Administration (UMTA) issued regulations pursuant to Section 16 of the Urban Mass Transportation Act of 1964, as amended. These regulations required that new mass transit vehicles and facilities be fully accessible to the elderly and the handicapped, including wheelchair users. New standard buses ordered after September 1979 were to have low floors and ramps for the handicapped.

Transbus Program

In the late 1960s UMTA began a research and development program aimed at developing a new urban transit coach (Transbus). The purpose was to encourage major design improvements in a vehicle that had not been changed since 1959. The original program was only tangentially concerned with the needs of handicapped travelers.

In July 1976 UMTA issued a composite specification for

Transbus, which mandated that all new buses bought with federal funds had to have front step risers not greater than 8 in. (200 mm) in height, wheelchair-accessible devices as an option, and an effective floor height of 24 in. (60 cm) or less after use of a bus kneeling feature. Litigation by a bus manufacturer and various elderly and handicapped groups virtually halted Transbus procurement at this point.

In May 1977 the DOT secretary reissued the Transbus specifications, requiring that after September 30, 1979, all buses purchased with federal funds meet the Transbus specifications. In January 1979 three cities (Los Angeles, Miami, and Philadelphia) formed a consortium and requested bids for 530 buses built according to the Transbus Procurement Requirements as developed by UMTA and with an addendum by the consortium. No bids from any U.S. manufacturers were received.

The DOT secretary then asked the National Research Council (NRC) of the National Academy of Sciences to establish an independent panel to review the Transbus specifications, performance, and costs. The NRC panel also chose to undertake specific evaluation of the alternatives to Transbus that could serve the needs of handicapped and elderly travelers. The secretary received the NRC report on August 31, 1979 (*1*). Since that time the DOT has been in the process of formulating alternative action plans regarding Transbus.

Rehabilitation Act of 1973

In January 1978 the U.S. Department of Health, Education, and Welfare (HEW) issued enforcement procedures and guidelines designed to implement Section 504 of the Rehabilitation Act of 1973, pursuant to Executive Order 11914. That act introduced the concept of "program accessibility" and states, in part: "No otherwise qualified handicapped individual in the United States . . . shall. . . solely by reason of his handicap, be excluded from participation in, be denied the benefits of, or be subject to discrimination under any program or activity receiving federal financial assistance. . . ."

Section 84.1 of the HEW regulations defines a handicapped person as any person who has a physical or mental impairment that substantially limits one or more major life activities. The impairments include physiological disorders or conditions, cosmetic disfigurements, anatomical loss, and any mental or psychological disorder.

The HEW guidelines issued in the beginning of 1978 listed several major requirements for the DOT:

- Guidelines on what constituted nondiscrimination against the handicapped in its programs were to be issued by the DOT. The criterion for eliminating discrimination was "equal opportunity to receive the benefits of federally funded services."
- The handicapped were not to be excluded by physical barriers, although it was not required that existing facilities be "barrier free."
- The highest priority should be given to an integrated service appropriate to handicapped needs. The DOT was allowed, however, to consider alternatives to structural changes if they provided "equal opportunity." Nevertheless, even where alternatives to structural change were found to offer equal opportunity, the DOT was not to ignore any mode that received federal assistance.

DOT 504 Requirements

On May 31, 1979, the DOT issued its final Rule pursuant to the HEW mandate, implementing Section 504 of the Rehabilitation Act of 1973 (*2*). This rule defined program accessibility, set schedules and deadlines, and required that accessibility be achieved by transit systems using a "staged series of fixed facility modifications, replacements, and new construction that reflects reasonable and steady programs" (*2*, Section 27.83).

DOT program accessibility was defined differently for rail facilities and bus systems and for wheelchair and nonwheelchair users. Program accessibility for persons who are able to use steps was defined as full-system accessibility for all highway and transit modes. Program accessibility for wheelchair users was defined as accessibility to one-half of the fixed-route vehicles in peak-hour service (for buses and light rail) and to key stations as defined for all rail systems. This accessibility was to be achieved within 3 yr of July 2, 1979. It was stipulated that, if extraordinarily expensive structural changes were to be required, deadlines could be extended up to 10 yr for bus-related facilities and vehicles and up to 30 yr for certain rail facilities.

The DOT Final Rule required that all new regular transit coaches for which a solicitation was issued after July 2, 1979, be accessible to the handicapped, including wheelchair users, with some specific exceptions for rail systems. No recipient system is required, however, to install a lift on any bus for which a solicitation was issued prior to February 16, 1977, other than to meet base/peak-hour minimums. Recipient bus-only systems were to submit a transition plan to UMTA by July 1, 1980, setting forth the stages and procedures by which the system would move to the required program accessibility. (See Appendix A for a list of various agency 504 transition plans, and Appendix B for an example of a specific operator's compliance plan.) Systems operating both bus and rail systems had until January 1, 1981, to submit their transition plans.

DOT Environmental Impact Statement on the 504 Regulations

On June 29, 1979, the American Public Transit Association (APTA) filed suit on behalf of itself and several named transit agencies. The APTA challenged the legality of the DOT's 504 regulations on three grounds. First, the environmental impact analysis of the regulations' implementation was insufficient. The DOT had made a negative declaration without performing an assessment; the APTA felt the cumulative national impact was negative. Second, HEW went too far in its instructions to the DOT. Third, the use of LE buses was not a cost-effective way to achieve mobility of the handicapped.

On February 7, 1980, a federal district court ruled in favor of the DOT. The judge retained jurisdiction until September

17, 1980, and asked the DOT to prepare a full environmental impact statement (EIS).

The DOT investigated the implementation of the existing 504 regulations as well as eight alternatives to full implementation to determine environmental impact in 12 areas. Among the eight alternatives considered were a "no action" response and three paratransit variations. The 12 potential impact areas included several of significance to this synthesis: level of service, traffic circulation, ridership, land use, vehicle operators, and fiscal aspects. The DOT's final EIS on implementation of the 504 regulations was published in October 1980 (*3*); the DOT found that neither the regulations nor the alternatives had significant environmental impacts.

CURRENT POSITION

On May 25, 1981, the U.S. Court of Appeals ruled, in the appeal of the case from the district court, that there was insufficient support in the Rehabilitation Act of 1973 for the DOT policy of requiring expensive bus and rail modifications. On July 17, 1981, the DOT issued new regulations superseding the debated 504 regulations issued in May 1979 (*4*). The new DOT regulations are a response to requests to allow local communities to decide the best way to serve the needs of the handicapped, whether through specialized door-to-door service, lift-equipped vehicles, or some combination of services. The regulations still require recipient transit systems to attend to the needs of the handicapped.

In spite of substantive opposition to mandatory accessibility, the accessible fixed-route transit service is a viable option for communities to consider. Most of the conflict over DOT mandates has centered on the ability of LE buses to meet the transportation needs of handicapped citizens. Most transit systems responded to the original DOT 504 regulations by purchasing transit coaches with lifts or retrofitting those without them. Because of those operational responses, and because of recent policy debates, this synthesis deals largely with the implementation of wheelchair-lift-equipped buses into regular, fixed-route transit service.

CHAPTER TWO

PHYSICAL, TECHNICAL, AND DESIGN FEATURES OF WHEELCHAIR-ACCESSIBLE BUSES AND RELATED SUPPORT SYSTEMS

The experience of a transit system with LE buses is a result of (a) the physical, technical, and operational characteristics of the equipment involved and (b) the policies, procedures and conditions under which that equipment is used. Exact specifications of wheelchair lifts and, to a lesser extent, transit coaches have been changing rapidly. It is rare to find an identical lift on the buses of two different agencies, even when the products are from the same manufacturer. Therefore, this chapter provides broad information (contact manufacturers for current vehicle and lift specifications).

PHYSICAL AND DESIGN FEATURES OF LIFT-EQUIPPED BUSES

In 1977 San Diego Transit retrofitted four conventional transit coaches and thus became the first known transit system in the United States to operate fixed-route transit service with LE buses. In 1979 the Transportation Systems Center (TSC) reported that 27 transit systems had wheelchair lifts or had ordered them. By late 1980 the TSC reported that approximately 90 transit agencies had more than 4,100 LE 35- to 40-ft (10.7- to 12.2-m) transit coaches, having either purchased or retrofitted them (*5*).

Transit systems made technical and design decisions about these buses and lifts in four areas: (a) the lift and its relationship to the bus; (b) the internal furniture and configuration of the bus; (c) the securement systems used to restrain wheelchairs; and (d) other accessibility-enhancing features, such as kneelers, additional signing, and handrails.

The Lift and Its Relationship to the Bus

Since 1977 the types of transit coaches and lifts used by transit systems implementing accessible transit services have become more uniform. Early efforts involved a variety of coaches (some no longer manufactured) and a variety of lifts (some no longer available, others completely modified). In 1980 four U.S. manufacturers were making full-size, heavy-duty transit coaches that could be equipped with wheelchair lifts. Most coaches were one of two types: the advanced design bus (ADB) or the so-called new-look bus. ADBs, of more modern design, are 40 ft (12.2 m) long and are available from two U.S. manufacturers. New-look buses, which were manufactured between 1959 and 1978, have much larger windows than pre-1959 buses and range from 35 to 40 ft (10.7 to 12.2 m) in length.

Currently General Motors Corporation (GM) makes only ADBs in the United States and uses only its own lift, which

must be mounted on the rear door. Grumman Flxible also produces only ADBs; the lift can be mounted on either door, and the company has used more than one manufacturer's lift. American Motors (AM) General Coach makes new-look buses and has used only one manufacturer's lift. At one time Gillig made LE full-sized transit coaches but no longer does.

Canadian GM makes only new-look buses and currently uses only one lift design. Flyer Industries of Canada also produces only new-look buses but has used more than one lift manufacturer. American transit systems have been able to buy Canadian buses despite the "Buy America" provisions of the Urban Mass Transportation Act by bidding only new-look buses. In some cases the Canadian bus bids are the only ones received.

In addition to these coaches, some systems operate articulated buses. Although some of them were bid with lifts, no data on their specifications or use are available.

After the research was completed for this synthesis, several European manufacturers expressed a strong interest in entering the U.S. bus market by building local manufacturing plants. Two of those expressing interest, Ikarus and M.A.N., will produce smaller, more traditional coaches. One European manufacturer is considering producing ADBs. Several small transit systems have ordered small heavy-duty buses from Scania for traditional fixed-route service using the Lift-U lift. Norwalk, Connecticut, is currently operating a number of such vehicles.

Four manufacturers other than General Motors make wheelchair lifts for full-size transit coaches. Another manufacturer made lifts for some time but has stopped. Many manufacturers make lifts for smaller transit vehicles and vans, but only two are among the four that also make lifts for larger vehicles. Several companies, however, have recently expressed interest in the large-bus lift market.

Bus manufacturers that do not make their own lift are generally required to provide a warranty for the lifts they use. The choice of lift installed on non-GM buses is dictated by (a) bid specifications and (b) the confidence of a bus manufacturer in any given lift. Because differences exist among the various lifts, a transit system, through its written specifications, may affect the selection of a lift.

Although a number of permutations of lifts and buses are possible, only 11 combinations existed at the time this report was prepared (see Table 1). A limited sample of cities and systems that have ordered various lift-bus combinations is presented in Table 2.

Lift Characteristics and Dimensions

The only known level-changing devices on heavy-duty transit coaches are lifts. One of the original Transbus prototypes had a ramped doorway for all passengers. Early federal regulations reflected some concern over whether the required level-change devices should be ramps or lifts. In the first Transbus procurement, which elicited no bidders, two members of the consortium, Miami and Philadelphia, asked for both ramps and lifts.

The NRC study of the Transbus procurement requirements (*1*) compared lifts and ramps and concluded: "The lift may be inherently better than a ramp since the slope of any ramp of practical length is too steep for efficient, safe operation particularly away from curbs or where curbs do not exist." The NRC noted that a significant amount of urban

TABLE 1
BUS AND WHEELCHAIR-LIFT COMBINATIONS KNOWN TO HAVE BEEN DELIVERED OR ORDERED (OCTOBER 1980)

Bus Manufacturer	Lift Manufacturer	Number Delivered	On Order
General Motors–RTS (ADB)	General Motors	1,607	1,200
Grumman Flxible–870 (ADB)	Environmental Equipment Corp. Lift (EEC)	1,372	339
Flxible–New Look	Vapor Corp. Lifts	250	175
	Transportation Design and Technology (TDT)	157	–
	Unknown	10	–
Flyer–New Look	Lift-U Lifts	289	120
	Vapor	–	175
AM General	TDT	224	–
Canadian GM–New Look	EEC	–	262
Cruisers	TDT	112	97
Gillig	TDT	52	–

Source: Robert Casey, Transportation Systems Center, from data supplied by manufacturers.

TABLE 2
CITIES USING OR ORDERING VARIOUS BUS-LIFT COMBINATIONS (SEPTEMBER 1980)

Manufacturers and Lift Combinations	Number of Buses
General Motors RTS-II, ADB with GM Lift	
Delivered	
Detroit SEMTA	348
Milwaukee County Transit, Wisc.	150
New Orleans, La.	150
Orange County Transit, Calif.	175
Philadelphia, Pa.	298
Santa Clara County Transit, Calif.	50
Westchester Co., N.Y.	105
Ordered	
Ft. Lauderdale, Fla.	35
Jackson, Miss.	16
Los Angeles, Calif.	940
Grumman Flxible 870's with EEC Lifts	
Delivered	
State of Connecticut	294
Houston MTA	326
Santa Monica Municipal Transit	47
Louisville, Ky.	53
Honolulu, Hawaii	74
Los Angeles SCRTD	230
New York City	200
Ordered	
Santa Clara, Calif.	219
New Orleans, La.	59
Flxible New Look with Vapor Lifts	
Delivered	
Washington WMATA	150
Milwaukee County Transit	100
Flxible New Look with TDT Lifts	
Delivered	
St. Louis BSDA	157
Flyer New Look with Lift-U Lifts	
Delivered	
San Mateo Transit	113
Torrance Municipal Transit, Calif.	13
Seattle METRO	163
Ordered	
Seattle METRO	60
Anchorage	10
Canadian GM New Look with EEC Lifts	
Ordered	
Denver, Colo.	127
St. Louis, Mo.	135

Source: Robert Casey, Transportation Systems Center, from data supplied by manufacturers.

and suburban bus operation occurs in such "no-curb" operation. Most commercial technology has developed in relation to lifts.

Because designs have changed in response to problems, not all versions of one company's lifts are identical. For example, there have been several models of the first lift on the market, TDT (Transportation Design and Technology). New models have incorporated design changes necessitated by mechanical problems and service failures. In addition, some agencies have requested different design and operational features to meet different safety, mechanical, and user needs.

Many cities in which lifts were installed as original equipment, such as the Southern California Rapid Transit District (SCRTD) in Los Angeles, have modified the original equipment so much that they refer to the lifts as "retrofits." Not all agencies use the same terminology, and it is important when evaluating equipment to identify the design changes that have been incorporated into what is considered original equipment. Several systems currently are in the process of retrofitting coaches already equipped with (unsatisfactory) lifts.

The key specifications of the five current and one previously available lifts for 35- to 40-ft (10.7- to 12.2-m) transit coaches are given in Table 3. The GM lift is a rear-door-only lift; all of the other lifts can generally be retrofitted or purchased for either door. Most systems using other than GM-ADBs employed front-door lifts.

All six lifts are frequently called *passive*, because they are not conformed as lifts unless activated. (This use of the word *passive* is slightly different from that of traditional engineering use.) Two of the lifts, EEC and Lift-U, rise up and in, following an arc pattern. The other four lifts rise from the ground in a vertical elevator fashion and are formed from the treads and risers of the bus door on which they are mounted; they extend and then raise and lower vertically. When these lifts are used, the steps no longer exist in the step configuration.

The EEC lift is also formed from the stair treads and risers of the door on which it is mounted, but its movement is different from that of the other four. The Lift-U lift is a solid platform that stows under the step well when not in use. All the lifts, when not in use, serve as ordinary entrances to the vehicle for ambulatory riders.

The lifts also differ in types of handrails, grab bars, and other aids or security devices that are part of the platform or are mounted in the stairwell of the bus. Most of the early versions of the six lifts did not have two handrails; most still do not have flanges or sideguards. Some later versions of the earlier lifts now have these devices. In an evaluation, handicapped travelers in Seattle felt that lifts equipped with side flanges or side handrails were safer and gave them a greater sense of security (*6*).

In a California Department of Transportation (Caltrans) test, wheelchair users and semiambulatory passengers recommended two handrails be affixed to each lift, mounted in such a way that they could be used by both standing and seated lift users (*7*). They also recommended that the sides of the lift provide protection to the user. Such safety features could be created by the bus stairwell (as they are in the GM lift) or by flanges or handrails on the lift sides (as they are on the Lift-U lift).

The six lifts differ in the approach angle of the lift platform. Good data on the angle of the various lifts on flat surfaces are not available; the angle changes if the road is crowned or the sidewalk or stop area is not level. Some early lifts were reported to have had a 15° incline, which was thought to be too steep. In both the Caltrans test and the Seattle study, users were uneasy with steep slopes. Some nonpowered-chair users could not move themselves onto steeply angled lifts without assistance, and even those who were able to mount reported a fear of falling backwards. Users were also fearful of the velocity that would build up when they disembarked from a steeply angled lift, especially when exiting backward.

The length of the platform also varies from 32 to 54 in. (81

TABLE 3
CHARACTERISTICS AND DIMENSIONS OF LIFT-BUS COMBINATIONS

Lift	Lift Position	Platform Dimensions	Security Gate Height and Angle	Handrails	Sensitive Edge	Lift Curb Clearance	Lift Motion	Notable Features
EEC Lift Environmental Equipment Corp. (San Leandro, Calif.)	Front door	39-1/4 x 32-1/2"	6-1/2" (N.A.)	One on right side when boarding	No	N.A.	Arcs up	User on lift looks at machinery (-)
GM Lift General Motors Corp. (Pontiac, Mich.)	Rear door only	51-1/2 x 38"[a] N.A. 35-3/4"[b]	9-3/4" (N.A.)	None on lift; handrails in stairwell	Yes	N.A.	Vertical elevator motion	Feels secure to user (+) 5-1/2" opening between edge of lift and bottom of security gate (-)
Lift-U Lift Lift-U, Inc. (Seattle, Wash.)	Front door	54 x 30-1/4"[a] 46-3/4 x 30"[b] (Other sizes available)	7" (45°)	Two handrails	Yes	Up to 15"	Arcs up	User on lift looks at stair configuration (-)
Steplift (TDT) Transportation Design and Technology, Inc. (San Diego, Calif.)	Front and rear door	37-1/2 x 28-7/8"	5-3/4" (N.A.)	None on lift; handrails on bus door	N.A.	N.A.	Vertical elevator motion	No flange or side edges (-) Entry angle steep (-)
Transilift[c] Transilift Equip., Ltd. (Calgary, Alberta)	Front door	46 x 31-1/2"	3-1/2" (N.A.)	Two handrails	N.A.	N.A.	Vertical elevator motion	Flat, easy to mount (+) Security gate low (-)
Travelift (Vapor) Vapor (Chicago, Ill.)	Front and rear door	50-1/2 x 34" (Other available)	8"[b] 6-1/2 to 8-7/8"[a]		Yes	N.A.	Vertical elevator motion	Entry angle steep (-) No flanges on sides (-)

[a]Manufacturer's specifications.
[b]As tested by United Cerebral Palsy (6).
[c]No longer available.
1 in. = 25.4 mm.

to 140 cm) in the six lifts. Users in both the Seattle and Caltrans studies preferred the longer lifts because they could accommodate longer wheelchairs and still keep both passenger and wheelchair from hitting the security gate. Longer lifts also would allow an attendant to ride on the lift.

All six lifts have a security gate on the edge of the platform. This is a metal restraining device that moves from a horizontal to an angled position as the lift rises from the ground with the passenger aboard. Usually the gate returns to a horizontal position only when the lift is stowed or when it touches the ground again as the user disembarks. The height of the security gate ranges from 3.5 to 9.75 in. (9 to 25 cm). Users in the Caltrans and Seattle studies preferred higher and more steeply angled security gates, believing that the height and steep angle would prevent a powered wheelchair from "overpowering" the edge if the chair were thrown against it in an unusual circumstance or if accidentally put into reverse.

Handicapped travelers also were concerned about other safety problems, such as the possibility that the five lifts composed of stairs and risers would stow, or go back into step configuration, while a rider was aboard. This actually happened in local tests, throwing passengers off the lift. Users were fearful of any lift failure that might cause the lift to drop suddenly to the ground with the passenger aboard. Other user concerns are described below.

Shear points or gaps between the mechanical or moving parts of the lift and between the lift and the stairwell or bus. In the GM lift there is a small gap between the bottom of the security gate and the top of the platform; users expressed the fear that their feet or parts of the chair would get caught. In the Lift-U there is a small gap on each side between the lift platform and the stairwell; users found this potentially dangerous. Other lifts also had potentially dangerous gaps or exposed machinery.

Poor ride quality. Some lifts were reported to shudder, jerk, or move unevenly. It was felt that passengers with

serious disabilities might find this harmful, but users were even more concerned that such movements might decrease their perception of safety or security.

Racking lifts. Several lifts were found to rack in operation; that is, one side of the platform lifted higher or faster than the other. Once in operation, the lift evened out; but when it was racking, a chair could move on the platform in response to the tilt. Also, one side of the lift could hit the ground first, releasing the security gate before the other side of the lift was on the ground.

Drooping and springing back of lifts. If weight was not distributed evenly on the platform, the ends of the platform might droop, or bend below the horizontal plane while in operation, causing a wheelchair to roll backward. Once the weight was released, the lift platform might spring back to the horizontal position immediately, possibly hitting part of the chair or moving up while the back wheels of the wheelchair were still on the lift.

Location of Lift on Bus

Few companies manufacture buses, so to ensure competition, UMTA procurement regulations forbid a transit agency from specifying front- or rear-door lifts on the purchase of new vehicles (*8*). Agencies have a choice only when retrofitting existing vehicles. In some cases a lift had to be mounted on the rear door because the front door was not wide enough to accommodate the lift.

Front-door lift location provides several advantages for drivers. It makes it easier for them to (a) operate the lift and provide assistance to the passenger, (b) line up the front end of the bus and the lift platform with the bus stop landing pad, and (c) collect fares. Also, it becomes easier for the driver to maneuver the front of the bus and position the lift to take into account the terrain, the angle of the stop, and the location of the curb, if any. The driver often can remain seated while activating the lift.

Front-door lift location has disadvantages for passengers, however. They have to maneuver past the fare box, the seats, other people, and so on, and make sharply angled turns to get into the proper securement position. And because the front end of the bus is more susceptible to accidents it is also more susceptible to lift damage. Because the lifts are often partially exposed or sensitive to shock, they can easily be damaged by minor accidents, such as hitting the curb. Several transit agencies reported that minor accidents were responsible for a significant percentage of their lift malfunctions, and they found it necessary to retrain drivers in the proper way to approach a curb for receiving and unloading a wheelchair passenger.

Rear-door lift location has the advantage of providing greater ease of entry and maneuverability for wheelchair passengers. This appears to be its principal advantage, however. Some handicapped people believe that it is unsafe for them to ride in the back of the bus, where they are not directly observed by the driver. If they travel alone, they may be victimized more easily in the rear of the bus. Additionally, if the bus is full or the driver's view is obstructed, the driver may not know or recognize that the call-stop button is being pressed by a handicapped patron. The driver may activate the back door, observe no one (or an ambulatory person) alighting, and simply drive on without having extended the lift. Finally, for the passenger, location at the back of the bus may have unpleasant associations ("in the back of the bus").

Driver difficulty in maneuvering the bus in order to align the lift with the stop landing pad, particularly at near-side stops, is a serious disadvantage of the rear-door location. Most transit systems do not allow drivers to put a transit coach in reverse in ordinary operation, as this is a very difficult maneuver, but several systems reported that it was necessary for drivers to back up buses occasionally to line up the rear-door lift with the curb.

The rear-door GM lift must be deployed no further than 12 in. (30 cm) from the curb to ensure that, once deployed to the curb, the passenger's weight is on the platform and not on the security gate. Failing that, the bus must be stopped at least 5 ft (1.5 m) from the curb to allow the lift to fully deploy to street level without damage.

It appears that most systems with rear-door lifts must either change to far-side stops, lengthen existing near-side stops, require buses to stop in the street and allow patrons to board from there, or allow the driver to choose a more suitable informal "stop" where the lift can be used. Many systems have a number of midblock or near-side stops; that is, landing pads in the middle of the block or near the corner of an intersection *before* the crosswalk and actual intersection. It is difficult for drivers to get a bus within 12 in. (30 cm) of the curb at midblock or near-side stops because parked cars and other obstructions hinder the maneuver. At a far-side stop the driver has a clear intersection in which to angle the bus gradually toward the curb. Although most stops are only 80 ft (24 m) long, the "effective" length of far-side stops is much greater because of the intersection.

Drivers routinely report that it is not possible to get the rear end of the bus within 1 ft (0.3 m) of the curb in a near-side bus landing pad of 80 ft (24 m). One major transit system undertook a series of static tests using bus stop landing pads with lengths varying from 80 to 120 ft (24 to 36 m). Repeated attempts were successful only at lengths greater than 100 ft (30 m).

The Los Angeles SCRTD advises drivers who cannot get the bus close enough to the curb to stop 5 ft (1.5 m) from the near-side curb stop, get off the bus, and assist the wheelchair patron from the lift to the curb or from the curb to street level. SCRTD drivers are currently trained in lifting wheelchairs onto curbs. Milwaukee allows its drivers to pull farther ahead into the crosswalk, but not into the intersection, on near-side stops; this generally allows the wheelchair patron to get into the street from nearby curb cuts. Milwaukee does not permit drivers to physically assist the wheelchair patron. Smaller systems routinely allow drivers to pull ahead of the bus stop landing pad or to actually cross the intersection to stop when a near-side stop is not adequate.

Instead of changing from near-side to far-side stops or allowing in-street maneuvers, some systems have made an attempt to get the proper agencies to lengthen bus stop landing pads; many believe that a near-side stop must be at least 110 ft (33 m) to accommodate a rear-door lift. However, most transit systems have no authority over bus stops or landing-

pad lengths. Most system requests to local authorities to lengthen stops have been ignored.

Additionally, it is more difficult for the driver to operate a rear-door lift (the driver must stop the bus, lock it, and move to the back to operate the lift mechanism) and collect fares. However, the most significant problem is that the complicated maneuvers required of drivers may significantly increase dwell time (the time that the bus is stopped). Because drivers are reluctant to get behind schedule, it has been found that wheelchair travelers are passed up and told it is because the lift is broken.

As transit systems begin ordering their second and third sets of LE buses, they may begin to have a mixture of buses and bus-lift combinations. A number of systems have a different kind of lift on the same kind of bus; the SCRTD has three different buses and two different lift locations.

This mixture of bus and lift combinations may pose problems for some transit agencies. If there are both front- and rear-door lifts, access to some stops will be possible for some buses but not for others. Riders, drivers, and mechanics may have to learn new procedures. Some of the economics of scale (e.g., parts inventories) and advancement on the learning curve will be sacrificed.

Bus Internal Furniture and Configuration

Modern heavy-duty transit coaches are from 35 to 40 ft (10.7 to 12.2 m) long and either 96 or 102 in. (2.4 or 2.6 m) wide. These external dimensions dictate, to some extent, the width of the aisles and the placement of seats and other furniture. However, various manufacturers' buses differ internally, and some of these differences affect the ease with which handicapped travelers can maneuver once aboard. This in turn affects the speed with which they can board and alight.

Important specifications and dimensions of the internal configuration of buses are (a) width of aisles; (b) location of stanchions, poles, and the fare box; (c) number, location, and position of wheelchair securement areas; (d) total number of seats; and (e) type and location of seats near securement areas.

Aisle width is not an important consideration for rear-door lift users, because the passenger in a wheelchair will not have to maneuver past any seats (in most configurations).

The width of the aisle between the seats in the *front* of the bus can vary from 36 to 41 in. (91 to 104 cm). Aisle width depends on the number and type of seats in the bus rather than on the width of the bus. For example, a 96-in.-wide (2.4-m-wide) Flxible ADB used in some tests had an aisle width of only 36.25 in. (92 cm), whereas a 96-in.-wide GM conventional coach had an aisle width of 40.25 in. (102 cm).

When handicapped wheelchair users rated the internal design characteristics of bus-lift combinations (*7*) (see Table 4), they showed a preference for a rear-door lift because less maneuvering was involved. They also preferred wider aisles because it was easier to move within the bus.

The internal configuration and the aisle width may greatly influence the amount of time a wheelchair user requires to board and disembark, and thus the dwell time. Data from another Caltrans study (*9*) indicate that more than two-thirds of the total boarding time for wheelchair passengers on front-door lifts is taken up after the person is aboard the bus and moving toward the securement area.

In some tests the angle at which the user moved off the front-door lift platform toward the securement, or tiedown, area affected both time consumed and user satisfaction. Some lifts have components that create a barrier once the lift platform has reached bus floor level; this barrier requires the user to depart from the lift straight ahead and then make a 90° turn toward the tiedown spot.

The fare box, poles, door shields, and seats near the door can also affect time consumed and user satisfaction; passengers may have to make sharp turns to avoid obstructions. For increased speed and maneuverability it is best if the user departs the lift at an oblique angle and does not have to make special maneuvers to avoid internal bus furniture. Test data indicate that any obstruction that requires evasive maneuvering by a person in a wheelchair can significantly increase boarding time (*9, 10*).

When front-door lifts are used, securement areas are usually placed as close to the front door as possible. In almost all existing transit coaches, however, the wheel casement areas directly behind the driver and the door do not allow for wheelchair securement. Instead, most agencies place longitudinal seats (seats that run parallel to the sides of the bus at right angles to the driver) over the wheel casement areas and then put the securement behind these seats. If only one securement area is provided, it is usually behind the driver; a second and even a third area can be placed behind the longitudinal seats on the door side. Figure 1 shows the internal dimensions and measurements of the front of an AM General coach retrofitted with a Lift-U lift. It indicates the three possible positions for wheelchair securement areas on a coach with front-door lifts.

Every transit system is concerned about the number of seats that must be removed from a coach to accommodate wheelchair tie-downs. Most systems have minimized the number of seats lost by using a spring-loaded jump seat that folds down to serve as a regular seat if handicapped travelers are not present. When empty, the seat is up and requires no action by the handicapped traveler; nonhandicapped riders have to push down on the seat to use it.

Most ADB buses, even those not equipped with a securement area, have the same passenger *capacity* as older buses (when both standing and seated riders are included) but fewer seats. Some systems have attributed the entire loss of seats in their new ADB buses to the presence of wheelchair tie-downs, but that is not true.

Most transit coaches will lose one passenger seat for each tie-down. In those buses not already using fold-down seats, a three-passenger fold-down seat or jump seat will replace two two-passenger transverse seats. On buses equipped with rear-door lifts, the tie-down area usually is directly across from the rear door and a three-seat jump seat will replace two two-passenger transverse seats.

Figure 2 shows the floor plan of a Flxible ADB coach (front-door lift) with and without tie-down areas. Without the tie-downs the maximum seating in this layout is 49 seats. If tie-down areas and jump seats are provided, the maximum number of seats, without the presence of riders in wheel-

TABLE 4
RATINGS OF INTERNAL BUS DESIGN BY WHEELCHAIR USERS (7)

	Back Door Lifts		Front Door Lifts			
	TDT Lift GM Coach	GM-ADB	Transilift GM 35' Coach	Travelift 40' Flxible	Lift-U 35' AMG Coach	EEC 40' Flxible ADB
Aisle width:	n.a.	n.a.	40-1/4"	41"	38-3/4"	36-1/4"
Activity Required						
• Ease of maneuvering off lift into bus	4.1	4.8	3.7	3.9	4.2	3.1
• Ease in turning from lift into aisle	4.8	4.4	3.7	3.7	3.7	2.8
• Ease in maneuvering down aisle	n.a.	n.a.	4.3	4.0	3.5	2.9
• Ease in maneuvering into securement area	3.7	4.2	3.5	4.1	3.4	2.0
• Ease in maneuvering out of securement area	4.9	4.7	3.8	4.7	4.2	3.5
• Ease in turning from aisle onto lift	4.9	4.9	2.9	3.4	4.1	3.0
• Ease of boarding lift on exit	4.3	4.4	3.8	4.0	4.6	2.8
Non-weighted average rating	4.5	4.6	3.7	4.0	4.0	2.9

Scale: 1 to 5 (5=highest)

chairs, is 47; if two handicapped users are present, the maximum seating capacity is reduced to 41.

Some systems (e.g., Montebello and Gardena) have provided only one wheelchair securement area; most others provide two such areas. The decision appears to be based on a transit system's view of its potential ridership. Most urban areas have no reliable data on the frequency of more than one handicapped person riding a bus at the same time.

Handicapped users in Seattle reported that they prefer at least two tie-downs on each bus in order to travel in pairs. Because tie-downs will reduce the number of regular passenger seats, agencies will have to trade off the likelihood that more than one handicapped traveler will want to ride at the same time against the number of people that might have to stand to accommodate the securement area.

Most transit systems have opted to use spring-loaded jump seats or fold-down seats, but some with heavy peak-period traffic have considered eliminating all seating in the front of the bus. The choice of internal seat configuration generally reflects average ridership patterns along routes with LE buses. Some agencies have more routes with standing-room-only ridership.

The material used for the floor and tie-down area affects passenger movement. Ribbed or textured materials were recommended for both the lift platform and the securement area. In several tests wheelchair users lost traction or were unable to maneuver in the bus on rainy days or when the lift or bus floor was wet. Some buses had textured materials in the tie-down area but not in the aisle, and some users reported having difficulty on the nontextured material on wet days.

Securement Systems

Two types of securement systems exist. One holds the wheelchair securely while the bus is in motion, usually by attaching to or through one or both wheels. The other holds or restrains the passenger in the wheelchair.

The system that secures the wheelchair is limited if the tie-down area is fitted with a fold-down seat. Two manufacturers—Collins and American Seating—make a wheelchair securement device in conjunction with a jump seat. The Collins holds two chairs; the American Seating

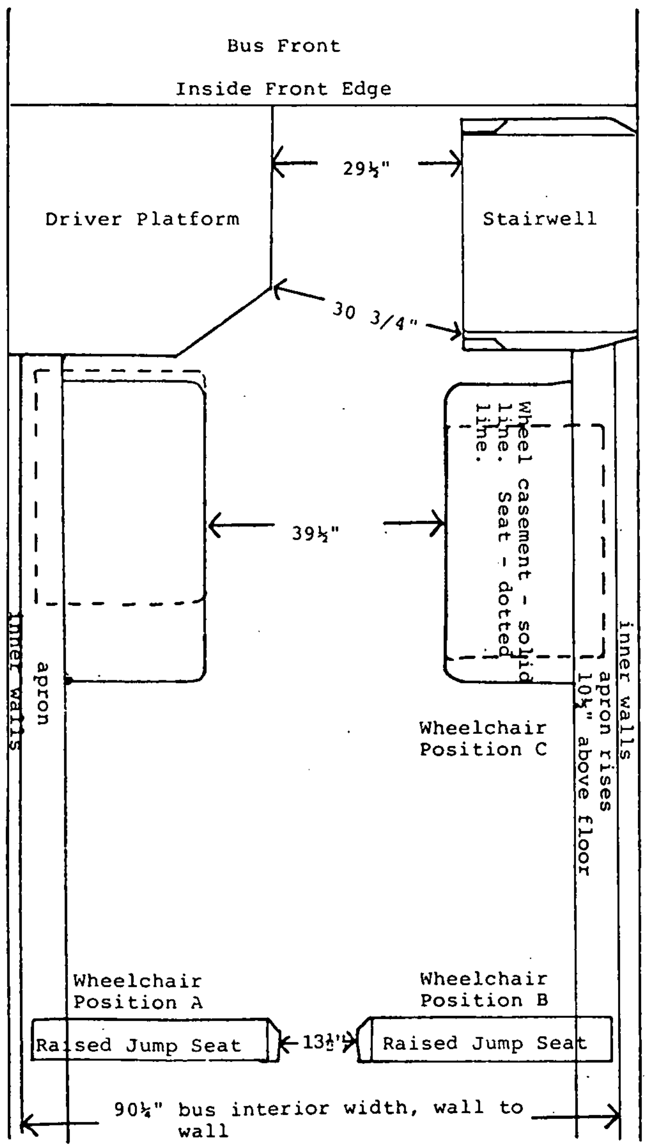


FIGURE 1 Bus interior plan: possible wheelchair securement areas on an AM General Coach (*9*).

holds one; both mechanisms require the chair user to back into a steel clamp that springs closed around the wheel. The user releases the clamp manually by reaching back and pulling a release lever.

Personal securement in the chair can be achieved with the use of one or more belts that wrap around the passenger; the belt serves the dual purpose of holding both passenger and chair. The belt can be mounted on the underside of the jump seat or in another appropriate location. Flxible buses offer personal securement with a padded armrest that springs to the front of the wheelchair when activated by a lever. Most Flxibles have both the padded armrest and a personal belt.

Three problems have arisen with existing chair securement systems. First, even when working properly, they cannot secure a wide range of chairs, including those with solid cam wheels and most powered chairs. The location of the battery pack on some powered chairs renders the clamp inoperable.

Second, the user must back into the spring fairly accurately and with sufficient force to cause it to clamp around the wheel. The user needs the agility and skill to turn around and pull the lever to release the clamp when leaving. Some handicapped users cannot easily perform either maneuver. In fact, some nonhandicapped travelers trying to experience-test the securement device could not maneuver the chair to activate the clamps.

Third, many agencies reported that the clamps were not well made and occasionally broke; for example, when the bus was traveling on a steep downhill grade. Because chair clamps are unreliable and because they do not secure all chairs, some agencies have installed belts as backup systems. And some users cannot use any securement devices without assistance; Seattle Metro has allowed its drivers to assist handicapped travelers.

Current securement devices have been rated very low by users and transit systems alike. Participants in the Caltrans study (*7*) suggested that wheelchair securements be redesigned so that they can be used by people with limited limb strength and torso mobility. Failing this, some users will need to be accompanied by an escort or assisted by the driver, prospects not attractive to handicapped users and not consistent with some work rules for the drivers.

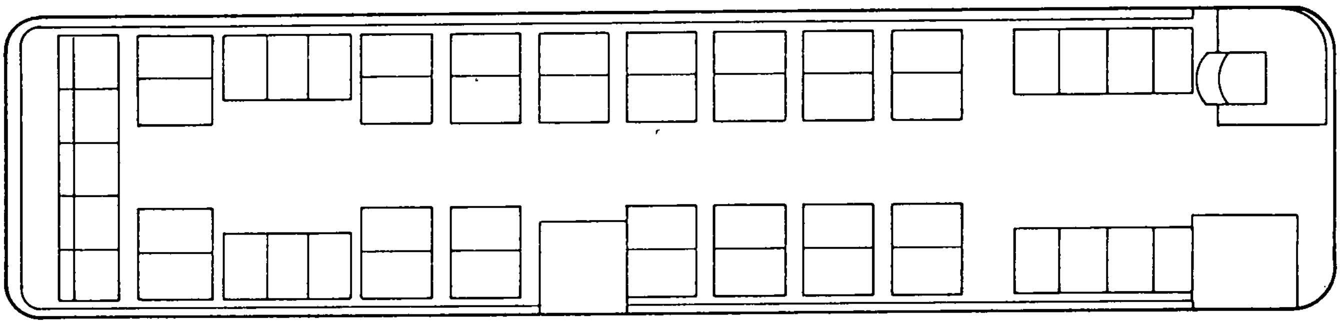
Kneeling Feature

The kneeling feature causes the bus to be lowered a few inches which makes the vehicle easier to board for nonwheelchair users who have trouble climbing the first step. This feature can be used, but is not required by mandate, on buses equipped with wheelchair lifts. Although some transit agencies believe that UMTA required purchase of the kneeling feature, there is no supporting documentation. This feature has many problems similar to those reported for the wheelchair lift: driver and user unfamiliarity and mechanical problems and failure.

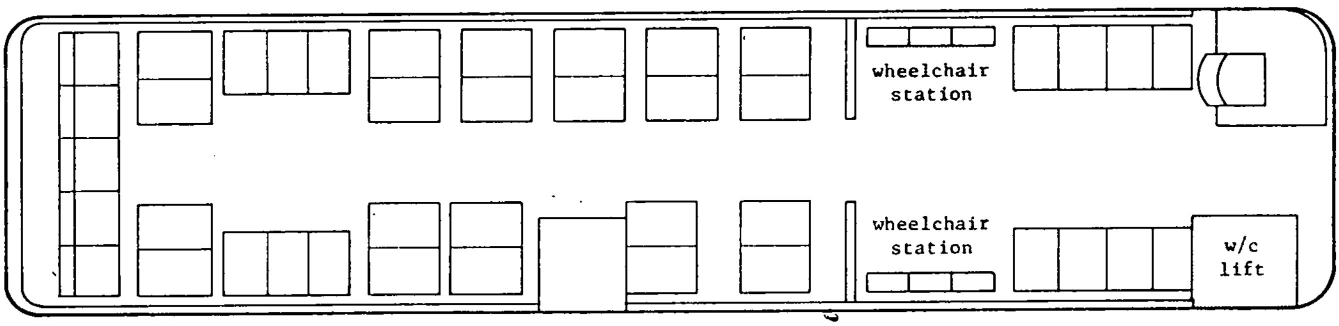
Several agencies reported that, although they would purchase lifts in their next vehicle acquisition program, they would not purchase the kneeling feature. Although this feature can accommodate more handicapped travelers than a wheelchair lift, it has not received much attention. Most systems do not automatically use the kneeler but will respond to requests for its use; that policy, however, may discourage users from asking, either out of lack of knowledge or general embarrassment. In its 504 transition plan the Niagara Frontier Transportation Authority acknowledged this problem and stated that it would change its work rules to require use of the kneeling feature.

CHARACTERISTICS OF THE OPERATING ENVIRONMENT OF LIFT-EQUIPPED BUSES

The climate and terrain in which LE buses operate affect the performance of, and perhaps the ridership response to, accessible service. In addition, the infrastructure of the surrounding community and the accessibility of bus stops along the LE bus route are of concern.



Regular Bus With 49 Seats



Wheelchair Bus With 47 Seats, or 41 Seats and 2 Wheelchair Stations

FIGURE 2 Alternative interior plans: Flxible ADB Coach with and without wheelchair lifts (*17*).

Climate and Terrain

LE buses are expected to operate in different climates and over varying terrain. It is not known if particular climates are more suitable for using and maintaining various lifts or bus-lift combinations. Some agencies have reported weather-related mechanical failures with the wheelchair lifts; electrical systems seem particularly prone to salt corrosion in snow-belt climates (*6, 11*). When a lift and its working parts are exposed, the likelihood of damage and corrosion from grit, water splash, and salt is increased.

Weather conditions affect the operation of wheelchair lifts. Some systems reported that such weather-related conditions as street icing and snow banks made it impossible to operate the lift without risk of damage.

Transit agencies should try to determine which available lifts are most suitable for the weather conditions under which they will operate. Suitability should include both resistance to damage or corrosion and the extent to which different lifts are usable by the handicapped under conditions of icing, snowdrifts, and similar inclement weather situations. Maintenance practices also affect lift suitability; after salt corrosion and water damage difficulties with lifts, the Milwaukee system completely changed its routine maintenance procedure.

The same set of standards should guide transit agencies when they consider (a) the terrain, (b) the grade, and (c) the slope of streets and stops along the routes of LE buses. Some transit agencies and user groups suggest that certain lifts are better than others because they are easier to use and easier to maintain at extremes of terrain. Transit agencies might wish to test the operation of prospective lifts at difficult stops or along possible problem routes.

The type of design standards sought by transit agencies actually reflects system policy on the operation of LE transit coaches in different environments. Some systems are highly concerned that the lifts be operable at as many stops and as long during the year as possible; others are not as concerned.

Accessibility of Streets, Stops, and Transfer Points

Difficulties for the operator or the user can be caused by steep slopes on streets or stops, by physical obstructions at, near, or on the stop zone, and by the absence of curb cuts or improperly designed curb cuts.

Street Conditions

Three related variables affect the angle of the lift when operated: the slope of the street, the slope of the curb, and the crowning of the street, i.e., the slope of the road from the center of the street to the gutter. Steep slopes make it difficult for the operator to operate the lift correctly without damaging it. Sensitive edges or sensing devices may not

accurately reflect the position of the lift platform in such situations.

Even if the lift is used correctly, the approach slope of the lift platform may be exaggerated by significant differences in degree and direction between the street and the tilt of the bus. Such differences are caused by road crowning and the angle of the curb or street. Some buses are reported to have the ability to correct for road crowning whether or not they are equipped with a lift.

Good data are not available on slope or crowning conditions appropriate for the successful use of various types of lifts. Many transit agencies merely surveyed or observed the street conditions at stops and zones and based their decisions largely on whether the lift could be operated without damage.

Stop Accessibility Evaluation Processes and Criteria

Safety is a priority consideration in determining accessibility at a stop. Terrain and street slope can pose potential dangers for the lift or bus in operation. A stop with satisfactory access for a handicapped traveler may still pose problems for the bus operator; the reverse is also true.

In general, once an agency selects a route, it inventories the stops along that route to determine whether they are accessible. However, accessibility of individual stops does not appear to be a major decision in any agency's route selection process. A few transit systems, such as the Los Angeles SCRTD, ran a LE bus along proposed routes, cycling the lift at each stop. Most agencies that conducted a stop inventory, however, did so in a car, driving along the route and observing possible problems. In questionable cases a bus was brought later to that stop. Factors that the SCRTD believed could prevent access to a stop include such items as a combination of the angles and slopes of street and curb; obstructions to the traveler posed by terrain, street furniture, and vegetation; and type and location of curbs and curb cuts. Specific items of concern to the SCRTD are listed below.

1. Curbs too high or too low.
2. Unimproved parkway.
3. Unimproved roadway.
4. No access to bus zone area.
5. No ramps.
6. Ramps or driveways too steep.
7. Medians with limited space or access.
8. Ivy, grass, or weed buildup.
9. Sprinkler heads.
10. Gravel/rock/sand/wood cuttings in parkway.
11. Obstruction such as benches, newspaper racks, or trees.
12. High crown of roadway.
13. Freeway stops—stairway access only.
14. Mechanical limitations of lift.

In another system's process for evaluating the accessibility of stops, the evaluator is asked to specify only whether the crowning of the street is level, slight, or steep and whether the curb is cut, flat, or unlevel; see Figure 3. Such a survey provides some useful information to the agency, but decisions on whether a lift can be successfully deployed without damage and used by a traveler with ease are still judgmental ones.

Transit System Action

Once an agency finds that the access to certain stops is difficult to impossible for the operator, the user, or both, it faces additional decisions. Most transit agencies have no responsibility for the transit stops; curb and street configurations are generally under the control of another agency. Some transit agencies, however, have made an active effort to persuade city traffic departments to alter or repair streets and curbs at problem stops. The SCRTD, for example, sent letters to all the cities through which its routes passed to bring to their attention problem stops and the needed alterations.

Seattle undertook a comprehensive review of its transit stops and made recommendations to assist the appropriate authorities in making repairs. The city ranked stops in need of alterations by priority; that is, by how seriously they needed repair and whether they were along routes that were expected to be heavily used by the handicapped. Seattle's stop improvement program is given in Appendix C.

In San Diego, where the transit agency is under the authority of the city, an effort has been made to program transit stop improvements and necessary curb cuts into the capital improvement program for the next few years. But even in this city, where both highway and transit agencies are under the same government, not all the stops were immediately repaired or programmed for repair.

Some systems, generally the smaller ones, have taken a far less active role in encouraging the alteration of problem stops. Several agencies said that handicapped travelers themselves should put pressure on the appropriate city officials and government agencies.

Curb Cuts and Ramps

It is not clear what type of curb cuts facilitates the access of the handicapped to public transit. The DOT adopted the 1971 design standards for curb cuts of the American National Standards Institute (ANSI). These standards are geared toward facilitating the movement of handicapped pedestrians or wheelchair users along streets and sidewalks; they do not, however, consider the use of curb cuts in terms of easy access to transit. ANSI standards prescribe a curb ramp that is at least 36 in. (90 cm) wide and has flared edges (Figure 4). Curb cuts or breaks are required to have a slope between 10 and 12.5 percent (*12*).

In a study to determine street and curb modifications needed to accommodate handicapped pedestrians, researchers tested the ability of wheelchair users to cross 12 curb ramps (*13*). The ramps varied in gradient from 1:5.3 to 1:2 and in length from 2 to 10 ft (0.6 to 3 m). They transversed curbs of 3, 6, and 9 in. (7.5, 15, and 23 cm) in height. The researchers found steep ramps were acceptable in some cases if they were short. Ramps with lips at the bottom were at best only marginally acceptable. Some of the tested ramps

BUS STOP ACCESSIBILITY

1. LINE #: ______
2. DIRECTION OF TRAVEL:
   N/B S/B
   W/B E/B ____________
   STREET NAME
3. STOP LOCATION: ____________
   F/S,N/S,MD,OPP CROSS STREET NAME
4. LENGTH OF RED CURB: ______ ft.
5. CURBED___ FLAT___ UNLEVEL___
6. SURFACE AREA OF STOP:
   CEMENT ____ GRAVEL ____
   ASPHALT____ GRASS ____
   DIRT ____ OTHER ____
7. OBSTRUCTIONS AT STOP:
   POLE ____ BUSHES ____
   BENCH ____ WEEDS ____
   DITCH ____ ROCKS ____
   RUTS ____ HYDRANT____
   OTHER ____________
8. CAN THE BUS PULL INTO THE STOP EFFECTIVELY FOR PROPER LIFT OPERATION? yes_____
   If no ____ Why not:______
9. INTERSECTION DATA:
   A. SLOPE (CROWN) OF STREETS:
      NORTH/SOUTH__________
      WEST/EAST __________
   (Specify level, slight, steep)
   B SAFETY: N/S E/W
      TRAFFIC LIGHTS ___ ___
      CROSS WALKS ___ ___
      STOP SIGNS ___ ___

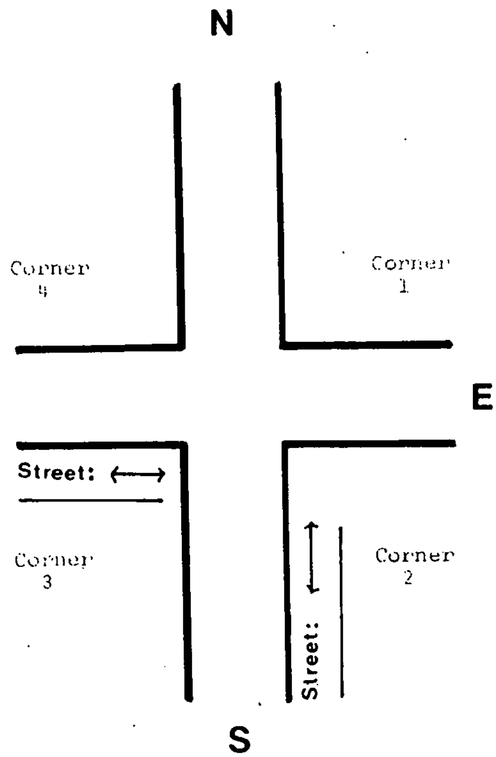
RECOMMENDATIONS ____________

EVALUATED BY:

DATE: ____________

CURB CUTS (RAMPS): I A

CORNER 1 ________ ___ ___
CORNER 2 ________ ___ ___
CORNER 3 ________ ___ ___
CORNER 4 ________ ___ ___



. Draw location of bus stops and islands.
. Mark ramps at intersection and on islands.
. If transfer point, indicate which lines stop where.

FIGURE 3 Bus-stop accessibility and criteria sheet.

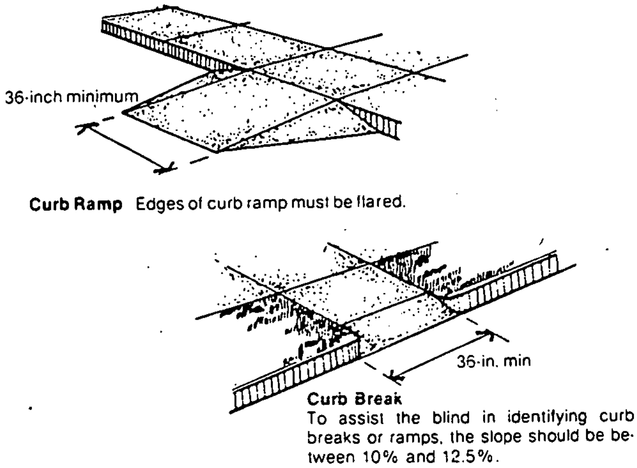


FIGURE 4 ANSI standards for curb cuts and ramps (*12*).

were not acceptable. The researchers recommended that the angled sides of the cut, the flares, should not exhibit a grade of more than 1:16 (Table 5). A grade of 1:12 was just barely acceptable to many groups but could not be negotiated by wheelchair users.

The researchers in this study were also concerned with the ability of visually impaired pedestrians to use curb cuts or to cross them without disorientation or difficulty. The overwhelming majority of visually impaired pedestrians were found to have little difficulty in detecting the presence of ramps as they walked and little problem in determining the top and the bottom of most ramps; less steep ramps (1:16/1:20) were somewhat more difficult for them to detect. Lips on the bottom edge of the ramp, designed to alert visually impaired users that they had reached the street, were found to offer more disadvantages than advantages. The researchers concluded that tactile surface materials should be

TABLE 5
RAMP GRADIENT RECOMMENDATIONS (*13*)

Curb Heights Not Exceeding	Maximum Gradient *				
	Gradients Steeper Than 1:8	1:8	1:10	1:12	1:16
3" (7.6 cm)	X	0	0	0	0
6" (15.2 cm)	X	X	0	0	0
9" (22.9 cm)	X	X	X	0	0

X Not Recommended
0 Acceptable

*Whenever possible slopes less than the maximum should be employed

used to assist visually impaired pedestrians in receiving active, cognitive clues from the environment. Table 6 gives their recommendations for walkway and signal materials. (*13*).

The possible location and direction of curb cuts and pairs of curb cuts were also studied. This information is less useful to those considering vehicular access to stops because the emphasis was on treating existing streets to better meet the needs of pedestrian traffic. Figure 5 shows 2 of the 13 curb and sidewalk treatments developed by researchers that appear to be the most useful in facilitating access to transit vehicles.

CHARACTERISTICS OF WHEELCHAIRS AND HANDICAPPED USERS

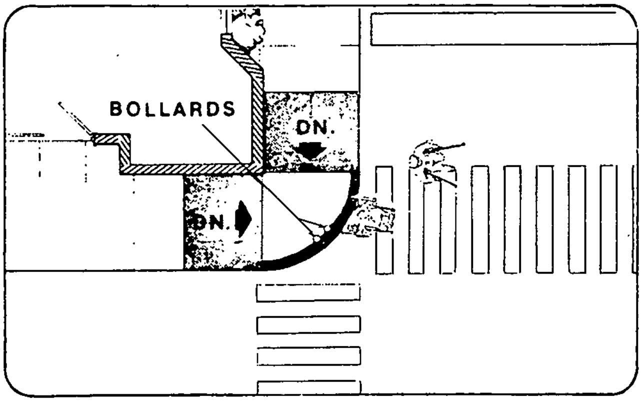
Both the physical dimensions of wheelchairs and the strength and agility of handicapped users may have some bearing on system design choices. Having information about chairs and users would enable transit systems to determine whether a given lift will accommodate all wheelchairs and whether normal characteristics of the lift in routine operation would pose security, safety, or emotional problems for some users. Such data also would assist transit systems in designing the internal configuration of the bus and the securement and fare collection systems. Additionally, such data could assist cities in determining the appropriate size for a bus stop landing pad, developing criteria for satisfactory access to stops, and evaluating the safety and effectiveness of various curb cut designs.

Figure 6 shows three typical wheelchairs: a nonpowered chair, a powered chair, and a portable wheel-base chair (*14*) and the protuberances, angles, jutting devices, and similar chair features that could interfere with the moving parts of lifts. These protuberances can hit or damage, or be hit or damaged by, parts of the lift, the bus stairwell, the seats, or equipment inside the bus.

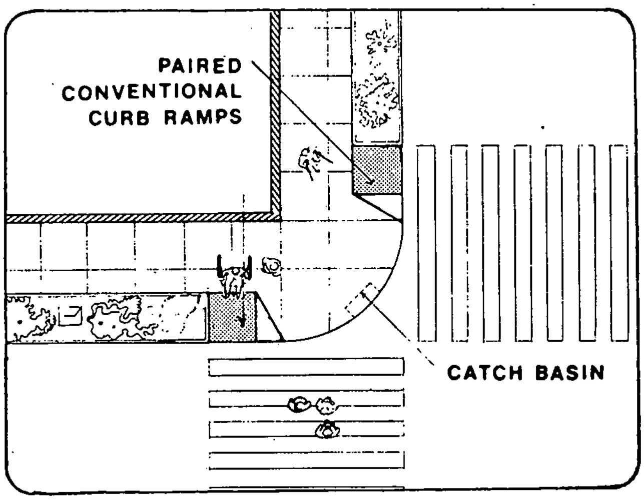
TABLE 6
DETECTABLE TACTILE WALKWAY SIGNALS FOR EXTERIOR USE (*13*)

WALKWAY MATERIAL	SIGNAL MATERIAL	DETECTION
Broom Finish Concrete	Asphalt*	N
" " "	Ruled Concrete (grooves 4" or 10.16 cm spacing)	N
" " "	Exposed Aggregate (pea gravel)	Y
" " "	Concrete Burlap Finish**	N
" " "	Concrete Washboard***	Y
" " "	Brick Paving	N
" " "	Thermoplastic Strips (6" or 15.24 cm)	Y
" " "	Pliant Polymer	N
" " "	Plastic Tennis Court Cushion Coating	Y
" " "	Thermoplastic Sheet	N
Asphalt	Broom Finish Concrete	N

* Regular Mix
** Burlap laid into wet concrete and pulled off before initial set is complete
*** Wet concrete struck with the edge of a board to give a washboard effect with grooves that are not more than 1/8" (1.27 cm), or so, deep.
N Surface difference not detectable by cane
Y Surface difference detectable by cane



Ramped Sidewalk



Double Conventional (Recessed) Curb Ramp

FIGURE 5 Two suggested curb and sidewalk treatments to enhance accessibility.

Researchers devised dimensions of "the typical wheelchair and passenger based on the 95th percentile measurements for males and females" (*15*) (Figure 7). These measurements were used by Michigan State University in developing equipment and maintenance requirements for small-bus operators. This information may be equally useful to systems operating full-sized transit coaches.

In a study undertaken for the Federal Highway Administration (FHWA (*13*), data on both powered and nonpowered wheelchairs were obtained from seven manufacturers of 201 chair models. The following are the findings with regard to the key dimensions of all the models:

Length
Less than 47 in. (120 cm): 83 percent
Less than 46 in. (117 cm): 55 percent
Less than 45 in. (114 cm): 33 percent

Width
Less than 28 in. (71 cm): 89 percent
Less than 27 in. (69 cm): 76 percent
Less than 26 in. (66 cm): 66 percent

Weight
Less than 51 lb (23 kg): 76 percent
Less than 46 lb (21 kg): 62 percent
Less than 44 lb (20 kg): 49 percent

Much less is known about wheelchair users. No data are available on such important user characteristics as weight, strength, agility in hands or upper torso, need for an attendant, and ability to maneuver a chair.

SUMMATION

Below is a list of the major decisions or policies a transit system could make concerning the design or technical features of the lift or bus and the environment in which those lifts and buses are used.

Bus Design Features

Lifts and Buses

- Choice of bus and lift manufacturers
- Location of lift on retrofits: front versus back
- Length and width of lift (within constraints)
- Auxiliary lift attachments (e.g., grab bars, side flanges)

Internal Bus Configuration

- Location of internal furniture and poles
- Location and number of wheelchair securement areas
- Total seating capacity of bus
- Special flooring

Securement Systems

- Type of primary and backup systems
- Degree of driver assistance that will be allowed if securement system fails or cannot be operated by user

Other Bus Features

- Decision to purchase kneeling feature
- Optional on-request use of kneeler versus mandatory use of this feature

Community Infrastructure

- Desired lift operation in different climates and varying terrain
- Determination of accessibility of stops for bus drivers operating lifts
- Determination of accessibility of stops for users
- Actions to be taken with regard to problem stops

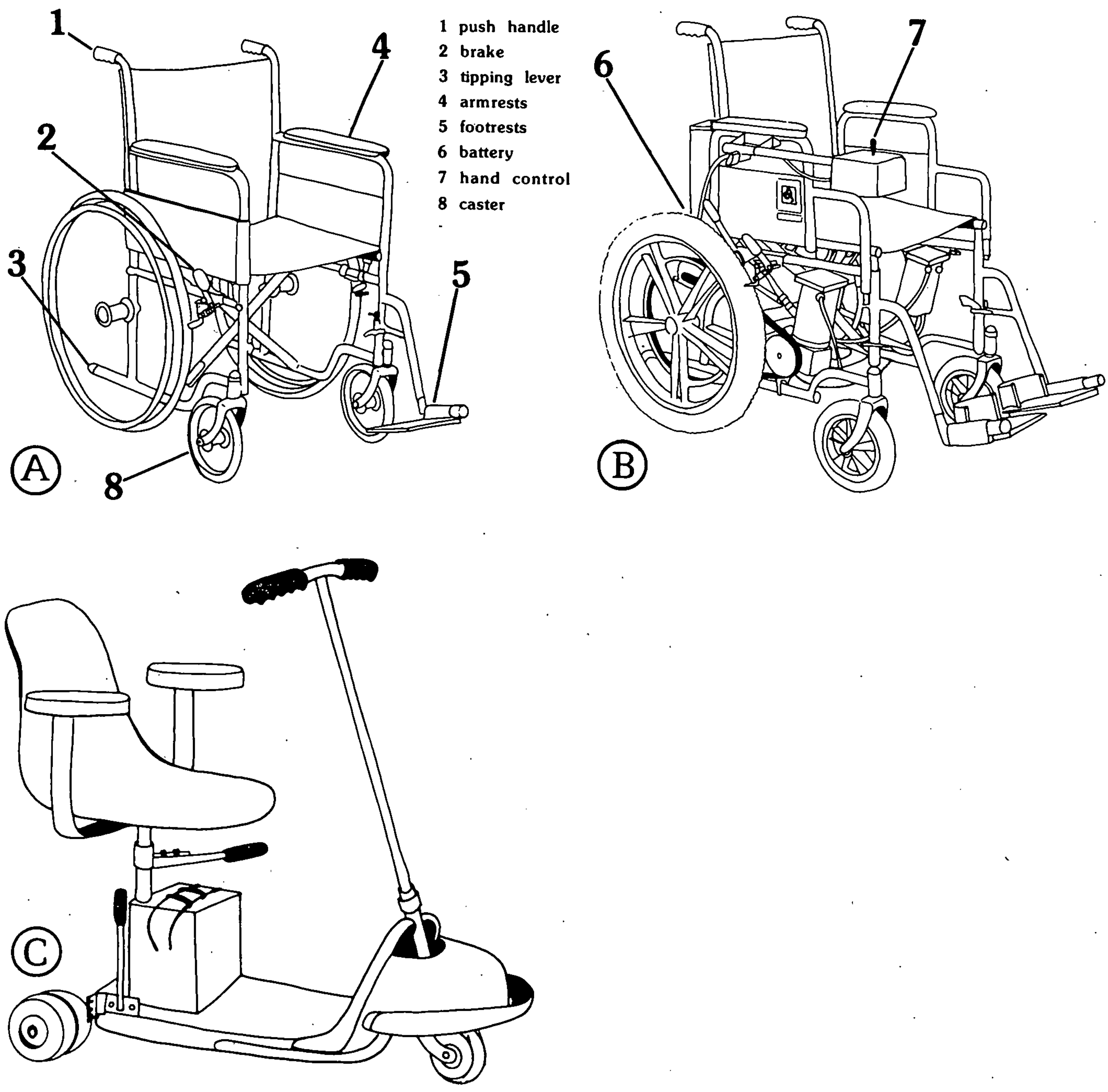
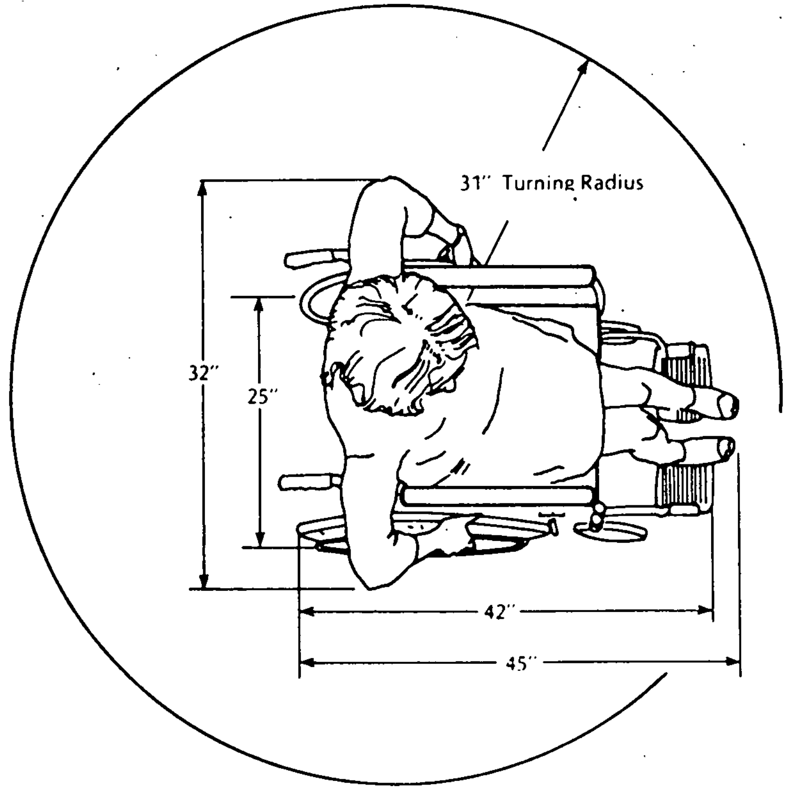
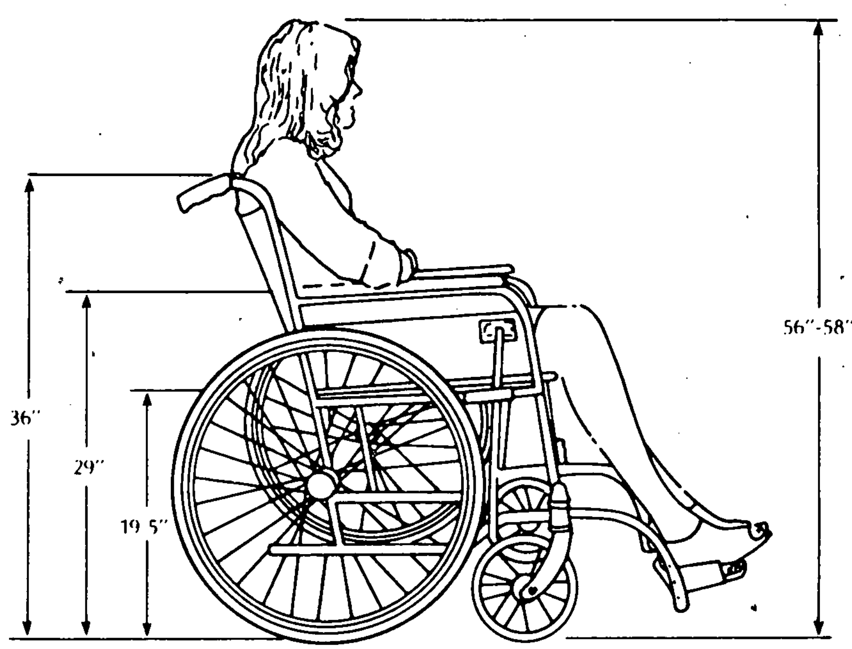


FIGURE 6 Examples of typical wheelchairs: *A*, standard; *B*, powerdrive: *C*, portable wheel-base chair (*14*).



TOP VIEW



SIDE VIEW

FIGURE 7 Wheelchair and user dimensions (*15*).

CHAPTER THREE

SERVICE, OPERATIONAL, AND MAINTENANCE EXPERIENCES AND POLICIES

The level of accessible service provided, the operational procedures chosen, and the maintenance experiences and policies followed in a wheelchair-accessible, fixed-route transit system affect each other. These factors also affect response of both handicapped and nonhandicapped riders.

SERVICE CHARACTERISTICS

The level of accessible service provided by a transit system is determined in part by the number of LE vehicles used, the number of routes that provide LE bus service, and the frequency and schedule of LE vehicles along those routes. Because most of the 90 or so U.S. transit systems with wheelchair-accessible, fixed-route service do not provide 100 percent accessible service on all routes, they have had to make choices and trade-offs among these service factors. In addition, transit systems must decide how many auxiliary services to provide for handicapped travelers (e.g., special printed schedules or special training programs). The auxiliary services are discussed in Chapter 6.

Transit systems exercise some discretion over such service issues as route selection, headways and level of service, allowable lift users, citizen training and information services, assistance by driver, and demand-responsive services.

Route Selection

Transit systems must make a number of decisions about the kind and frequency of accessible service they will provide, especially if the entire fleet is not lift equipped. The criteria most agencies use to select routes are:

- Total ridership on route,
- Expected handicapped ridership on route,
- Sites served by route,
- Geographic service coverage,
- Transfer potential between high ridership lines,
- Location of maintenance facilities,
- Possible headways and impact on overall schedules,
- Number of available accessible spares, and
- Standing and seating capacity of available vehicles.

Transit systems have formal and informal policies for selecting routes on which to put LE vehicles into service and for establishing "accessible headways" on these routes. Generally, the larger an agency is, the more formal the route selection process. And, the larger the agency, the more likely it is that a number of operational factors enter into route selection, including the location of maintenance facilities, the number of spare LE vehicles, the needs of the scheduling department, and transfer points on the system. The Los Angeles SCRTD was limited in its initial route selection by the need to operate vehicles out of the only one of its eight maintenance facilities that could service the lifts.

Most transit agencies have put LE buses into service on those routes heavily used by the general ridership. If specific information on the demands of the handicapped was not available, a transit system often assumed that handicapped people would be best served by the routes that had the heaviest demand and best met the needs of most other travelers. Those were generally routes that served large shopping concentrations, commercial activities, and employment sites. Efforts also were made to select routes that served training schools, independent living centers, and colleges. Data from Seattle suggest positive correlation between lines with high regular ridership and lines with high use by the handicapped.

Some agencies are flexible in selecting routes; they work actively with handicapped citizen groups to alter routes if it appears that travel needs are not being met. The Washington Metropolitan Area Transit Authority (WMATA) in Washington, D.C., solicits information from handicapped people regarding their preferences for specific sites and facilities; routes can be changed based on citizen input. The Seattle transit system made a conscious effort to see that routes providing access to large institutions, schools, and the like were those on which LE vehicles were put into service.

Where transfer between bus routes is likely, most systems try to provide accessible service to accommodate transfer passengers. WMATA has attempted to provide accessible service that allows transferring to the accessible subway system. Seattle, which will shortly have a series of accessible trolleys, has tried to select routes that feed into these trolley routes and permit transfers. Detroit's SEMTA first chose long line-haul routes on which to implement accessible service and then used its paratransit services to feed those routes.

Headways and Level of Service

Transit systems must decide how to schedule the LE buses among the routes selected when not all vehicles in the fleet are lift equipped. In some systems one or two routes have LE buses on all runs; in others the headways between LE vehicles are minimized. And most systems try to achieve some regularity; for example, making every bus on the hour lift-equipped. These decisions often have been made with the assistance of handicapped groups. Local groups have different concerns. In some areas users wanted many routes with LE buses, even if LE vehicle headways were very long. Elsewhere, users preferred a few routes with just about all

vehicles equipped with wheelchair lifts. Scheduling to meet these needs can cause operator and line fluctuations. If not all buses on a line are lift equipped, schedule irregularities can be significant.

Many transit systems are still uninformed about the demand for bus travel by handicapped persons, their need for transfer, and acceptable headways. Many of them simply experiment with different routes and try to be responsive to the needs of the handicapped.

Allowable Lift Users

Agencies need to decide whether nonwheelchair-handicapped or even nonhandicapped travelers should be allowed to use lifts. Some lift designs are more conducive to nonwheelchair use than others, but all lifts require standing people to lower their heads at some time during the operation of the lift in order to enter or depart the bus. Some agencies (e.g., Milwaukee and St. Louis) have thought this too great a danger and have prohibited nonwheelchair use of lifts. Seattle Metro permits the driver to cycle the lift for anyone who asks for the service. Such policies can affect the total number of travelers served by the lift.

Citizen Training and Information Services

Most transit systems provide some information and training and some conduct active public relations and marketing campaigns for the handicapped. Most provide informational programs and even training sessions when requested; some devote considerable time and resources to such training efforts. Every system interviewed in the preparation of this synthesis reported that, as handicapped users became more familiar with the operation of the lift and the tiedowns, the use of LE buses in regular service became more efficient. To encourage familiarity with lift operation, some systems offer extensive and continuing public training programs for handicapped travelers. Others desire to do so but lack sufficient resources. And some agencies indicated that handicapped ridership is too small to justify the commitment of resources for these programs.

A few systems, like Seattle, have dedicated one LE vehicle, with an appropriately trained driver, for group training sessions at nursing homes, rehabilitation centers, independent living centers, and the like. In Santa Clara a mock-up of the front end of a bus is taken to different locations as requested. The Santa Clara transit system often trains drivers and users together, in effect allowing them to "practice" on one another.

Seattle provides handicapped travelers with a list of accessible stops on any given route; many systems will provide this information by telephone. Also, Seattle has inventoried all streets and curb cuts in the downtown area and prepared a map showing these features.

Some agencies mark the stops of LE buses. Seattle used the international handicapped symbol to mark stops (Figure 8), but this policy created some problems. First, it is not always clear to users whether there is easy access to the stop or whether it is a stop for LE buses. (Even if a route uses LE buses, the access to a given stop may be poor to impossible.) Second, if not all buses on a route are equipped with wheelchair lifts, or if a stop is identified as one where LE buses stop and it is on more than one route, this may be confusing. Third, the international handicapped symbol does not help blind people. Seattle has attempted to overcome this latter problem by replacing the standard poles holding transit signs at stops for LE vehicles with square poles.

FIGURE 8 Example of an accessible-stop marker (Seattle Metro, 1980).

Assistance by Driver

Perhaps the most important service decision a transit system must make is the degree of assistance the driver can give to the handicapped traveler. Systems differ widely in their policies on driver assistance. Some systems, such as San Diego, forbid the driver to touch the handicapped traveler; the driver may not assist the traveler onto the lift, secure the wheelchair on board the bus, or take the fare. Some systems discourage direct assistance but do not forbid it. Other systems, like Seattle, encourage the driver to actively help handicapped persons.

These widely differing policies generally reflect a system's perception of accessibility. Some systems see it as a physical feature only; that is, handicapped travelers should be able to enter the vehicle but should not require any more assistance than that given ordinary passengers. Several systems, in their marketing documents, urge handicapped travelers to bring escorts if they require assistance.

Drivers respond differently to these formal policies. Handicapped groups report that drivers, in general, are more helpful than some formal system policies would indicate. In Ventura, California, for example, drivers were physically assisting wheelchair riders during boarding before buses were equipped with lifts.

Some systems are worried about the impact of driver assistance on labor relations and negotiations. So far no system has had to change its negotiated work rules. Only the Detroit Department of Transportation gives its drivers additional pay

to drive LE buses. Most systems offer the LE vehicles on the regular route boards and let the drivers bid; this has worked well so far.

Demand-Responsive Services

Many transit systems implementing wheelchair-accessible, fixed-route service also have some type of door-to-door demand-responsive or advance reservation service for handicapped and elderly travelers. Such specialized services usually exist in response to one or more stimuli (e.g., the UMTA 504 requirement for interim service and the UMTA elderly and handicapped special efforts requirement) or in response to pressure from local handicapped and/or elderly groups. Chapter 5 deals with the cost-effectiveness of these services.

A transit agency with a viable specialized transportation service will probably expend only the minimum required on wheelchair-accessible, fixed-route service. These agencies appear less willing to have extensive driver or citizen training programs or to give serious attention to the development of accessible operational policies. Such systems often encourage users to call on the specialized services rather than use lift-equipped service. The system in Montebello, California, did not have a wheelchair user on board its LE vehicles for 2 yr, although a significant number of such travelers have used the special system.

Some agencies, such as the one in San Mateo, occasionally use the specialized service if they must refuse a handicapped passenger service on the fixed-route system. San Mateo originally intended to provide specialized service feeders to the fixed-route, LE fleet, but travelers have not used it. Detroit's SEMTA successfully uses its special services to feed a wheelchair-accessible, fixed-route line.

OPERATIONAL CHARACTERISTICS

A number of variables are linked to the work rules and general operating characteristics of an accessible service. Operational factors are affected by both service levels and maintenance experience, which in turn affect those factors. The key operational features of an accessible system are scheduling, driver training, procedures at problem stops, procedures in case of lift malfunctions, and service refusal policies.

Scheduling

Probably no variable has presented more problems than scheduling. It takes longer for a handicapped traveler to board and disembark than the average traveler, which affects scheduling. Three hard-to-predict factors are involved: (a) how long it takes handicapped travelers to board and disembark and what impact this has on both actual and average dwell time, (b) when and how often handicapped travelers use the system, and (c) how flexible the schedule can be regarding both routine and random use by the handicapped.

The DOT EIS concluded that lift-assisted boardings would have only a slight impact on bus operations, slight enough that increased dwell times due to lift-assisted boardings will average less than a minute per transit trip (*3*). Most systems will be able to make up this average loss through slack en route and through minor reductions in turnaround or layover times between routes (*3*). The EIS also noted that if there are known regular riders the system can change its schedules at the next appropriate schedule change.

The APTA disputed these claims. In its response to the EIS, the APTA charged that these DOT conclusions were based on miscalculations, omissions, and lack of familiarity with transit operations. The APTA concluded that calculations of dwell time are central to any evaluations of the impact of implementing accessible service on transit operations (*16*).

Wheelchair Boardings and Dwell Time

The issue here is whether lift-assisted boardings delay a bus appreciably, and if so, whether schedule changes are required.

Since the time that the federal government began considering the use of LE buses, analysts have tried to gauge the average time it takes handicapped travelers to board and alight. Early tests were stationary ones, under better conditions than would be found in actual operation: drivers were generally familiar with lift operation and under no other pressures; wheelchair users were generally well informed and felt relatively secure; the stop or area used for the test was usually level and had no significant obstructions; other people used in the test or present on the bus were friendly and supportive. All these conditions precluded generalizing the results to real-life situations.

In addition, tested boarding time may fall short of dwell time because the activity of the driver is not usually taken into consideration. With rear-door lifts drivers must stop, park the bus, and walk back to operate the lift. Although most systems do not require the driver to assist the handicapped traveler in boarding, many drivers do, which further increases dwell time. Moreover, most agencies forbid the operator to move the bus until the handicapped person is secured, whether the securing is done by the driver or the passenger, so additional time is taken.

Finally, tests produce discrepant results. In general, tests conducted by transit agencies indicate far longer (often by orders of magnitude) boarding and alighting times than do tests conducted by handicapped groups or for transit agencies by handicapped people. The wide variance among tests (shown in Tables 7–11) and the difficulty of using optimal boarding times to calculate dwell time cause some of the current controversy in the transit planning community.

Most high-side calculations of the boarding time of handicapped travelers do not compare this time with the boarding time of nonhandicapped travelers. Moreover, such calculations usually do not recognize that, in buses with two sets of doors, some travelers may be alighting while the lift is being deployed and that, therefore, no extra time is being used.

The EIS analysis included calculations of average boarding and alighting times, average route delays caused by lift-

TABLE 7
AVERAGE BOARDING AND ALIGHTING TIMES (IN SECONDS) INCURRED USING LIFTS UNDER TEST CONDITIONS WITH STATIONARY VEHICLES

Lift User and Lift Type	Boarding: Level Change	Boarding: Move to Tie-down Area	Boarding: Total	Alighting	Total Boarding and Alighting
Wheelchair Users, Nonassisted(9)					
Rear-door lifts*	-	-	23.0	21.0	44.0
Front-door lifts*	-	-	27.7	24.3	52.0
Lift-U (front door)*	11.8	21.8	33.6	24.0	57.6
Lift-U (front door), loaded bus	11.4	48.4	59.8	22.3	82.1
Second chair	-	80.6	92.0	29.1	121.1
EEC (front door)*	-	-	170	80	250
Wheelchair Users, Assisted(10)					
EEC (front door), assisted by attendant	-	-	118	92	210
EEC (front door), assisted by driver	-	-	187	125	312
Semi-ambulatory, Nonassisted(9)					
Lift-U (front door)*	-	-	16.8	18.4	35.2

*No driver time is included (i.e., boarding time ≠ dwell time).

TABLE 8
AVERAGE WHEELCHAIR LOADING AND UNLOADING TIMES (IN MINUTES) (3)

	St. Petersburg	Denver	Sweden
LOADING			
1. Vehicle Stop[1] & Lower Platform or Ramp	:29	:23	:25
2. Assist Rider & Raise to Floor Level	:48	1:28	1:12
3. Maneuver to Wheelchair Position	:36	:18	:18
4. Tie-Down	:26	:13	1:15
5. Secure Ramp or Lift[2] & Start Vehicle[1]	:22	:28	:20
TOTAL	2:41	2:50	3:30
UNLOADING			
1. Vehicle Stop[1] & Lower Platform or Ramp	:20	:17	:18
2. Disengage Tie-Down & Exit Vehicle	:24	:27	:41
3. Assist Rider off Ramp of Platform	:43	:03	1:05
4. Secure Ramp or Lift & Start Vehicle[1]	:27	:28	:20
TOTAL	1:54	1:15	2:24

[1]These times apply to all boardings, handicapped or not.
[2]This time can be reduced since the ramp or lift can be secured during tie-down.

TABLE 9
ASSUMED TYPICAL BUS DWELL TIMES (3)

	Bus Stop Time (Seconds)											
	Base Situation No Handicapped Passenger			Case I Single Handicapped Boarding			Case II Second Handicapped Boarding w/Passengers			Case III Two Simultaneous Handicapped Boardings		
	Fast	Typ.	Slow	Fast	Typ.	Slow	Fast	Typ.	Slow	Fast	Typ.	Slow
Open/Close Doors, Prepare lift, stow lift	2	3	4	30	45	60	30	45	60	30	50	65
Handicapped entry/ Departure	—	--	--	10	12	15	10	12	15	20	24	30
Wheelchair Tie-down/Release [b]	--	--	--	30	45	65	40	60	90	50	75	110
Load/Disembark other Passengers (a)	12	15	25	2	3	10	2	3	10	--	—	--
Total Dwell Time, Wheelchair Patron				70	102	140	80	117	165	105	149	205
Total Dwell Time, Other Lift-Assisted Patrons [a]				42	60	85	42	60	85	50	74	95
Total Base Dwell Time	14	18	29									

NOTES: (a) Other passengers assumed able to board during handicapped entry/departure. Time added in Cases I and II because average for other passengers exceeds handicapped entry/departure times.
(b) Time required for wheelchair patrons only.

TABLE 10
ROUTE DELAY CAUSED BY BOARDING OF LIFT-ASSISTED PATRONS (3)

	Lift-Assisted Boardings		
	Non-Wheelchair	Wheelchair	Total
Percent of T.H. Ridership	30.6	4.4	35
Typical Bus Dwell Time For Single Boarding (sec)	60	102	65
Typical Route Delay Per Lift-Assisted Rider (sec) [b]	84	148 [a]	94

NOTES: (a) Lift-assisted wheelchair disembark assumed to require 80% of boarding time.
(b) Route delay = (Handicapped board + disembark time) - 2 x typical time without handicapped movement.

TABLE 11
SAMPLE DWELL TIMES FOR WHEELCHAIR USE (*17*)

	UNATTENDED PERSON IN WHEELCHAIR (seconds)
Deploy Lift	15
Boarding	55
Travel to Station	30
Secure at Station	30
TOTAL BOARDING	130
Deploy Lift	15
Alight	60
Stow Lift	20
TOTAL ALIGHTING	95
TOTAL DWELL TIME/TRIP	225 (3.75 min)

assisted passengers, and total system impact of such calculated delays on transit systems of various types and under a variety of operating conditions. Also calculated were delays created by nonhandicapped travelers (people boarding with luggage, delays in paying fares, etc.).

A comparison of the boarding times found in a Caltrans stationary test in San Francisco and those from an unpublished test conducted by the Houston Metropolitan Transit Authority (MTA) indicates marked differences between tests conducted under similar conditions (Table 7). The Houston MTA (with the front-door EEC lift) found total boarding and alighting times four to five times longer than did the Caltrans test conducted by United Cerebral Palsy. These data also suggest what happens when a second wheelchair user boards. The first wheelchair user, in effect, creates a barrier around which the second one must maneuver, which takes extra time.

Table 8 gives average wheelchair loading and unloading times by individual components of the process. Table 9 presents typical bus dwell times based on the delay times in Table 8. Table 10 gives average route delays and the total system effect that can be expected. All three tables are from the 1980 EIS (*3*).

Controversy surrounds these calculations. Several transit systems believe that the EIS-reported estimations of boarding times are too low. The Bi-State Development Authority (BSDA) in St. Louis performed a stationary test and concluded that total average boarding and alighting times are closer to 4 min than to 2 min (*17*) (Table 11 presents the BSDA data). Milwaukee reported an average delay of 5.1 min because of boarding a handicapped passenger and a total delay of 7.3 min for boarding and alighting (*11*). The APTA reported that, in tests in Atlanta and Washington, D.C., the lift operation alone averaged from 2 to 4 min and ranged from 1.5 to 6 min (*18*).

Both the SCRTD and Seattle report total boarding and alighting times of 2 to 3 min with an experienced driver and an experienced passenger. Booz-Allen & Hamilton reported that some travelers in Washington, D.C., have been able to reduce their boarding time from 4 min to 1.5 min (*19*).

Scheduling Activities

Even if experts agreed on average dwell times, the information could not be used easily to calculate delays or determine schedule changes because the current levels of ridership by handicapped people are so uneven. Average data are misleading. For example, it takes significantly longer for a wheelchair passenger to board a crowded bus than a partially full bus. Thus, the impact of wheelchair boardings will be greater in peak periods.

Only the St. Louis BSDA is known to allow time for wheelchair boarding delays (*17*). The BSDA allocated an extra 24,435 scheduled hours for delays but only about 500 hours of delay were recorded in the first 12.5 months of operation.

In 1979 the BSDA did a spot check on one of its lines (*17*). Although low handicapped ridership makes it difficult to generalize, the delay found at the end of three trips on which handicapped riders were aboard ranged from zero to 6 min, which indicates that the driver made up the time in some cases. Similar trips without wheelchair riders ranged from being 3 min early to 5 min late. On the average, St. Louis experienced only a 0.025 percent total increase in road time due to wheelchair boardings.

In Seattle, accessible service had no significant impact on the on-time performance of runs with LE buses (Table 12), which, even on routes with heavy use of the lifts, are early less often than runs with bus without lifts, but are also less frequently 5 min or more late. Delays from lift boardings are usually made up by the driver during the course of the trip or by the reduction of scheduled layover time. Delays that cannot be made up in those ways are handled on a case-by-case basis through the traffic coordinator's office.

Seattle Metro has not added scheduled time to routes to compensate for accessible service, and at this time there appears to be no need to do so. Apparently, with so many other factors affecting on-time performance, the impact of accessible service on a fleetwide basis is negligible.

In Hartford, the system changed the schedule to accommodate the known frequent riders; the additional time was found to be unnecessary, however, and schedules will be changed back.

Most systems have not changed their schedules to allow for increased dwell time. Many see handicapped ridership as small enough that the average layover would cover the occasional handicapped passenger. However, as the Milwaukee system notes, its 7.3-min average time loss due to wheelchair boardings is greater than the layover time of most routes.

The average schedule delays discussed here do not consider the affect of lift malfunctions. The SCRTD noted that the average schedule delay for other on-road vehicle repairs was 6 min, compared to an average delay of 17 min when a lift malfunctioned.

The problem of scheduling for delays is complex; on one hand, if the system allows considerable additional time and

TABLE 12
IMPACT OF LIFT USE ON SCHEDULE PERFORMANCE (SEATTLE METRO, 1980)

	Percent Early	Percent On-Time	Percent* Late
Accessible Runs	21.62	66.45	11.93
Non-Accessible Runs/ Accessible Routes	23.80	63.52	12.68
Accessible Runs on 7 Frequently used Routes	21.35	67.75	10.89
Non-Accessible Runs on 7 Frequently used Routes	24.64	64.86	10.50
System Average	21.26	65.17	13.57

*Definitions are Metro Council Standards:
"Early" - 1 or more minutes early
"On time" - 0 to 5 minutes late
"Late" - 6 or more minutes late

no wheelchair users board the bus, the vehicles will be ahead of time all along the route. On the other hand, peak-hour service is sensitive to time delays; dispatchers and passengers can be greatly inconvenienced if delays occur at that time.

Driver Training

Most agencies and most lift manufacturers consider the driver's role and attitude to be the most influential factor in the operation and maintenance of the lift. To use a newly installed lift properly, even on a conventional bus, requires training; to use it with facility requires experience. Drivers who drive an LE ADB for the first time must learn a whole range of new skills.

The time allowed for training drivers in the use of the lift varies among transit agencies. In general, drivers attend either a 2- to 4-hr session designed to acquaint them with the lift or a training session designed to acquaint them with the ADB, which includes instruction in lift use. Most agencies are unwilling to devote much time to lift training because they feel there is little demand for the lift. This may be self-fulfilling prophecy. Predicting great difficulties with the use of lifts and being unwilling to expend resources to train drivers properly may lead to problems.

The questions facing most transit systems are (a) the point at which driver error becomes cause for appropriate design changes and (b) the effectiveness of training and retraining programs in addressing recurring operator-related malfunctions in the lift equipment.

One of several recurring problems with certain lifts is that the lift continues to cycle after it touches the ground, in effect "jacking up" the bus with the lift. Such problems have been caused by a combination of faulty design and driver error. The lift manufacturer's position is that if the lift were cycled properly such problems would not occur. Operations people feel that such devices require more skill and experience than most drivers can be expected to possess.

Even well-trained drivers sometimes forget how to operate the lifts when they do not use them frequently. Systems with more than one type of vehicle or lift (e.g., the SCRTD in Los Angeles) may experience even greater problems with driver errors. The WMATA in Washington, D.C., is considering periodic retraining programs as a response to problems created by driver error based on unfamiliarity with the lift. Detroit's SEMTA has a quarterly retraining session that is believed to be effective.

Many handicapped users and some transit managers are convinced that drivers require more than technical training in the use of LE buses; they feel that the attitude of the driver is a major factor in the successful operation of the lift. Therefore, they advocate consciousness-raising training programs designed to familiarize drivers with the variety of wheelchairs and mechanical aids used by handicapped travelers and with the problems faced by them when using lifts and boarding LE vehicles.

In Santa Clara's transit system, drivers in training programs sit in wheelchairs and use the lifts under different conditions (e.g., on hills, curves, and driveways). The WMATA also conducts a program of consciousness-raising for its drivers.

Procedures at Problem Stops

In some transit systems the policy is that the driver informs handicapped travelers that certain stops present a problem for operating the lift and may present a problem to the alighting traveler, and refuses to allow the passenger to disembark, even if the passenger insists he can manage the stop. In other systems the driver informs the handicapped person that a

certain stop will present problems in alighting and that the driver will not assist the passenger, who then decides whether to leave the bus at that stop. Some systems have no policy because no problem stops have been encountered as yet.

Some systems have on-demand stops for all passengers, but do not allow the cycling of a lift at an unpaved or dirt stop, which would expose the lift to potential dysfunction. In some systems, i.e., Ventura County in California, drivers are not permitted to stop at dirt stops but can operate the lift at paved driveways. Some agencies allow the vehicle to operate the lift anywhere within a certain distance of the landing pad if this enables the handicapped person to board; others refuse to allow the driver to stop anywhere but at the scheduled stop. Smaller systems tend to be more flexible; this may reflect less congested traffic conditions and less strict schedules.

Drivers in systems of all sizes apparently are permitted considerable discretion, and they often cycle the lift at a stop that could present problems to the lift and the handicapped passengers. However, this may be confusing to handicapped travelers because drivers differ in their discretionary decisions.

Lift Malfunctions

Agencies should have a policy regarding (a) what to do with a handicapped traveler when the lift malfunctions while in use and (b) what to do with an otherwise operational bus when the lift is not working properly.

Problems With the Handicapped User

A problem arises if a lift malfunctions when a handicapped person is on it or fails to operate as the person attempts to leave the bus. Most systems require the driver at this point to call and wait for a supervisor, who then physically assists the handicapped traveler either off the vehicle or off the lift. In some agencies, if the malfunction occurs at the start of the trip, the supervisor either drives the handicapped traveler to his or her destination or calls on the system's demand-response service to do so.

Almost every system has faced a situation in which a handicapped traveler was stranded aboard a vehicle, and most systems have felt obliged to make sure that the traveler reached the destination. This contrasts sharply with the decision to pass up a handicapped person waiting at a stop because of a full vehicle.

Problems With the Bus

When the lift on an otherwise operational bus is not functioning properly, four factors need to be considered: (a) the point at which it becomes known that the lift is not operable, (b) the number of LE vehicles available, (c) locations of bus garages and maintenance facilities, and (d) general scheduling and routing needs.

Many systems require the driver to cycle the lift each day before going out on a run. This has two advantages. First, the driver's increased experience with the lift's operation reduces the potential for accidents and problems due to driver error. Second, some lift malfunctions can be detected before the bus leaves the garage. This policy also has disadvantages. Certain types of lifts inactivate the entire bus if they are operated while not totally functional, thus inactivating an otherwise operational bus. Other lifts may disable the bus on the lot by "freezing out" in an extended position, thus putting that bus out of service and also all the buses behind it in line.

In transit systems where drivers are not supervised in operating the lift before the run, they sometimes do not do so or do not report lift failures. Two of the systems visited in the preparation of this synthesis had LE buses on-line or ready for service, confident that the lifts were operational because they had not been reported as inoperable. In fact, the lifts were not operational, and no one in either system could explain why.

The Seattle transit system has decided that the disadvantages of the routine practice of the driver cycling the lift daily outweigh the advantages. In Seattle and in Detroit's SEMTA a maintenance supervisor cycles each lift every night after the bus has returned from a run and before it is parked in formation. Seattle believes that a maintenance person will be less inclined than a driver to fail to report lift malfunctions. The BSDA in St. Louis also requires the lift to be cycled daily by mechanics.

When a lift on an otherwise operable bus is found at the garage to not function properly, a transit system must decide what to do with the bus. If there are sufficient LE buses, one of them generally is substituted. If there are no spare LE buses, a non-LE bus must be assigned to that route which has been announced as having LE bus service. Where spare buses are in short supply, management often decides to run a bus with an inoperable lift instead of putting the bus out of commission until the lift is repaired. This decision is influenced by the experience of transit systems with downtime for inoperable lifts.

A related issue is what to do when the lift is discovered to be inoperable *after* the bus is out on a run. Some agencies report that, if available, an operable LE coach is substituted as soon as the problem is reported. Observations of the transit systems visited and reports from some handicapped groups indicate that this remedial action is not always practiced. Inoperable lifts are frequently allowed to remain in service for a day or longer. Casual observation fails to discern whether an inoperable lift is kept in service because (a) spare coaches are not available, (b) the driver has not reported the problem, or (c) system management decides not to change the bus.

Several systems admit that the number of service refusals reported by handicapped travelers exceed the number of lift malfunctions reported by drivers. Failure of drivers to report lift malfunctions may be because: (a) the bus is full, (b) the lift really is operational but the driver either does not remember how to use it or does not wish to delay the schedule by operating the lift, (c) the lift is inoperable but the driver chooses not to report the malfunction because he/she does not want to contend with the inconvenience and the time loss involved in changing a bus on a long run, or (d) the driver

does not know the condition of the lift and is unwilling to risk using it, perhaps rendering it and the bus inoperable.

Some transit systems are unwilling to change a bus on a run; instead they require the driver to call in to have a supervisor deal with the needs of any handicapped traveler who has been refused service. If there has been no service refusal, the driver is required to report the lift problem at the end of the run. In many systems these decisions are at the discretion of the supervisor.

Both Washington WMATA and Seattle Metro indicated that drivers probably underreport difficulties with the lift even when they return to the garage. Drivers may simply be unwilling to take time to fill out the required forms. Such inaction may be based on (a) a driver's belief that management really doesn't care about the operation of the lift, or (b) management's view that the lift is in demand so infrequently that it is not worthwhile to repair it.

Service Refusal Policies

Agencies face the problem of the arrival of a full vehicle at a stop where a handicapped person is waiting to board. Some systems have made the formal decision that handicapped travelers will be treated similarly to other waiting travelers faced with a full vehicle; they will be passed up to wait for the next bus.

Some systems have decided that drivers may request riders on a crowded bus to stand in order to make wheelchair tie-down spaces available. A policy decision is also necessary if passengers will not vacate the tie-down area. Systems differ markedly in the amount of pressure the driver is asked to put on passengers who will not vacate the tie-down area. In Seattle and Washington, D.C., drivers are requested to actively try to get people to move so the handicapped person may be accommodated. Other systems do not require this.

In the Los Angeles SCRTD system, handicapped people have been refused service and left at the stop because other riders would not move out of the tie-down area. In Seattle, if necessary, the driver leaves his seat to ask passengers to move; no handicapped travelers have been known to have been refused service because the vehicle was too crowded.

In one system visited, a driver got up from her seat and told three people standing or sitting in the tie-down area to get off the bus and board the one behind it in line so that two wheelchair users could travel together.

During peak periods or along heavily used routes, it is possible that potential wheelchair passengers will repeatedly be passed up, if that is the system's policy. The Houston MTA had indicated, in its response to the DOT EIS, that it might be fairer to handicapped travelers to notify them that they could only travel in off-peak periods. This would also be objectionable on several grounds.

MAINTENANCE

Background

Several transit systems, including the Los Angeles SCRTD, Milwaukee (*11*), St. Louis (*17*), and Seattle delayed placing LE vehicles into revenue service, or operated the vehicles for significant periods of time without providing lift service, because the lifts did not function satisfactorily from the time they were delivered.

Although emergency or manual procedures were established for the operation of damaged lifts, most agencies found them to be inadequate. Often the mechanical devices are inconveniently located; sometimes it is not possible for the driver to manually operate them. The control panel and its location and complexity were of concern to some transit systems as well.

Many lifts are integrated into bus hydraulic or electrical systems so that if some component of the lift is not functioning, the bus is disabled. Although most of the agencies interviewed indicated a need for safety and sensing devices, they believed that the lifts should have manual overrides to permit a bus to be driven with an inoperable lift without lengthy mechanical work at the site of the problem. Most agencies were also unhappy with any feature in the design and installation of the lift that disables the bus when the lift itself is disabled.

Milwaukee and St. Louis illustrate the extreme cases. In both cities, because the lifts drifted out so frequently (sometimes at every stop), they were initially bolted into place to prevent them from disabling the bus. As a result, they could not be used as level-changing devices for the handicapped.

Some transit agencies reported that a number of design features caused operational problems for the agency or were inadequate for the intended purposes. Some transit systems reported that some lifts were likely to "drift" or begin to "float" when not in use, or that the lifts did not stow properly after use. Both conditions, often by design, make the entire bus inoperable. If the bus could be driven with a lift that had floated or drifted, the lift could easily be damaged.

Most lifts are designed with edges or devices that can detect when the lift platform touches the ground and can stop the continued downward movement of the lift. Most agencies, regardless of the type of lift that is used, have serious problems with this feature. Often the edge is only a thin protruding wire; if the ground is uneven it could touch a high place and stop the downward movement of the lift, releasing the security gate, even though the platform is not on the ground and conditions are not appropriate for a rider to board or alight. Conversely, the sensing device could reach a depression in the ground, allowing the lift to keep cycling even though the platform is already on the ground.

Some lifts are provided with devices that allow the driver to override the sensing device to correct for uneven ground or slopes, etc. Both procedures often lead to damage of the lift and sometimes result in the phenomenon of the lift "jacking up" the bus.

Some agencies reported that lift manufacturers are not very helpful on this point. Manufacturers noted that driver error was often involved when the lift was cycled even after the platform had hit the ground or when the ground was uneven or sloped. However, many agencies believed that such devices require too much skill or judgment on the part of the driver to prevent accidents or lift damage.

The major parts and components of two lifts, Lift-U (as of April 1980) and a TDT lift as installed (and modified) by

Flxible (June 1977), are shown in Figure 9. It gives some idea of the similarities and the differences in the overall design of these lifts.

Commonly Reported Repair Needs

Commonly reported problems with wheelchair lifts can be categorized as:

- Electrical system:
- Hydraulic system (particularly if the lift hydraulic system is linked to the bus);
- Release of the lift while bus is in motion ("drifting" or "floating");
- Failure of the lift to cycle down, recycle, and stow (inadequate storage prevents the bus door from closing); and
- Movement of the lift back into step configuration with a rider aboard ("stowing").

It would be useful to know the specific kinds of problems experienced by transit systems and the frequency of these problems. However, agencies are just beginning to develop comprehensive repair records that indicate the frequency of repairs, the mean time between failures (by part or by function), and the mean downtime (the time the lift or vehicle was out of service) for each functional problem or part where possible. Several of the agencies surveyed for this synthesis have been developing such records. When available, such records may reveal any effect that changes in procedures, design components, modifications, etc., have on lift maintenance and speed of repair.

Experiences of the St. Louis BSDA

The best documented maintenance experience with LE buses has been in St. Louis (*17*). The Bi-State Development Authority, serving the entire St. Louis metropolitan area in both Kansas and Missouri, was the first large purchaser of accessible buses, beginning service in August 1977 with 157 Flxible coaches equipped with TDT lifts. Its experience was monitored extensively by a contractor to the Urban Mass Transportation Administration's Service and Methods Demonstration Program. The BSDA implemented accessible bus service in two stages: (a) 60 Flxible coaches 40-ft (12.2-m) long and 8.5-ft (2.6-m) wide, with TDT lifts, were delivered first (Group A) and (b) 97 buses were delivered subsequently (Group B). The lifts of both groups were modified by Flxible before delivery. The vehicles were significantly different from previous purchases in their engine design, transmission, push-type rear door, and kneeling feature.

Of the repairs to the three types of major lift components experienced by the BSDA in St. Louis, mechanical systems required more than 3- and 4.5-fold more repairs than the electrical and the hydraulic systems, respectively (Table 13). Analysis of the cumulative repair record of the two distinct groups of LE vehicles put into service at different times in St. Louis (Table 14) showed that on a per-bus basis the first vehicles put into service (Group A) had about 2-fold more repairs than those in Group B.

TABLE 13

REPAIRS OF MAJOR COMPONENTS OF WHEELCHAIR LIFTS BETWEEN JULY 1977 AND SEPTEMBER 1978 ON 157 BUSES OF THE BSDA IN ST. LOUIS, MISSOURI (*17*)

System	Repairs (no.)
Electrical	
Control box/circuit board	53
Microswitches	45
Hydraulic	
Ramp extend cylinders	32
Hydraulic manifold	7
Pump related	29
Mechanical	
Slides	107
Skid pan	157
Sensitive edge	56

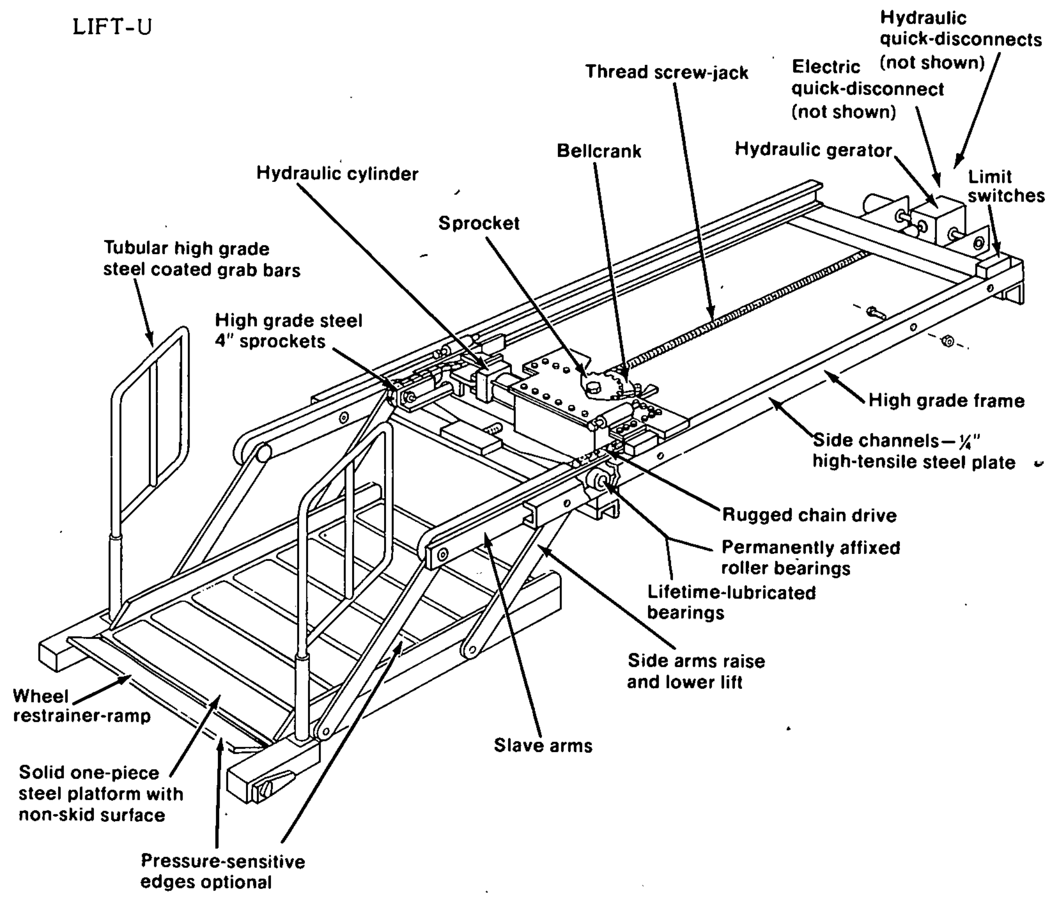
When the average mileage was taken into account, the ratio of repair visits by Group A and Group B was 1.5:1. The first vehicles delivered had a higher proportion of lift problems and failures; the trend toward fewer problems (and although not evident from the table, less serious problems) may have resulted from changes in design of the lifts in Group B and advance on the maintenance learning curve (*17*).

Analysis of the total repair and failure experience of the BSDA between July 1977 and September 1978 showed that the total number of problems decreased over time (Figure 10). Most transit systems visited during this survey had similar experiences. They reported fewer difficulties with later versions of the first lifts on the market and with lifts from newer manufacturers. Different factors contributed to this trend of fewer repairs with time: (a) improvements in the design of various lifts; (b) improved operator and system familiarity with the lift in operation and the types of repairs needed, and (c) a better understanding of system changes in routine service and maintenance practices needed to keep lifts functioning properly.

This reduction over time in dysfunctions of and needed repairs to lifts is one reason why the St. Louis experience in particular, and past experience with the first uses of LE vehicles in general, may not be representative of current repair and maintenance experiences with LE buses.

Overall Experience

Many agencies have been, and are currently, dissatisfied with the guidance and direction received from some lift manufacturers concerning latent defects, operational problems, routine and emergency maintenance, and other procedures. Several transit systems reported that lifts arrived



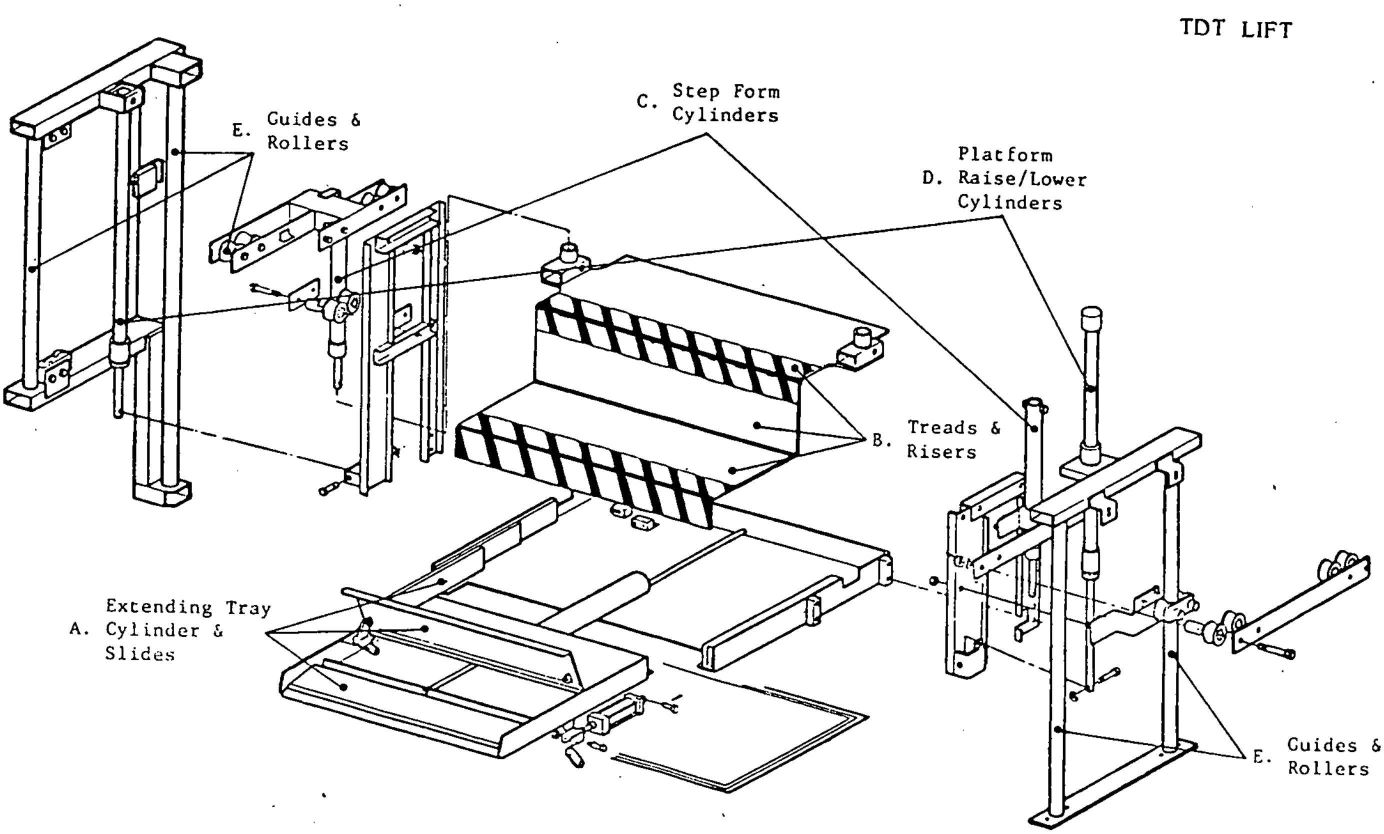


FIGURE 9 Major components of two wheelchair lifts for buses.

TABLE 14
COMPARISON OF REPAIRS FOR TWO GROUPS OF LIFT-EQUIPPED BUSES BETWEEN JULY 1977 AND SEPTEMBER 1978 (ST. LOUIS, MISSOURI) (*17*)

BUS GROUP	A	B	TOTAL
# BUSES IN GROUP	60	97	157
# SHOP VISITS	326	261	587
# VISITS/BUS	5.43	2.69	3.74
RATIO TO GROUP A	1.0	0.496	0.689
AVERAGE MILEAGE	55,000	40,000	46,000
RATIO TO GROUP A PER MILE	1.0	0.682	0.824

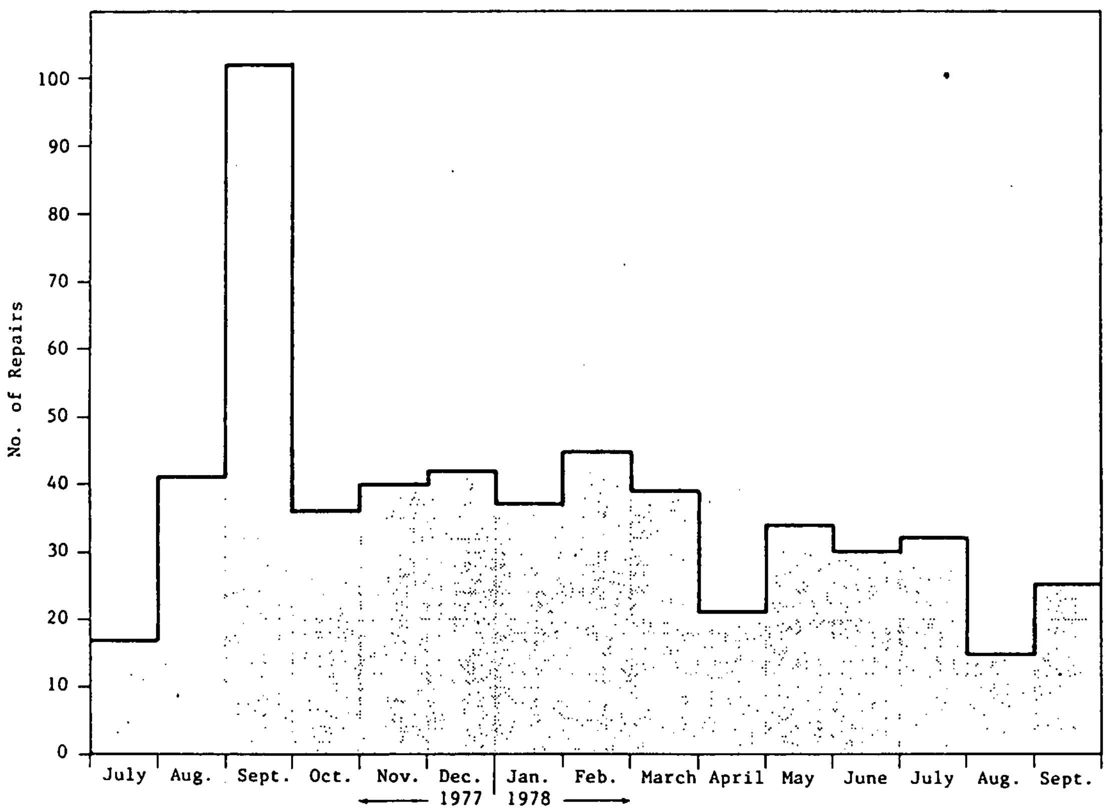


FIGURE 10 Repairs by month to 157 LE buses of the BSDA in St. Louis, Missouri.

without manuals and that none was received later. A maintenance supervisor with one transit agency warned that bus systems should never take delivery of a lift or bus-lift combination that was not accompanied by up-to-date driver and service manuals.

Several transit authorities currently have lawsuits pending against the manufacturers of lifts, the bus manufacturer that installed the lift, or both for latent defects that caused accidents to users (e.g., St. Louis, Milwaukee), for failure to meet original specifications, and for defects caused by poor manufacturing. In contrast, some systems that experienced serious problems (e.g., Los Angeles, San Diego) found lift manufacturers helpful and ready to provide assistance.

Transit properties planning to purchase lifts might: (a) learn of the concerns of handicapped about the suitability of various designs for LE buses, (b) contact other systems that have recently purchased similar equipment from the same manufacturer to discuss problems that may have been previously encountered by other agencies, and (c) work with manufacturers to ensure operational problems with LE buses have been corrected or overcome. Also a system should discuss with all lift or bus bidders: (a) availability of up-to-date driver and service manuals, (b) the type of service representation and assistance that will be routinely provided, (c) the type of service that will be provided in case of difficulties, (d) the warranties and equipment exchange provisions that accompany the equipment, (e) the responsibilities of the bus manufacturer and the lift manufacturer in several types of lift dysfunctions, (f) the replacement of any part or subsystem that is either functioning normally or is a problem with a more advanced design of that component, and (g) the type of written guidance and directions that will be provided to both operators and mechanics when the buses are delivered.

SUMMATION

The type of policies and decisions available to transit systems for the service, operation and maintenance of accessible services and examples of systems employing the various options are summarized in Table 15.

TABLE 15
POLICY OR PROCEDURAL DECISIONS REGARDING SERVICE, OPERATION, AND MAINTENANCE OF ACCESSIBLE, FIXED-ROUTE SYSTEMS

ISSUE	POLICY OPTIONS	SYSTEM WHERE POLICY IS USED
Service		
- Route selection and headways	o many routes, long headways	o Santa Clara
	o few routes, high accessibility	o Detroit SEMTA
	o choose routes in order to operate bus from special facilities	o Los Angeles SCRTD
- Allowable lift users	o only those in wheelchairs	o Milwaukee; St. Louis
	o anyone who requests the deployment of lift	o Seattle; Washington, D.C. WMATA
- Citizen training and information services	o marginal additions to existing marketing program	o Gardena; Ventura
	o outreach efforts and training programs	o Detroit SEMTA
	o establishment of regular user training programs	o Seattle METRO
- Driver assistance	o driver may provide no direct or nonverbal assistance	o San Diego Transit
	o driver may assist traveler	o Seattle METRO
- Provision of demand-responsive service	o allow special services to be competitive with accessible, fixed-route service	o Montebello, Calif.; Milwaukee
	o use special services to feed accessible, line-haul services	o San Mateo; Detroit SEMTA
	o allow both services to operate without coordination	
Operations		
- Scheduling responses to accessible services	o schedule longer run times to accommodate predicted use and estimated delay	o St. Louis BSDA
	o allow layover and slack to absorb any delay	o Seattle
	o alter schedule to respond to needs of known riders	o Hartford
- Driver training	o add 2- to 4-hour session to existing program	o Milwaukee
	o no additional training	o Ventura; Montebello
	o periodic retraining	o Detroit SEMTA
	o inaugurate special training for potential drivers of LE buses	o Los Angeles SCRTD
- Procedures at problem stops	o allow boarded passenger to alight if they say they can manage	
	o refuse to allow passengers to board or alight	o Los Angeles SCRTD
	o move to a point near the stop where the traveler can alight	o Ventura, Calif.
- Procedures for lift malfunctions	o driver or supervisor assists traveler off the bus	o Los Angeles SCRTD
	o traveler who is denied boarding is driven to destination by alternate means	o Seattle; San Mateo
	o bus is run with an inoperable lift o bus is replaced at garage with an operable LE bus o bus on route is changed immediately for an operable lift-equipped bus	o varies with daily condition of accessible and other fleet; at discretion of dispatcher
	o malfunctions are detected by drivers cycling lift at beginning of day	o Milwaukee; Denver; Los Angeles SCRTD
	o malfunctions are detected by mechanics at end of day	o Detroit SEMTA; Seattle Metro; St. Louis BSDA
- Service refusal policies	o refuse any traveler when the bus is full	o Los Angeles SCRTD
	o ask seated or standing passengers to move out of securement area	o Washington, D.C. WMATA; Los Angeles SCRTD; Seattle Metro
	o take denied-boarding passenger to destination by alternate means	o Seattle Metro

CHAPTER FOUR

RIDERSHIP RESPONSE TO ACCESSIBLE SERVICE

POTENTIAL HANDICAPPED RIDERSHIP

Over the last decade a number of studies have been conducted to identify the types of obstacles faced by handicapped travelers, to estimate the number of travelers affected by these obstacles, and to evaluate appropriate methods to overcome them.

In 1979, as part of the Transbus study, the National Research Council undertook a review of the major studies in this area. The number of people considered to be handicapped in the United States ranges from approximately 5 percent of the urban population to 6.2 percent of the entire U.S. population (Table 16) (*1*).

The definitions of "handicap" vary greatly, as do the severity of handicaps reported; some who are physically handicapped in some way can use mass transit or drive cars and might not be included in the "transportation handicapped" category. Although this synthesis focuses only on the handicapped and not the elderly, the two groups overlap significantly and because of this overlap, they are often grouped together in national estimates.

Much of the literature aimed at identifying and analyzing the needs of the transportation handicapped (however defined) is beyond the scope of this study. The interested reader is referred to the National Research Council study (*1*) and a U.S. Department of Transportation study (*20*) for identification and comprehensive review of the major studies in the field.

The actual ridership response of the handicapped to the provision of accessible fixed-route services tends to overshadow the usefulness of the past literature. Although current ridership data (presented in following sections) should be used with more caution than is generally the case, they show remarkable consistency among transit agencies. Ridership response to accessible service has been considerably below the lowest estimate of the need calculated or documented in any previous studies.

FACTORS AFFECTING HANDICAPPED RIDERSHIP

Variables that influence transit ridership by the nonhandicapped also affect handicapped travelers. Such factors include the location of routes, schedules, fares, and headways. A number of variables, however, affect the handicapped more seriously. Climate and terrain, inherent in fixed-route

TABLE 16
ESTIMATES OF ELDERLY AND TRANSPORTATION-HANDICAPPED PERSONS IN THE UNITED STATES (*1*)

Source	Percentage of Elderly Who Are Handicapped	Percentage of Handicapped Who Are Elderly	Total Elderly and Handicapped and Percentage of U.S. Population	Total Urban Transportation Handicapped and Percentage of U.S. Urban Population[a]	Total Transportation Handicapped and Percentage of U.S. Population
Grey Advertising Study for UMTA 1976-78	21	47	—	7 440 000 5.0	—
1973 UMTA Handicapped and Elderly Market Study	76	53	26 406 000 12.0	—	—
1970 U.S. Census and 1969 HEW National Health Survey	30	50	26 500 000 12.4	—	—
1970 National Center for Health Statistics	NA	NA	—	—	13 390 000 6.2

Notes: NA = not available.
Benchmark: 1970 Census; people 65 and over = 20 087 000.
[a]5 years of age and older.

operations, affect all riders but appear to affect the handicapped more significantly.

Some factors that are not necessarily inherent in fixed-route operation can affect the use of accessible services by the handicapped. Eight of these factors disproportionately affect ridership by the handicapped:

Transit System Related

- Reliability of the accessible service provided.
- Frequency and availability of scheduled LE buses.
- Driver attitude toward handicapped travelers.
- Percentage of system routes with LE buses.
- Type and quality of user information and training available.

Community Infrastructure

- Number and percentage of nonproblem stops along routes with LE buses.
- Negotiability by the handicapped of streets and walkways.
- Ease with which the handicapped can gain access to trip attractors and buildings.

Transit System-Related Factors Affecting Handicapped Ridership

Transit ridership depends on the type and quantity of accessible services provided. Transit ridership by the ambulatory is responsive to headways and route coverage; handicapped riders on systems that are not fully accessible are probably more sensitive to such factors. Additionally, transit ridership of both the nonhandicapped and the handicapped is affected by the reliability of the vehicles of a transit system and to its adherence to announced schedules.

Many agencies provide LE buses on a few selected routes, or only on some runs on certain routes; such service restrictions and the poor operating history of many lifts combine to deter ridership. An understanding of the quantity of *reliable* accessible service actually provided by any given agency is needed before its ridership experience can be evaluated. Management in both San Diego and Seattle maintains that it is too early to draw definitive conclusions about the transit ridership of the handicapped.

Information and marketing services furnished by the transit agency affect the transit ridership by the handicapped. Several transit systems with poor lift performances were hesitant to change their printed schedules to provide information about the routes with LE buses. Some systems were fearful of being inundated and having their vehicles delayed if they actively advertised accessible services. Systems that obscure the availability of the lift feature on their buses, however understandable their reasons, deter ridership by the handicapped.

The attitude of the management of transit systems toward the lift and its potential use by the handicapped affects not only rider response directly but also other factors that may affect ridership response. Perceived management attitude may affect driver attitude and behavior toward riders, toward reporting lift malfunctions, and even toward keeping good ridership records. Perceived system management also affects maintenance and operational policies, which also may affect ridership by the handicapped. Those systems with the highest handicapped ridership appear to be those with the most positive attitude toward providing accessible services.

Community Infrastructure

The equipping of a system's vehicles with wheelchair lifts does not constitute complete accessibility service. The capacity of stops along the routes to accommodate lift operation by LE buses is also relevant. Some agencies cannot or will not allow the driver to operate the lift at certain stops. Other stops are a problem for the handicapped traveler to reach and/or negotiate. In San Diego (*21*), stops along two routes served by LE buses were classified according to the ease of access to them (Table 17).

One or two problem stops along a route served by LE buses are not serious barriers for the handicapped. However, some transit systems have a significant number of problem stops, and these can deter ridership by handicapped people.

In addition, access for the handicapped to the urban environment and infrastructure is not adequate. Many streets do not have curb cuts, and access to many buildings is unsatisfactory. If access to the destinations of handicapped travelers is inadequate, their demand for transit will likely be minimal.

Conditions are changing, however; the same 504 regulations that mandate transit coaches with ready access for the handicapped mandate that buildings constructed and/or supported with federal funds provide ready access for the handicapped. Many states have similar laws and there is increasing public and local interest in providing appropriate facilities in public buildings for access by the handicapped. This may be a chicken and egg issue; if travelers cannot get to certain facilities, private individuals and cities may be less likely to expend resources to improve the access to them by the handicapped.

Some groups have suggested that transit operators, while not having responsibilities for making sure there is access to bus stops, are in a position to advise cities and local traffic departments of the need for changes at certain stops. Some agencies have surveyed the stops along their routes and advised the relevant local jurisdictions of the need for change. Perhaps cities would be more willing to make such changes if they were advised that the lack of curb cuts and street treatments were preventing the handicapped from using the available accessible service furnished by the transit system. Some cities and states now routinely program curb cuts and related improvements into annual public works programs (*12*).

Other Factors Affecting Handicapped Ridership

Ridership may be greatly affected by the availability of demand-responsive and paratransit systems. If such services were readily available, handicapped travelers might prefer them to fixed-route service. In cities where these services

TABLE 17
RELATIVE ACCESS TO STOPS ON ROUTES WITH LIFT-EQUIPPED BUSES (SAN DIEGO, CALIFORNIA) (*21*)

LEVEL OF ACCESS	ROUTE 3 NUMBER OF STOPS	ROUTE 3 PER-CENT	ROUTE 7 NUMBER OF STOPS	ROUTE 7 PER-CENT	BOTH NUMBER OF STOPS	BOTH PER-CENT
Ideal	38	22.6	22	14.1	60	18.5
Accessible Stop	10	6.0	10	6.4	20	6.2
Partially Accessible Stop	59	35.1	46	29.5	105	32.4
Usable Stop	18	10.7	5	3.2	23	7.1
Not Suitable for Non-Ambulatory	43	25.6	73	46.8	116	35.8
TOTAL	168	100.0	156	100.0	324	100.0

exist, the ridership response to accessible systems will be different from the ridership in other cities. At present, the only choice in some cities is between a relatively reliable and available specialized service and an unreliable and malfunctioning accessible fixed-route service.

Personnel of the Milwaukee transit system believe low ridership of the system by handicapped people may be due to a significant county-sponsored user-side subsidy program (*19*). Ridership experience in cities with other viable alternatives for the handicapped (e.g., Milwaukee and Montebello) cannot be directly compared to ridership in cities with no other available services.

The amount of time that accessible transit services have been available to the handicapped also affects their use of these services. In Seattle, for example, some handicapped travelers chose to relocate their homes in order to use the fixed-route service. If people believe that accessible services will be available and reliable, over time they may be willing to consider moves to take advantage of such services. Conversely, if reliability is a continuing problem, people who have experienced difficulties will not return to the system. Others will be discouraged from making any changes that would increase their proximity or other access to fixed-route service.

In summary, the more often lifts are used, the more familiar drivers and maintenance personnel will be with their operation and repair. The greater the frequency of the use of the lifts by handicapped riders, the more familiar they become with lifts and the easier it becomes for them to deal with minor malfunctions.

Stories abound of wheelchair riders telling inexperienced drivers how to cycle and stow the lift. Once travelers are over their initial fear and gain experience and facility with the lift, they may be willing to make more trips. Probably concomitant with increased use of the lifts by handicapped travelers are increased acceptance and helpfulness by the general public. For example, several agencies reported that fellow passengers frequently assist the handicapped traveler with the tie-down.

ACTUAL RIDERSHIP

National Statistics

Little is known concerning ridership statistics for the 7.4 million transportation handicapped travelers except for those using wheelchairs. A compilation of the reported ridership experiences of 17 of the 90 transit systems that provide accessible service reveals that ridership of the handicapped has been low in all the systems except in Seattle (Table 18).

In a survey of 13 cities, relating the lift boardings to the number of scheduled LE buses provided a better indicator of ridership response by the handicapped than just the total number of passengers using the lift (Table 19). Seattle had the highest number of lift-assisted boardings and the highest intensity of use of the LE vehicles. The transit system of Champaign-Urbana, Illinois, was second to Seattle.

The ridership response by the handicapped was compared in seven U.S. cities (Table 20). The two indicators of the reliability of accessible service used were (a) the number of attempted boardings that were denied and (b) the number of runs scheduled for LE buses that were missed (i.e., operated with non-LE coaches).

The reasons for the denied boardings are not clear. Perhaps the handicapped traveler was denied entry because the bus was full and there was no room. Or the boarding could have been prevented by mechanical problems with the lift. Seattle and Champaign-Urbana, which have a higher ridership response, had the more reliable service as assessed

TABLE 18
RIDERSHIP ON ACCESSIBLE. FIXED-ROUTE SERVICES

City	Number of Handicapped Boardings or One Way Trips In Recent Month	Number of Individual Travelers (Estimate)	General Reliability During Time Period	Percentage of Total Routes	Major Specialized Services Available In Same Area
Champaign-Urbana (1)	95	N.A.	-	2 routes; 20%	Yes
Detroit (SEMTA) (2)	120	N.A.	Good	31 routes; 50%	Yes
Gardena, Calif. (2)	32	3	Good	2 routes accessible	No
Hartford, Conn. (1)	157	N.A.	Good	21 routes; 100%	No
Janesville, Wisc. (3)	86	-	Good	7 routes accessible	No
Los Angeles (SCRTD) (2)	103	N.A.	Poor	21 routes	Yes*
Milwaukee (3)	29	15	Poor	N.A.	Yes
Montebello (2)	0	0	Good	2 routes accessible	Yes
New Haven (1)	178	N.A.	Good	18 routes; 100%	-
Palm Beach County (1)	125	N.A.	-	19 routes; 100%	-
San Diego (2)	27	N.A.	Fair to Good	2 routes accessible	No
San Mateo (2)	45	N.A.	Fair to Good	4 routes accessible	Yes
Santa Clara (2)	38	N.A.	Good	2 routes accessible	No
Seattle (2)	1900	N.A.	Good to Excellent	26 routes; 26%	No
St. Louis (1)	42	40	Poor; getting better	12 routes; 7%	No
Ventura (2)	22	4	Good	2 routes; 18%	No
Washington (WMATA) (1)	155	-	Poor	37 routes; 28%	No

* In some areas.

Sources: (1) Computed from data supplied by Robert Casey, Transportation Systems Center, 1980
(2) Direct from transit system
(3) Reference 8

TABLE 19
DAILY BOARDINGS PER LIFT-EQUIPPED BUS AS AN INDEX OF RIDERSHIP RESPONSE BY THE HANDICAPPED IN 13 U.S. CITIES (OCTOBER 1980)[a]

SITE	DAILY LIFT BOARDINGS	DAILY BOARDINGS PER SCHEDULED ACCESSIBLE BUS
PALM BEACH COUNTY	4.2	0.08
STAMFORD	1.2	0.05
HARTFORD	5.2	0.03
NEW HAVEN	5.9	0.07
BRIDGEPORT	2.7	0.14
CHAMPAIGN-URBANA	3.2	0.29
ORANGE COUNTY	17.0	0.17
SANTA MONICA	1.3	0.04
MILWAUKEE	2.1	0.02
DETROIT (DDOT)	0.7	0.004
SEATTLE	54.0	0.50
LOS ANGELES	5.0	0.03
WASHINGTON, D.C.	5.3	0.05

[a] Data supplied by R. Casey, Transportation Systems Center, February 1981.

through a low percentage of both missed runs and denied boardings (Table 20).

Cities with a higher percentage of their routes served by LE buses, which have a good reliability record and have not had severe maintenance problems, also appear to have higher ridership levels relative to the quantity of accessible service offered.

Specific Cities

St. Louis BSDA

The St. Louis BSDA carefully monitors ridership. Data of ridership trends over time (August 1977 to August 1978), normalized to account for the number of LE buses actually available and used (Figure 11), indicate that handicapped ridership was at its highest at the beginning of the service, and then dropped rapidly, concomitant with mechanical problems that caused service denials. Ridership remained low through the winter, although more buses were being placed into service and reliability was increasing. Ridership increased sharply after the winter, but several peaks and valleys are not totally explainable. Data from the summer of 1980 show that ridership continued to drop substantially.

A comparison of the pattern of the ridership of handicapped in St. Louis by the time of day with times for total transit trips (Figure 12) revealed major peaking in the early morning and again at mid-day for trips by handicapped riders.

TABLE 20
INDICATORS OF THE RELIABILITY OF ACCESSIBLE SERVICE (OCTOBER 1980)[a]

SITE	PERCENTAGE OF ATTEMPTED BOARDINGS DENIED	PERCENTAGE OF SCHEDULED RUNS MISSED
PALM BEACH	2%	0%
STAMFORD	17	9
HARTFORD	7	12
NEW HAVEN	8	8
CHAMPAIGN-URBANA	1	<1
SEATTLE	2	<1
WASHINGTON	6	20

[a] Data supplied by R. Casey, Transportation Systems Center, February 1981.

Seattle Metro

Seattle's experience with wheelchair-accessible, fixed-route transit provides a sharp contrast to St. Louis in most respects, including ridership. Seattle Metro began service in the summer of 1970 with 143 Flyer diesels (New Look) with Lift-U lifts, along two of the heaviest used transit routes in the service area. New routes were added as more buses were put in service; by February 1980, 23 routes offered service with LE buses at about 1-hr intervals. Three additional routes were added in September 1980. Seattle increased service of LE buses in early 1981 by adding 225 Lift-U equipped Flyers to the service.

From March through October of 1980, between 1,500 and 2,000 one-way trips were made each month by people who boarded via the lift. Seattle Metro permits semi-ambulatory people not in wheelchairs to request the use of the lift. However, between 92 and 95 percent of all lift-assisted boardings involved wheelchair users.

Preliminary information from an UMTA Service, Methods, and Demonstration study shows that Seattle has an excellent reliability record and a less than 1 percent denied-boarding rate. Those data also show that 59 percent of all lift-assisted boardings were on only five routes (D. Kaufman, 1981, *personal communication*).

It is not possible, with Seattle's ridership data or with any

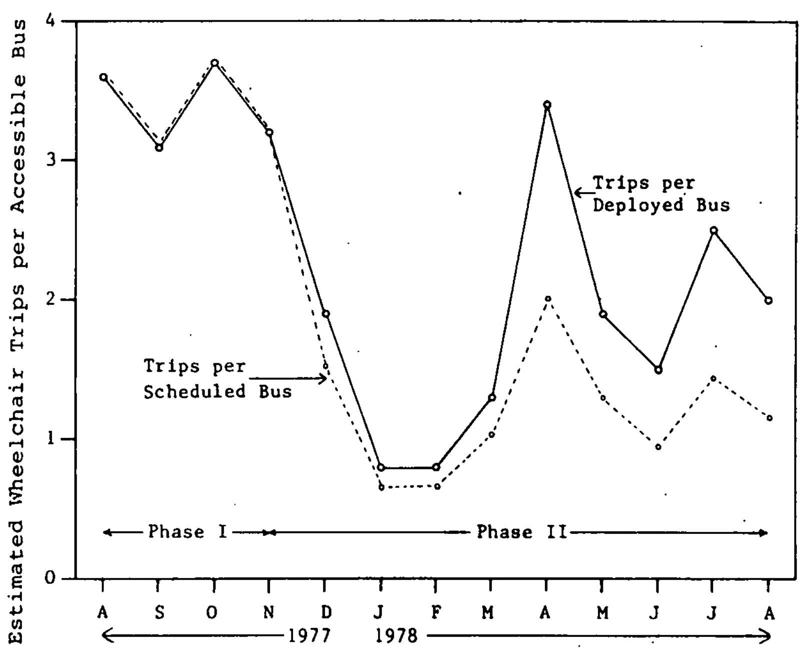


FIGURE 11 Average estimated trips per LE bus and per scheduled LE bus (*17*).

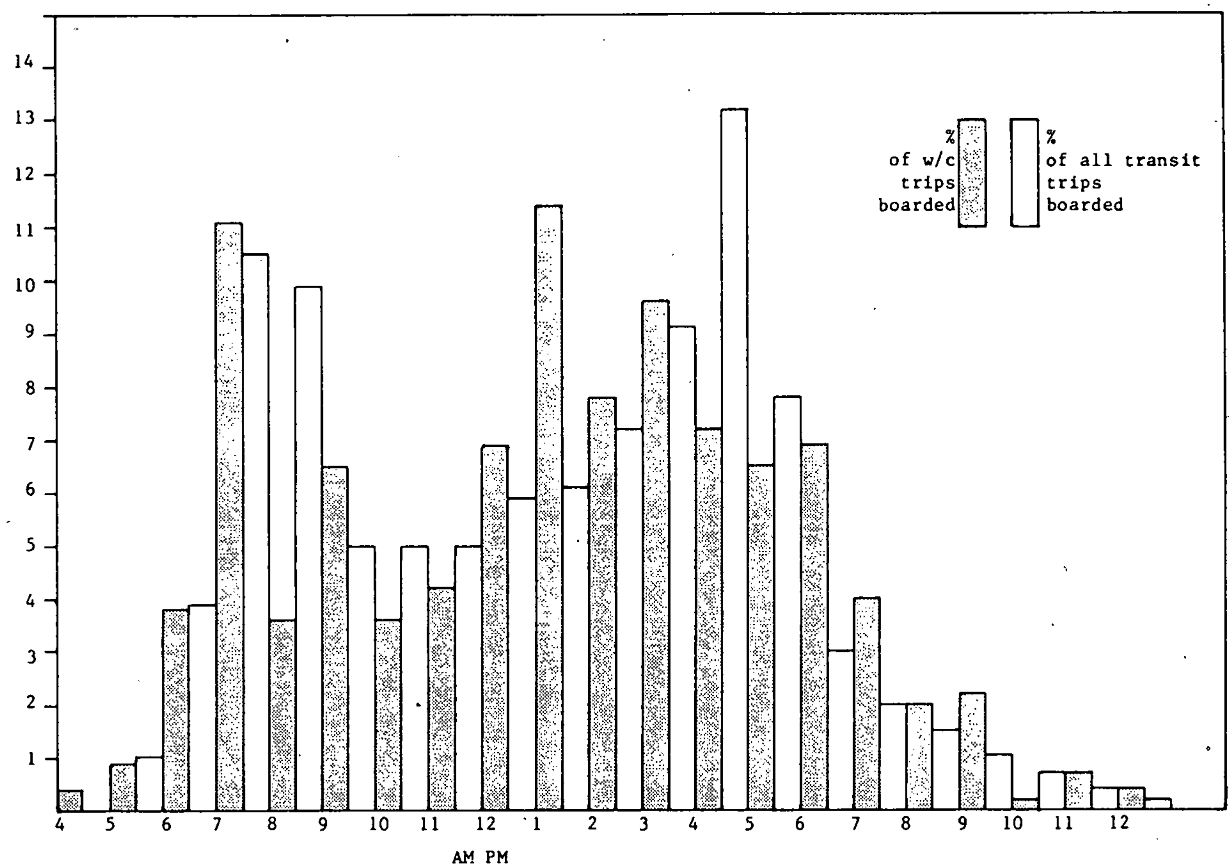


FIGURE 12 Comparison of handicapped ridership to total ridership by time of day (BSDA, St. Louis, Missouri) (*17*).

of the ridership data presented in Tables 18 and 19, to ascertain the number of individual people boarding. Because some trips involve transfers, some linked trips were counted twice. Seattle Metro received responses from 73 people in a ridership study on the number of persons using lift-equipped service and their trip frequency patterns. Thus, 73 was considered the minimum number of individual travelers being carried by the system.

It appears that while there is a group of people making many trips, there are also a number of individual travelers using the system less frequently (Figure 13).

Seattle attributes its ridership response to the active involvement of citizen groups and a driver task force plus a strong commitment by maintenance and operations personnel. Also, it has experienced relatively few problems with the lift, which was chosen after an intensive *user* evaluation of available lift systems.

Implications of Record Keeping

Information from a number of transit systems suggests that there may be substantial undercounting of wheelchair boardings and of attempted boardings denied.

Some transit systems require drivers to fill out a slip, as shown in Figure 14, whenever a handicapped person is boarded with the lift or is denied boarding. Other systems require the driver to radio the dispatcher who keeps ridership records. No incentive is provided to a busy driver to take the time to do either activity. Only in Detroit are drivers paid extra for boarding wheelchair users.

Even in well-monitored systems, the accuracy of ridership data is questionable. In St. Louis when handicapped riders were asked to keep daily travel logs, drivers were found to be reporting only about one-half of all trips (*19*).

In Seattle, both officials and handicapped groups feel that both actual boardings and denied boardings are undercounted. The WMATA in Washington, D.C., also feels that drivers are probably not reporting some boardings.

Undercounting by drivers may be an indication of lack of interest by system management, or the perception that few people will ride. Several systems, for example, Ventura, Calif., reported frankly that they had stopped collecting ridership data. Some systems had a few recognized regular riders. When one of these systems was asked to calculate the total ridership of handicapped passengers, it simply estimated the number of school trips made by two regular riders who were students at the local community college.

Planners and administrative people often admitted that system operations and maintenance personnel were not very

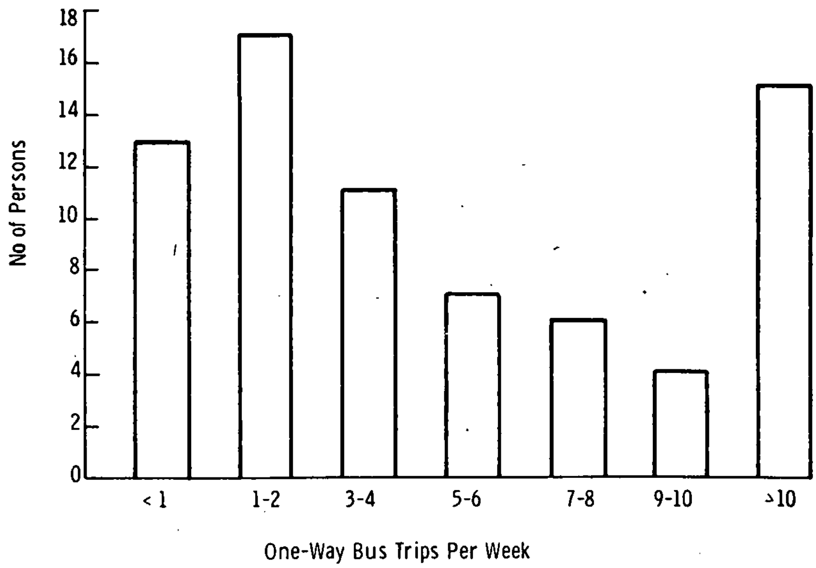


FIGURE 13 Lift-assisted trip rates (Seattle, October 1980). (Data supplied by R. Casey, Transportation Systems Center, February 1981.)

WHEELCHAIR PASSENGER DATA DATE ____________

OPERATOR ________ BADGE ______ ROUTE ______ RUN ______ BUS NO. ______ DIRECTION ______

BOARDING LOCATION ____________________

TIME REQUIRED; FROM: ______ A.M.–P.M. TO ______ A.M.–P.M. TOTAL ______ MINUTES

ALIGHTING LOCATION ____________________

TIME REQUIRED; FROM: ______ A.M.–P.M. TO ______ A.M.–P.M. TOTAL ______ MINUTES

TOTAL DELAY ENCOUNTERED ________ MINUTES

INSTRUCTIONS BY DISPATCHER OR SUPERVISOR TO RESTORE SCHEDULED SERVICE:

REMARKS:

FIGURE 14 Example of a form to be completed by the driver of an LE bus each time a handicapped person boards with the lift or is denied boarding.

interested in the wheelchair service and thus did not pressure drivers to keep accurate tallies. Some observers noted that it was difficult to get drivers to keep any kind of discretionary records. In Detroit's SEMTA, drivers ordinarily are required to and do keep detailed ridership records; their supervisors are failing to file the required handicapped ridership reports.

The extent of undercounting cannot be known. Ridership levels in some systems are so low that even if ridership were doubled, it would not present an appreciable increase. However, undercounting of denied boardings is a more important service indicator. In some cases, the person may wait for and be boarded on the next LE vehicle; to the extent that ridership records are kept, that rider will be counted. But if the person is discouraged and perhaps abandons the system entirely, the impact is more severe and not accurately quantified.

SUMMATION

Ridership response to most accessible services has been low and is affected by a variety of factors, some of which are changing. As accessible service becomes more ubiquitous, reliable, and frequent, ridership response may improve. There is no way to predict what ridership will be under better service conditions, but poor service is known to and continues to deter some wheelchair ridership.

Seattle has a ridership response perhaps 10 times greater than that of any other system and has some commendable features that may suggest what determines ridership levels: (a) a committed management at both the administrative and operational levels, (b) intensive driver involvement, (c) continuing and good user involvement, (d) a reliable lift, (e) fairly good route coverage, and (f) reliable service.

CHAPTER FIVE

COSTS AND COST EFFECTIVENESS OF WHEELCHAIR-ACCESSIBLE, FIXED-ROUTE SERVICES

This chapter compiles available information about the costs of implementing wheelchair-accessible, fixed-route transit in urban areas, and relates those costs to ridership volumes to evaluate the cost effectiveness of accessible service for the handicapped. This task is complicated because (a) cost data have not been carefully and accurately gathered on a number of variables that affect or are affected by wheelchair-lift implementation, (b) many of the costs that have been recorded may not be typical of the ordinary operation of these lifts, and (c) existing passenger volume may not be an accurate indication of the potential ridership of the handicapped on a reliable, accessible bus service.

COSTS OF IMPLEMENTING ACCESSIBLE SERVICES

In a general listing of the types of cost items that can be or are involved in furnishing accessible services, some occur once only in a fairly long time period and others will be daily. Five major categories of costs can be identified; their general nature and duration are summarized in Table 21.

Not all systems incurred all of these costs in implementing wheelchair-accessible, fixed-route services. Moreover, many of the systems that may have incurred such costs had neither the time nor resources to monitor these expenditures or to gauge their overall impact on system costs.

Because some systems have detailed records and others do not, most system cost data may not be comparable. Moreover, studies of cost patterns made different assumptions about (a) the items to include as part of the implementation costs of accessible services and those to be excluded and (b) the costs incurred in providing *alternatives* to wheelchair-accessible, fixed-route service. In general, comparisons of alternatives fail to include costs that might be or are incurred by special transportation systems.

Marginal Costs Compared With Averaging Costs

Probably one of the most important differences in the way that various systems and studies accounted for costs is reflected in the varying focuses on *marginal costs*. Many overview studies attributed the costs of wheelchair-accessible, fixed-route transit to those items representing a *new* or different expenditure for the system. Thus, these studies did not include (a) driver costs unless a driver is paid more to drive a LE bus or more driver time must be scheduled to handle delays en route, (b) marketing costs if the system already has a marketing program and simply reorients that service without hiring new people or committing additional resources, (c) training program costs unless the program was lengthened to deal with the needs of the accessible service. The Congressional Budget Office report, for example, included only the marginal changes in cost patterns caused by implementing wheelchair-accessible, fixed-route service (*22*).

Most of the system-specific data, however, include both "marginal" costs and more general system average costs. For example, the St. Louis BSDA study attributed the following items to the costs of accessible service: (a) all the

TABLE 21
NATURE OF POTENTIAL COSTS INVOLVED IN THE ESTABLISHMENT AND OPERATION OF FIXED-ROUTE, ACCESSIBLE TRANSIT SERVICES IN URBAN AREAS

Cost Item	One-time Investment	Continuing Cost	New Expense	Marginal Increase to Existing Expense	No additional expense
Start-up Costs					
• Driver and mechanics' training		X		X	
• Advertising and promotion	X		X		
• Rider-user training program		X		X	
• Maintenance preparation	X		X		
Capital Costs					
• Lifts (new or retrofits)	X		X		
• Vehicle modifications (rails, etc.)	X			X	
• Auxiliary equipment (e.g., supervisors' vans)	X		X		
• Remodeling maintenance facilities	X		X		
• Accelerated bus purchases	X		X		
Administration & Management					
• Planning and designing routes, stops	X				X
• Citizens meetings		X			X
• Monitoring & evaluations	X			X	
• New staff positions		X	X		
• Outreach & marketing		X			
Operating Costs					
• Extra schedule hours		X		X	
• Extra driver pay		X		X	
• Extra maintenance time		X		X	
• Extra supervisorial time		X		X	
• Retraining drivers		X		X	
Insurance					
• Additional premiums		X		X	
• Claims settlements	X		X		

personnel time expended on the project (except drivers) whether or not new people were hired, (b) all marketing costs, (c) all training costs, and (d) an equitable share of the overhead and general system expenses. These computations reflect the real and full costs of delivering accessible services. These calculations, however, should not be compared with data that do not also reflect these full costs. Moreover, the cost data for most alternative specialized systems do not usually include those kinds of expenses.

Different transit systems handled cost items differently; Seattle calculated its marginal expenses and then added the value of administrative time spent on the service whether or not new resources were committed. Seattle, however, did not add to these costs any general overhead or system-wide expenses.

CLASSIFICATION OF COSTS

Increases in costs due to implementing wheelchair-accessible, fixed-route service in urban areas can be classified into four areas:

- Bus purchases to regain lift capacity and/or to meet program accessibility deadlines;
- Scheduling time required to cope with delays caused by passengers using the lift and by lift malfunctioning while on a run;
- Maintenance time required to service just the lifts plus the training and retraining of mechanics and supervisors; and
- Fuel and oil consumption caused by additional weight of the lifts.

Much uncertainty exists about the amount of these cost items and the new or additional resources that will be required to accommodate these cost items. They generate such questions as: (a) How many new specially trained mechanics will have to be hired? (b) How many new or additional hours will have to be added to the schedule? (c) How many hours of delay will be incurred (for example, while a supervisor goes to help a stranded handicapped person alight from a bus with a broken lift)? Different transit systems have had different experiences with these factors, handle these cost items differently, and make different assumptions about whether the cost will be incurred (e.g., are additional buses needed to regain capacity?).

Cost Analyses

The EIS of the DOT (*3*) regarding the implementation of the DOT 504 regulations states that the primary costs generated by response to the regulations are the capital expenditures to purchase wheelchair lifts on new fixed-route urban transit coaches. It is estimated that this cost will be $10,000 per bus (in 1978 dollars) for a national total of $43.3 million per year for lift purchases.

After service start-up difficulties are overcome, the EIS states that maintenance and operating costs will fall. The EIS estimates that during the initial period of operation (several years), the routine costs of operation and maintenance will be $800 per bus-year and then it will decrease to $300 per bus-year.

The discussion accompanying the DOT regulations implementing Section 504 states that the marginal increase in operating costs will average 1.3 percent of current operating expenses. However, a 1979 study for the Texas Department of Highways and Public Transportation estimated that operating expenses for maintenance would not increase above 7 percent as a result of implementing accessible service and would drop to 5 percent or less as experience is gained in maintaining lifts (*23*).

The Congressional Budget Office (CBO) study of alternative ways to serve the handicapped estimated that the total annual operating costs of providing lift-equipped service would be almost 74 percent of the annual capital costs involved in equipping the national bus fleet [$34 million to 46 million (*22*)]. The CBO study estimated that short-term increases in maintenance costs would be about 12 percent of current maintenance costs or about $1,800 per bus the first year. However, the report estimates that by the time today's fleet of buses is replaced with LE vehicles (by 1991), additional operating and maintenance costs might be higher by only 5 percent or $800 per bus annually (*22*).

Estimates of Capital and Operating Costs

The CBO's conservative cost estimates assume that the national bus fleet will have to be expanded by 1.5 percent to restore lost seating capacity (due to tie-downs and securement) and by an additional 2 percent because the fleet will be effectively reduced below normal by extensive off-line maintenance time and by increased scheduling time. The CBO study assumes that new LE buses cost $2.38 per vehicle mile ($1.48/km) to operate and maintain.

The Texas study (*23*) also estimated a 5 percent long-term increase in operating expenses, but did not include any costs due to increased scheduling time or capital costs for lost seating capacity. The study included a capital cost for accelerated purchase or retrofitting (whichever was cheaper) to meet DOT program accessibility deadlines. That study concluded that potential ridership would not affect scheduling needs, although operating costs were estimated to double (that is, to 10 percent) if it were necessary to reduce schedule speeds (*23*).

The Texas study concluded that a state-wide weighted average operating cost for LE buses in the 17 Texas cities with transit systems would be $1.54 per vehicle mile ($0.96/km) in 1979. The weighted figure for the state's three largest systems (Dallas, Houston, and San Antonio) was $1.68 per vehicle mile ($1.04/km) (*23*).

The liberal assumptions of the DOT EIS with regard to these controversial cost items were strongly challenged in formal responses to the draft EIS. Although some operators have experienced extremely high maintenance costs, the Department noted in the final EIS, issued in October of 1980, that some systems had not incurred any significant additional costs. DOT considered its original estimates of $800 per bus for the first 3 years and $300 per bus each year thereafter as reasonable.

DOT included no additional capital costs for the purchase of extra vehicles to (a) increase "the maintenance float," that is, the number of vehicles required as spares because of increased downtime due to lift malfunctions and/or (b) make up for lost seating capacity. The DOT indicated that both of these costs would be minimal and not recurring.

The EIS also did not include extra operating costs for increased schedule time. The DOT indicated that operators would have sufficient time to plan any necessary schedule changes without extra cost (*16*).

Variations in Cost Estimates

Transit systems, government agencies, private interest groups, and others differ in how to measure and record increased operating costs and increased purchase needs, as well as the actual incremental cost of purchasing LE buses. The total purchase price of most LE buses does not itemize the cost of the lift or other vehicle modifications. The EIS and the CBO reports estimate the cost of each lift at an average of $10,000; the estimate used in the Texas study is $11,000. When challenged, the DOT EIS noted the estimated cost of lifts of two LE bus manufacturers: General Motors, $12,000 (ADB bus), and Grumman Flxible, $10,000–$12,000 (in 1980 dollars); and of Mitre Corporation, $9,000–$10,000 (in 1979 dollars) (*16*).

There is a lack of agreement, too, over the cost of additional vehicle modifications necessary to accommodate wheelchair travelers on transit coaches. Most systems also purchased a package of internal vehicle modifications including one or two wheelchair securement systems, extra stanchions, handholds, signs, flooring, and special stop-call buttons. None of the major studies cited above included these costs in their capital costs estimates, or, they incorporated those expenses into the item they called lift purchase cost.

Using capital cost data such as that in Table 22, TSC has concluded that the cost of wheelchair lifts installed on new vehicles will range between $11,000 and $17,000 (1980 dollars), while the estimated cost of retrofits will be between $20,000 and $30,000 (1980 dollars) (R. Casey, 1981, *personal communication*). TSC also concluded, however, that the costs of other internal vehicle modifications were negligible and not worth considering as a separate cost item.

In summary, variations in cost estimates are in large part due to fairly different assumptions about the changes in operating and maintenance costs and the need for additional vehicle purchases. Moreover, even studies making similar assumptions about the magnitude and movement of these cost variables do not necessarily handle them in the same manner; note that the CBO study included increased scheduling time as a capital cost (incurred by buying more buses) rather than as an operating expense.

Most of the national and overview studies give a fairly clear idea of what their assumptions are and on what cost data their calculations are based. However, data reported at the local and project level often fail to include such descriptions, and, thus such data should be used with considerable caution.

COST DATA AND OPERATING/MAINTENANCE PATTERNS OF INDIVIDUAL TRANSIT SYSTEMS

St. Louis Bi-State Development Agency

The BSDA in St. Louis was one of six sites that TSC monitored for UMTA (*17*). Good cost data are available for the BSDA for the first 12.5 months of operation. All cost data developed for the BSDA system include a computation of the value of the time expended by personnel, whether already employed or hired to deal with new vehicles, plus a 17 percent overhead rate.

Calculating salary costs for the time used in daily lift cycling and two inspections in the first 10 months of operation, the preventive maintenance costs were computed at about $8,000 per month. In July and August 1978, the monthly costs fell to $344 per month, reflecting reductions in the time devoted to the lifts. The total preventive maintenance costs were calculated at $84,563 for the first 12.5 months of operation.

The marginal operating costs of the LE buses for phases I and II were estimated at $622,170 (see Table 23), or about $0.10 per vehicle mile ($0.06/km). This increased the overall system operating costs by about 5 percent. If the BSDA had not increased its platform hours for accessible transit, the operating cost per mile would have increased by about $0.02, or about 1 percent. Annual operating costs, based on out-of-pocket expenses were $696 per bus. It is ironic that the BSDA figures are often used to dispute the DOT EIS and challenge the DOT 504 regulations, but both the BSDA cost per bus and the overall increase in operating expense are less than EIS estimates, when more liberal cost assumptions are made.

Seattle Metro

Metro accepted delivery of 143 Flyers and began accessible service in August of 1979 along two routes. By the end of 1980, Metro had 163 operational LE vehicles, 143 of which were in service on 23 routes during peak hours. Metro is adding 72 more LE full-sized transit coaches, which are to be operated on 41 routes.

The maintenance and operational experiences and costs of the Seattle Metro (Table 24) are different from those of the St. Louis BSDA. The Lift-U lifts installed on the first set of Flyer Diesel buses cost $5,700, which were amortized over 12 years assuming a 10 percent interest rate. Operating costs, other than maintenance, totaled $125,000 for the first year of operation. Those costs included extra driver time required to train 1,200 full-time drivers in a 2-hr training session with 50% of those people on overtime pay. Marketing costs were included for an outreach program, mailings, bus zone decals, and bus posters. Also included was the equivalent of 2.5 staff positions spent during the first year in planning, marketing, scheduling, consultant services, and staff training.

Of the estimated $427 per year per bus cost for maintenance calculated by Crain and Associates (Table 24), the cost of the four component items were (a) repair—$234, (b) preventive maintenance—$141, (c) mechanics' time on road

TABLE 22
CAPITAL COSTS OF LIFTS AND INTERNAL VEHICLE MODIFICATIONS FOR BUSES AT SIX SITES MONITORED FOR UMTA BY THE TRANSPORTATION SYSTEMS CENTER (5)

	Cost per Bus	Number Purchased	Total Cost
Champaign-Urbana:			
EEC retrofit (1979)	$23,477	15	$352,155
EEC ADB (1979)	15,000	25	375,000
			$727,155
Connecticut Transit:			
EEC ADB (1978)	$8,000	280	$2,240,000
Palm Beach County:			
TDT retrofit (1978):			
lifts	$14,272	22	$313,984
jump seats	1,370	22	30,140
TMC (1979)	N.A.	40	N.A.
St. Louis:			
TDT (1976)	$5,000	60	$300,000
TDT (1977)	6,315	97	612,555
			$912,555
Seattle:			
Lift-U (1979)	$5,700	143	$815,100
Washington, D.C:			
Vapor (1978):			
lifts	$6,618	150	$992,700
kneelers	350	150	52,500
other features	4,000	150	600,000
			$1,645,200

TABLE 23
TOTAL PROGRAM COSTS FOR 157 LIFT-EQUIPPED BUSES ON 17 ROUTES DURING 22.5 MONTHS (ST. LOUIS, MISSOURI) (*17*)

	Fully Allocated Costs	Marginal (Out-of-Pocket) Costs	Marginal (Out-of-Pocket) Costs Excluding Service Hour Costs
1. Phase I & II Operating Totals	$ 622,170	$322,483	$ 109,301
2. Phase III Operating Total	385,605	283,168	137,974
3. Depreciated Capital[a]	143,407	143,407	143,407
4. Depreciated Start-up	29,858	29,858	29,858
TOTAL	$1,181,040	$778,916	$ 420,540
5. Cost/Trip[b]		$ 296	$ 160

[a] Buses were received in two phases—60 buses delivered at first and 97 buses delivered subsequently.
[b] Based on an estimated total of 2,630 trips.

TABLE 24
ESTIMATED COSTS OF ACCESSIBLE SERVICE (SEATTLE METRO)

	Seattle Metro First Year (143 Buses)*	Crain & Assoc. (163 Buses)**	Seattle Metro Projected (338 Buses)
Capital			
Lifts	$119,624	--	$324,544
Lifts on service supervisor vans	--	--	7,914
Annual Depreciation	--	$140,400	--
Subtotal	$119,624	$140,400	$332,458
Operating			
Maintenance and repair	$ 71,500	$ 69,600	$169,000
Driver training	35,000	35,000	10,000
Marketing	15,000	15,000	4,000
Staff Time	75,000	75,000	45,000
Subtotal	$196,500	$194,600	$228,000
TOTAL	$316,124	$335,000	$560,458
Maintenance & repair cost per bus	$ 500	$ 427	$ 500
Ridership	21,600	20,500	75,900
Cost per trip	$ 14.64	$ 16.34	$ 7.38

* The number of LE buses operated during the peak hours.

** The total number of LE buses owned by the transit system was used because each bus in the fleet was occasionally used in wheelchair-accessible, fixed-route service and thus it was believed that the costs should be apportioned over the entire available fleet.

Sources: Columns 1 & 3, memorandum, Seattle Metro (processed), November 28, 1980.
Column 2, Robert Casey, Transportation Systems Center, from a draft of a study undertaken by Crain & Associates (personal communication).

calls—$47, and (d) nonwarranty parts—$5. The two sets of cost analyses (Seattle Metro and Crane and Associates; see Table 24) did not include any capital costs due to loss of capacity, loss of on-line vehicles due to excessive repairs, or any operating costs due to increased time added to the schedule because Seattle did not encounter any of these situations. Seattle Metro estimates that the total first year cost of implementing the accessible service was 0.39 percent of Metro's transit service budget.

Seattle personnel feel that first year costs for planning, operator training, and marketing will be significantly reduced in future years, even as service is increasing. While there will be further expenses, such as outfitting supervisors' vans with lifts so that they can transport or "rescue" stranded handicapped travelers, Metro estimates that maintenance costs per bus will remain constant.

UMTA Service and Methods Demonstration Sites[1]

Among the six sites monitored by TSC for their programs and procedures used to establish and operate wheelchair-accessible, fixed-route service for the handicapped, St. Louis and Seattle provided the most data, with the other four sites yielding considerably less data. However, TSC made some general observations about costs and expenses for all six sites. Cost data for three of the sites are presented in Table 25.

Some common cost patterns emerged:

- During the start-up phase, extra costs may or may not be incurred for service planning, schedule modification, and increased insurance premiums.
- Costs generally *are* incurred in training mechanics and drivers during start-up.
- Costs for advertising and marketing are relatively modest. Palm Beach County was an exception; it spent over $80,000 in advertising and promotion at the start of the accessible service (*5*).

Driver training costs ranged from $15 to $175 per driver trained. TSC suggests a program that would have a 4-hr session with modules for lift operations plus sensitivity training. Its estimated cost is between $55 and $66 per driver, based on 4 hr of a driver's time at $11 per hr including fringe benefits and overhead plus an additional 25 to 50 percent of those costs for instructors and training materials.

[1] All data in this section were taken with permission from *1980 Service and Methods Demonstration Project Annual Project,* under preparation by Urban and Regional Division, Transportation Systems Center, February 1981 (*5*).

Operating Costs

TSC evaluated operating changes in six cost categories: administration, scheduling modifications, maintenance and inspection, continued driver training, marketing and promotion, and accidents and insurance.

For administration, TSC noted that the equivalent of one or more full-time people is required to accomplish the staff activities associated with accessible services.

TSC reported that, based on the systems reviewed, costly schedule changes did not appear to be warranted. Only the St. Louis BSDA calculated a cost for schedule changes to implement accessible services, although Connecticut Transit originally included extra time for potential schedule delays.

The average lift maintenance and repair costs were estimated to average about $650 per lift annually. It was noted that maintenance costs were sensitive not only to problems with lift design but also to maintenance policies, procedures, workload, and the capabilities of maintenance personnel. Connecticut Transit had only a slightly different design version of the lift that the St. Louis BSDA operated, but experienced fewer problems and lower maintenance costs.

The costs of marketing programs and promotional activities were found to be variable.

Changes in the costs of insurance with the initiation of accessible service for the handicapped by transit systems were site-specific. As most operators are self-insured, the only additional costs are those due to accidents or payment of claims.

The St. Louis BSDA had the most settled claims involving the use of the lift for a total of $13,600 resulting from claims on 33 accidents in 22.5 months. Settlements for wheelchair users (4 of the 33) averaged $1,120; settlements for non-wheelchair users averaged $185.

Connecticut Transit reported 37 incidents over an 8-month period, with no wheelchair users involved; no claims costs data are yet available. The system did have six incidents involving wheelchair users in 15 months of service; three claims were made and two were settled at a total cost of $397. The sixth claim is being contested (*5*). Connecticut Transit is the only system known to have an increase ($515 per year) in its insurance premiums due to accessible service. While self-insured for personal liability and property damage, this system is insured by a private company for damage to its own property.

Cost Data From Other Transit Systems

The cost data from transit systems in three West Coast cities, three Midwest cities, and one New England city are presented in Table 26. The Milwaukee County Transit System with 100 Grumman Flxible buses with Vapor lifts and 150 GMC RTS-II buses estimated that its operating and maintenance costs, including parts and labor, for 1980 were $225,000, and that these costs would reach $525,000 in 1981 because the GMC buses will no longer be under warranty and thus the cost of parts will increase. This transit system depreciated the lifts over 5 yr rather than the 10 or 12 yr used by other transit systems which considerably increases operating costs (H.M. Mayer. December 1980, *personal communication*).

In its response to the DOT EIS, the Los Angeles SCRTD reported costs for maintaining the lifts on its 200 new look American Motors coaches with TDT lifts, and 400 Flxible ADBs with EEC lifts at $3,400 per bus annually (SCRTD letter to G. McDonald, August 19, 1980).

San Diego Transit operates five older coaches retrofitted with TDT lifts and estimates an annual operating cost of $5,000 per lift. The system reported severe break-in costs (*3*, pp. 111–131). Using records from this transit system, the Texas Transportation Institute estimated that between July 1977 and April 30, 1978, the system's monthly cost for lift maintenance was $350 per vehicle or $4,200 annually. The Institute, using data furnished by the Denver Regional Transportation District (RTD) regarding its operations experience with 10 LE buses, estimated that Denver RTD's annual costs for maintenance were about $260 per bus (*23*).

The Houston Metropolitan Transit Authority, which operates but does not provide accessible service with 323 LE Grumman ADBs, estimates its annual cost will be $3,600 per bus to maintain the lifts once put into service.

OTHER COSTS ASSOCIATED WITH WHEELCHAIR-ACCESSIBLE, FIXED-ROUTE TRANSIT

Both the DOT EIS and the responses to it discussed other types of costs and benefits that would or could be associated with implementing accessible, fixed-route service including (a) environmental, (b) energy consumption, (c) traffic congestion, and (d) social measures. The DOT EIS concluded

TABLE 25
MAINTENANCE AND INSPECTION COSTS FOR LIFT-EQUIPPED BUSES AT THREE UMTA SMD SITES (*5*)

	Number of accessible buses	Survey Period	Total Monthly Cost	Monthly Cost per lift	Projected Annual Cost per Lift
Champaign-Urbana	25	6/80–7/80	$ 859	$ 57	$ 684
Connecticut Transit	152 82	6/80–8/80	12,851	46	552
Palm Beach County	71	5/80–8/80	4,373	70	840

that (a) costs for the first three items would either be small to negligible or small compared with costs of the alternatives, and (b) the overall social benefits of accessible service would be positive.

Most protests to the DOT EIS identified specific costs (Table 27) that could arise from the implementation of accessible service. In most cases there are few data to support either side's contention about these costs. For example, while costs assumed to stem from the increased weight of the bus due to the lift can be verified empirically, they have not been tested. Thus, increased delay or fuel consumption due to weight cannot be validated.

Some objections to the DOT estimates and some of the EIS rationale come from comparing costs or benefits of accessible service with the costs or benefits of the alternatives to meeting the transit needs of the handicapped. In these comparisons, the estimates differ widely for costs, delays, ridership response, and other related factors for both the accessible service option and all the specialized alternatives. These evaluations in conflict are beyond the scope of this synthesis; interested readers are referred to the documents supporting the DOT final EIS for fuller discussions.

WHEELCHAIR-LIFT COSTS IN PERSPECTIVE

A number of transit systems interviewed for this synthesis noted that the costs incurred in implementing wheelchair-accessible, fixed-route service should be put into perspective. Many systems noted that advanced design buses were more expensive to operate (lower fuel mileage than earlier buses) and maintain than previously purchased buses. The ADBs, in general, are heavier than older buses even without lifts, have many operating parts that seem more prone to accident and damage, and have more expensive routine maintenance costs.

VIA, the transit system serving San Antonio, Texas, reported that air-conditioning units alone in the ADBs increased the annual maintenance costs by over 30 percent. The St. Louis BSDA found that lifts increased costs about 5 percent or $0.01 per bus mile and reported *nonlift* repair costs on the same vehicle of $0.10 per bus mile. The BSDA estimated that the ADBs increased repair costs not covered under warranty by 23 percent and total repair costs by 33 percent (*17*).

The Los Angeles SCRTD reported that the maintenance costs per bus for air-conditioning exceeded its per bus costs for wheelchair lifts. Several systems reported their ADBs to be out of service more often for non-lift related repairs than for lift repairs, and far more frequently than their experience with earlier bus models. Two small California systems reported that wheelchair lifts accounted for less than 5 percent of all repairs on their ADBs (although lifts account for 6-10 percent of bus purchase prices). Thus, although lifts have been expensive to maintain, in general, maintenance costs have not increased in proportion to the capital value of the component as industry rules of thumb predict (*21*).

COST EFFECTIVENESS OF ACCESSIBLE AND ALTERNATIVE SERVICES

Two key policy issues are (a) the cost per passenger for accessible service and (b) the cost per passenger for alternative methods of serving the transit needs of the handicapped.

The U.S. Department of Transportation has concluded, based on its ridership and cost estimates for wheelchair-accessible, fixed-route transit and for other alternatives (*3*):

> It is much less expensive and most cost-effective to make existing transportation systems accessible to handicapped persons than it is to create separate, special systems just to serve a small number of handicapped individuals with very

TABLE 26
MAINTENANCE AND OPERATIONS COSTS FOR WHEELCHAIR LIFTS ON FULL-SIZED BUSES

System	Annual Maintenance Cost per Bus: Current	Annual Maintenance Cost per Bus: Projected	Increase in Operating Costs (%)	Increased Cost per Vehicle Mile	Initial Purchase Cost of Each Lift	Annual Operating Costs per Bus: Current	Annual Operating Costs per Bus: Projected
Connecticut Transit (5)	N.A.	$552	N.A.	N.A.	$8,000 (1979)	$1,927[b]	N.A.
Detroit SEMTA[a]	$162	N.A.	N.A.	N.A.	10,000 (1978)	480	N.A.
St. Louis BSDA (17)	829 (157 buses)	N.A.	1.0	$0.02	5,846 (1977)	1,804[b,c] 879[d]	N.A.
Seattle Metro[a]	500 (143 buses)	500 (338 buses)	0.39	N.A.	5,700 (1979)	2,210[b]	$1,658[b]
Los Angeles SCRTD[a]	6,100 (200 buses)	4,015 (1370 buses)	2.2	N.A.	N.A.	N.A.	N.A.
Milwaukee County Transit[a]	N.A.	N.A.	N.A.	N.A.	10,000 (1979) 11,500 (1980)	2,100	N.A.
San Diego Transit (23)	4,200 (4 buses)	N.A.	4.9	N.A.	N.A.	4,200	N.A.

[a]Direct from transit system.
[b]Includes capital depreciation.
[c]Out-of-pocket costs only.
[d]Out-of-pocket costs with unneeded platform hour costs removed.

TABLE 27
OTHER SPECIFIC (ACTUAL OR POTENTIAL) COSTS REPORTED BY RESPONDENTS TO THE DOT EIS

PROBLEM/COST	SPECIFIC DETAILS REPORTED BY	DOT RESPONSE
Increased noise caused by lifts' increased weight on bus engine.	Office of Governor, Alaska, City and Burough of Juneau; New York, MTA	Unlikely to produce perceptible noise impacts (III-117).
Increased energy consumed by additional weight and delay time.	State of Rhode Island, Statewide Planning Program	Only a small proportion of weight of bus (III-24).
Rough terrain and severe weather will increase maintenance.	Office of Governor, Alaska, City and Burough of Juneau; Puerto Rico Metropolitan Bus Authority; New York, MTA	Will not be out of proportion to any increases in maintenance cost (III-31).
TRAFFIC DELAYS		
Minutes lost by cars trapped behind buses deploying lifts.	Office of Governor, Alaska, City and Burough of Juneau; Broward County, Florida; Bellingham Municipal Transit	Small and not high probability (II-8).
Minutes lost by passengers aboard buses delayed by lift implementation.	Puerto Rico Metropolitan Bus Authority, Metropolitan Suburban Bus Authority	Real but small; only one of many passenger service delays imposed (II-9-10).
Minutes lost by passengers aboard other buses in a queue delayed by lead bus deploying lift.	State of New Hampshire, Dept. of Public Works and Highways; Rock Valley Metropolitan Council; Chicago Transit Authority	Minor delays, small time losses.
URBAN INFRASTRUCTURE		
Costs of changing abutting sidewalks and curbs, traffic islands, lengthening trafic signal cycles (e.g., $1500 paving per bus stop, $300 per ramp).	State of Idaho, Transportation Department; Broward County, Florida; CPO; San Diego	Costs not within purview of DOT.
Increased hydrocarbons with resulting impact on ozone layer.	Texas Dept. of Highways and Public Transportation; New York, MTA	Small compared to alternatives.

limited transportation options. This is particularly true for fixed-route bus systems.

The NRC Transbus study, in analyzing fixed-route accessible transit (as might be provided by Transbus) and other alternatives to enhance mobility, noted (*1*):

> The options that involve physical modifications to existing transit systems involve the highest initial capital costs but marginal operating expenses. The options that involve coordination among different existing transportation providers generally involve small initial capital investments with high operating costs and a continuous need for additional vehicle purchases. . . . The options involving design changes in conventional transit fleets have high costs and low effectiveness in meeting the needs of the handicapped. Options involving a number of different providers working together to provide variations of door-to-door service have high continuing costs but appear to offer services to far more handicapped travelers.

The Congressional Budget Office study undertaken for the Senate Budget and Transportation Subcommittee of the House concluded (*22*):

> To serve the travel needs of handicapped persons through modifications to mass transit systems would appear to be more costly than to provide specially tailored services. In particular, plans such as the Transit plan (a scenario equivalent to putting wheelchair lifts on fixed-route transit coaches) built around regulations issued by DOT to apply the provisions of Section 504, show not only higher total costs but also higher costs per trip than do plans that rely on specialized door-to-door services and adapted automobiles.

The Congressional Budget Office study placed a dollar figure on the differences, and concluded that modifying transit coaches to make them accessible would cost $6.8 billion over 30 yr, or 2.5 times the current annual federal spending level. Accessible fixed-route transit would serve about 7 percent of the handicapped population at a marginal cost of $38 per trip for severely handicapped travelers. Taxi-type options would serve about 26 percent of transportation-handicapped persons at a cost of about $4.4 billion, or a per trip cost of $7.62.

Cost Per Passenger Served

For the few systems for which data are available, the minimum cost per passenger of $14.64 (Table 28) is reported by the Seattle Metro, which estimates that the cost will drop to $7.38 per rider when the system is fully accessible.

The cost per passenger served is a gross measurement of benefit provided; the degree of disability of the passengers, as well as the number of options available to persons served, should be considered (*22*). For example, it might be more worthwhile to serve a few very handicapped travelers rather than a large number of slightly disabled travelers. This type of benefit and utility evaluation is lacking in data on aggregate costs per passenger served. Also the cost data do not take into consideration the benefits to the handicapped derived from being "mainstreamed," or being clearly in-

TABLE 28
COSTS PER PASSENGER FOR WHEELCHAIR-ACCESSIBLE, FIXED-ROUTE TRANSIT

System and City	Cost per Boarding ($) Current	Projected
Connecticut Transit, Hartford and New Haven[a]	148.00	N.A.
Los Angeles SCRTD[b]	5,000.00	N.A.
Milwaukee County Transit System[b]	2,665.00	N.A.
Seattle Metro[b]	14.64	7.38
St. Louis BSDA[c]	160.00[d]	N.A.
CBO national estimate		
moderately handicapped	-	10.54
severely handicapped	-	38.08
Texas Transportation Institute estimate	-	17.00

[a]Robert Casey, TSC.
[b]Transit system itself.
[c]Reference 17.
[d]Out-of-pocket costs only.

N.A. = not available.

cluded in the overall transit system. The civil rights issue raised by the 1973 Rehabilitation Act is also not addressed.

Comparative Costs of Alternative Systems

Most cost-effectiveness comparisons, both in the literature and in actual practice, compare the annual operating and amortized capital costs of accessible service with known trip or vehicle-hour costs for alternative systems, particularly paratransit services. These data, however, are often not comparable.

Alternative systems costs often fail to include the costs that transit operators attach to accessible service calculations: annual capital depreciation, overhead expenses, and administrative and staff time. Paratransit systems have been found (*24*) to underestimate these costs by 15 to 40 percent; even paratransit systems run by transit authorities underestimated these costs by 15 to 20 percent.

Current system costs for alternatives, however computed, are also based on current ridership levels. Many paratransit systems operate with donated resources, volunteer escorts and drivers, and Comprehensive Employment and Training Act (CETA) employees. To increase capacity to serve a large number of new handicapped travelers, these paratransit systems may not be able to use these low-cost resources. Their costs might increase out of proportion to their increased ridership, and their current costs could not be compared with costs for accessible services.

Current system ridership data are also based on the type of service offered. For example, some systems provide congregate meal transportation to able-bodied elderly riders in urban areas; these tend to be highly efficient, low-cost trips. Some systems provide random demand-responsive services to seriously handicapped people in a large geographic service area; the costs per trip tend to be expensive. Cost data averaged from a system providing both types of services might be misleading. Comparing data from a system providing principally congregate trips for ambulatory people with data for accessible transit would not be valid because the handicapped travelers considered in both alternatives could not be transported by the paratransit system at its average cost figures.

Evaluations at the Local Level

Cost data from alternative systems should be used with caution when comparing options at the local level. Costs of most paratransit alternatives are sensitive to increased ridership volumes, the type of handicapped traveler, the geographic service area, and the response time required. Because many of these factors do not as significantly affect the costs of providing wheelchair-accessible, fixed-route transit, the DOT has concluded that fixed-route transit is more cost-effective in the long-run.

In any given locality accessible transit may be less expensive than other alternatives, if appropriate cost figures are taken into consideration. Seattle Metro has concluded:

> (W)hen the costs of equipping new buses with lifts, and of operating a dial-a-ride system throughout a large and diverse service area, were estimated and compared, it was determined that an accessible fixed-route service could provide more mobility at a lower cost.

SUMMATION

As a technical question, the cost effectiveness of accessible transit service depends on how and when various cost

items are counted, and how and when ridership counts are made. When comparing the cost per passenger served of accessible services to the costs arising from other alternatives, the crucial factor is how costs and ridership response are estimated for the alternatives.

More than technical questions is involved. The Congressional Budget Office stated (*22*):

> Much controversy has also arisen over costs. Those who favor door-to-door services often argue that they cost less to provide. Others who favor transit adaptations argue either the reverse, or that cost is not an issue where civil liberties and integration are concerned. *There is no question however, that either approach is very costly, and that pursuing one would reduce the financial means available to pursue the other.*

The National Research Council Study noted that cost-effectiveness was based in part on the objectives chosen by policymakers. That study concluded (*1*):

> There is an immediate need for policymakers to identify unequivocably their target group (e.g., all elderly *or* only the handicapped elderly), to delineate carefully their policy objectives (e.g., to make available accessible services to all the handicapped or to meet unfulfilled (transportation) needs), and to define program requirements and legislative mandates clearly (e.g., "program accessibility" on transit systems).

CHAPTER SIX

ADDITIONAL NEEDS OF HANDICAPPED TRAVELERS

Lift-equipped, fixed-route transit services, as currently provided, appear to address the needs of only a small number of handicapped travelers, principally wheelchair users. These and other transportation handicapped travelers who do not seem well served by level-changing devices on urban buses experience a spectrum of travel problems. In turn, some transit systems have undertaken remedial action to meet the range of travel barriers faced by handicapped travelers.

RANGE OF HANDICAPPED TRAVELERS

Federally aided transit systems are required by law to attend to the needs of a broad spectrum of handicapped persons. Section 16 of the UMTA Act of 1964 as amended and the DOT regulations issued pursuant to Section 504 of the Rehabilitation Act of 1973 address the needs of various groups of handicapped people, including, but not limited to, those in wheelchairs. Section 16(b) of the UMTA Act defines the elderly and handicapped:

> [F]or purposes of this Act, the term 'handicapped person' means any individual who, by reason of illness, injury, age, congenital malfunction or other permanent or temporary incapacity or disability is unable without special facilities or special planning or design to utilize mass transit facilities as effectively as persons who are not so affected.

Section 7 of the Rehabilitation Act of 1973 contains a broader definition:

> [T]he term handicapped individual means any individual who . . . has a physical or mental disability which for such individual constitutes or results in a substantial handicap to employment.

Most transit systems have responded to the mandate to provide buses with lifts; many have not responded to the mandates to address the needs of other handicapped travelers, i.e., the retarded, the deaf, the blind, and others. Perhaps this is because these latter mandates have not been accompanied by specific UMTA sanctions. Discussions with several of the transit systems visited for this synthesis also reveal that many systems are really unaware of their other responsibilities under the existing legislation.

Heterogeneity of the Transportation-Handicapped Population

Nearly 7.5 million people in the United States suffer from *physical* disabilities that create functional problems in their use of conventional transportation systems (*1*). Many people who are defined as handicapped by the 1973 Rehabilitation Act are not incorporated in this estimate, including 6 million who are mentally or developmentally disabled (*25*).

Data on the handicapped, developed for UMTA by Grey Advertising (Table 29), reveal that of the more than 7 million handicapped people who live in urban areas in the United States, less than 5 percent use a wheelchair. Therefore, to the extent that level-changing devices meet the needs of those in wheelchairs, they address a significant travel barrier, but only to under 5 percent of the handicapped population. However, over 65 percent of the handicapped have difficulty using stairs, and, therefore, they may also be expected to be helped by mechanical lifts.

About 53 percent of the handicapped surveyed for UMTA (*1*) had one of four specific dysfunctions and 17 percent of this group experienced more than one dysfunction. The other 47 percent of the survey sample were transportation handicapped because they faced other barriers in the transportation network. Many respondents reported both physical and

TABLE 29
DYSFUNCTIONS OF THE TRANSPORTATION HANDICAPPED (*1*)

Category	Total	Percentage of Total Transportation Handicapped Population	Percentage of Respondents Not Able to Use Transit At All	Percentage of Respondents Able to Use Transit With Little More Difficulty Than Able-Bodied Travelers
Respondents with specific dysfunction	3 937 700	52.9		
Need wheelchair	409 200	5.5	68	12
All the time	201 200	2.2		
Occasionally	208 000	2.3		
Need mechanical aids	1 938 600	26.1	28	36
Hearing impaired	1 572 800	21.1	21	51
Totally deaf	371 700	5.0		
Visually impaired	1 566 000	21.0	25	44
Totally blind	259 100	3.5		
Dysfunction combinations				
One dysfunction	2 645 200	35		
Two dysfunctions	1 056 600	14.1		
Three dysfunctions	215 400	2.9		
Four dysfunctions	20 500	0.3		
Respondents with other problems; no specific disabilities	3 502 300	47.1		

Note: Base = 7 440 000 transportation handicapped in urban United States. Percentages total more than 100 because of multiple responses.

functional barriers to transit use and reported multiple barriers throughout transit systems (*1*). The data raise the question of how effective lifts can be in meeting the needs of any significant number of people experiencing physical problems with mass transit use, including those in wheelchairs.

Among the five physical barriers to bus transit use identified as significant in the UMTA survey (*1*), a solution such as lifts on buses can address only two: getting on and getting off a bus (Table 30). Lifts do not address the three other barriers to use for handicapped travelers—getting to the bus stop, waiting for the bus, and standing in a moving vehicle.

Barriers to transit use were reported to include: the vehicle, the quality of service, the level of service, and problems in the auxiliary infrastructure. Most respondents in the survey had more than one physical problem and identified more than one problem perceived as a barrier to their use of transit services. These physical barriers were often linked in a complex way to emotional and economic barriers. The nonphysical problems described in the survey were fear of getting lost, fear of falling, inability to calculate fares, and inability to pay fares.

The NRC study of these and other data concluded (*1*):

> Remedy of only one physical problem may not significantly increase transit use among any particular handicapped market segment because so many physical and other barriers remain . . . even if physical barriers throughout the system were removed it is possible that important perceptual barriers will still remain.

Thus, the transportation-handicapped population is composed of a number of different groups of people. Several specific disabilities act, in different ways, to create physical barriers to transit use. The blind and the deaf may both have difficulty with fixed-route buses but for reasons that differ between them and are different than those experienced by wheelchair users. Hence, different responses may be required to address the various underlying handicaps. Moreover, physical difficulties often are linked to nonphysical barriers, which in turn require yet a different type of solution.

The types of problems experienced by certain handicapped travelers in the use of bus systems, other than those commonly recognized as physical and functional, are identified in this chapter.

Disabilities and Barriers Overlooked by Current Federal Policies

Current policies stress the remedy of some specific design features that act as physical barriers to the use of bus systems. DOT has adopted the 1971 ANSI standards for rail systems that address more than one type of physical barrier faced by the transportation handicapped. Rail systems are required to assist the hearing and visually impaired by providing simultaneous audible and visual cues that warn of danger or of the approach of a vehicle. These aids are not, however, required of bus systems or of LE buses (although some bus-lift combinations do provide such cues when in operation). Current federal policies for bus systems fail to address the physical barriers faced by these groups.

The transportation handicapped also face nonphysical bar-

riers. A Carnegie-Mellon study (*26*) found that about 18 percent of the population that the study defined as handicapped have emotional problems that create barriers to transit use and a need to be accompanied by an escort to overcome that difficulty. Among the handicapped, 30 percent had physical problems that could also be overcome if they were accompanied by an escort; less than one-third of this group would be helped by a LE bus. The study found that 20 percent of the transportation handicapped could be helped by wheelchair lifts on buses if nonwheelchair riders were allowed to use these lifts (*26*).

In addition to those who face obvious physical barriers or emotional problems, there are others who face travel barriers from more subtle, but no less disabling, conditions. Included in this group are people with impaired manual dexterity, reduced upper-body motion, speaking difficulties, and mental problems. They may face difficulties in obtaining and using system information, problems in paying and calculating fares, and difficulties in riding on a moving bus (*27*).

PROBLEMS AND SYSTEMS RESPONSES

In order to address travel barriers, it is necessary to identify what barriers are faced by various transportation handicapped groups. Much of the literature contains varying estimates of the number of persons who can be categorized into the various disability groups and their transportation problems. This vast body of literature is beyond the scope of this synthesis; interested readers are referred to other reports (*28-31*).

An UMTA study identified nine major functional categories of the transportation handicapped (*27*): impaired ambulation, impaired reasoning ability, impaired manual dexterity, impaired postural mobility, impaired sight, impaired hearing, impaired speaking ability, emotional instability, and susceptibility to sudden attacks of helplessness.

The barriers faced by handicapped people within these categories may be addressed by the traveler, the community, and the transit system. First, the traveler can (a) modify his or her lifestyle to avoid difficulties caused by both the transit system and barriers in the urban infrastructure, (b) move to a location with greater access to the transit system's service area, and (c) travel with an escort to help circumvent physical or design barriers or to overcome mental or emotional problems. Some transit systems allow the escort to ride at a reduced rate or free.

Second, communities can address the design and physical problems in their buildings, streets, and facilities that combine with other system barriers to create problems in the use of the transit system by the handicapped.

Third, transit systems can endeavor to reduce the travel barriers faced by these handicapped people. Transit systems have addressed major problem areas facing these travelers; eight of these are summarized in Table 31 and will be discussed further in this chapter. Most of the solutions developed by transit systems to problems of the handicapped benefit the nonhandicapped traveler also. Only two could be considered an inconvenience to the nonhandicapped traveler—wheelchair lifts on buses and priority seating for the elderly and handicapped.

Need for Information

Prior to Traveling

Before starting on a trip, most riders usually need information regarding the proper bus to take, bus departure and arrival times, and the stop to use for a given bus. Many travelers occasionally need assistance en route for transfers or in learning where and when to wait for a return bus. Many transit systems publish schedules and maps of all their routes, and have telephone services that aid riders seeking

TABLE 30
RANKING OF MAJOR BUS BARRIERS BY GENERAL AND SPECIFIC DYSFUNCTION GROUPS (*1*)

Category	Total Transportation Handicapped in Mass Transit Areas	Transportation Handicapped Who Cannot Use the Bus	Specific Dysfunction Groups				
			Wheelchair	Mechanical Aids	Impaired Vision	Impaired Hearing	Other Problems
Major Barriers							
Difficulty riding/standing	1	1	5	1	1	1	1
Difficulty waiting for the bus	2	5	6 [sic]	4	2.5	2	2
Difficulty getting to the bus stop	3.5	2	3	4	4	3	3
Difficulty getting on the bus	3.5	4	1	2	2.5	4	4
Difficulty getting off the bus	5	3	2	4	5	5	5
Number of transportation handicapped (000)[a]	4940	1046	308	1304	982	1002	2406

[a]Base = Transportation-handicapped people in mass transit areas.

TABLE 31
EFFECTIVENESS OF VARIOUS SOLUTIONS IN MEETING THE TRANSIT NEEDS OF SPECIFIC GROUPS OF HANDICAPPED PERSONS AS WELL AS NONHANDICAPPED PERSONS

Problem in Using Conventional Transit	Potential System Solutions	For Non-Handicapped Is This Ever a Problem?	For Handicapped: Visual Impairment	Hearing Impairment	Retarded	Upper Torso Restriction	Emotional Problem	Semi Ambulatory and Elderly	Wheelchair Bound
Information needed -Prior to travel	Problem?	Yes	Yes 3	Yes 3	Yes 3	Yes 1	Yes 1-2	Yes 2*	Yes 2*
	TTY terminals	1	1	3	1	1	1	1	1
	Braille maps and schedules	1	3	1	1	1	1	1	1
	Detailed phone information	2	3	1	(2)	(2)	(2)	2	2
	Training courses	1	3	2	3	2	(2)	1	3
-During travel	Problem?	Yes	Yes 3	Yes 2	Yes3	Yes 1	Yes (2)	Yes 1	Yes 1
	Announcement on board	2	3	1	3	1	2	1	1
	Public announcement at stops	2	3	1	3	1	2	1	1
	Driver assistance	2	3	2	3	1	2	1	1
	Street stands/maps	2	2	3	3	1	2	1	1
Difficulty Waiting or Standing at Stops	Problem?	Yes	Yes 1	Yes 1	Yes 2	Yes 1	Yes (2)	Yes 2	Yes 2
	Lighted, protected shelters	2	2	2	2	2	2	2	2
	Benches	2	2	2	2	2	2	2	2
Difficulties Standing in Motion	Problem?	Possible	Yes 2	Yes 2	Yes 1	Yes 2	Yes 1	Yes 3	N/A
	Guaranteed handicapped seat	0	2	2	2	2	2	2	-
Difficulties With Bus in Motion	Problem?	Possible	Yes 1	Yes 1	Yes 1	Yes 2	Yes 1	Yes 2	Yes 2
	Unknown								
Difficulty Boarding and Alighting	Problem?	Yes	Yes 1	Yes 1	Yes 1	Yes 2-3	No 0	Yes 2-3	Yes 3
	Lifts on buses	0	1	1	0	2-3	0	2	3
	Kneeling buses	1	2	2	1	2	1	2-3	1
	Wider doors	2	2	2	1	2	1	2	2
	Low rise buses	1	2	2	1	2	2	2-3	1
	Driver direction	1	3	1	3	1	2	1	2
Difficulty in Calculating Fare	Problem?	No	Yes 1	Yes 1	Yes 3	Yes 1	Yes 2	Yes 1	Yes 1
	Fare cards/passes	1	1	1	2	1	2	1	1
	Driver assistance	1	1	1	2	1	2	1	1
	Training course	1	2	2	3	1	3	2	1
Difficulty in Paying Fare	Problem?	No	Yes 2	Yes 1	Yes 3	Yes 2-3	Yes 2	Yes 1	Yes 2
	Fare cards/passes	2	2	2	3	1	1	2	2
	Driver assistance	2	2	2	2	2	2	2	2
	Modified collection equipment	1	2	1	0-1	2	1	1	1
	Voluntary payment	1	1	2	2	2	2	2	2
Emotional and Mental Disorientation	Problem?	No	No 1	No 1	Yes 3	No 1	Yes 3	No 1	No 1
	Training courses	1	1	1	3	1	2	1	1
	Driver assistance	1	1	1	3	1	2	1	1

KEY:

Problem is:

0 = less than that experienced by average traveler
1 = the same as that experienced by average traveler
2 = slightly more serious than that experienced by average traveler
3 = much more serious than that experienced by average traveler

* = It is a problem now for handicapped travelers to know which buses on which routes are accessible. Once 1982 standards are met, they should have no more problem than average travelers.

The impact of solution for each specific group's problems in this area:

0 = negative impact
1 = neutral or no impact
2 = positive impact
3 = very positive

- Bracketed numbers (2) mean the answer is site or user specific but generally goes as the number indicates.
- Please note that each disability column refers to the presence of one disability only. If multiple disabilities are presented the most relevant rating would be taken.

route and fare information (see Appendix D). Certain handicapped groups have difficulty in using these "ordinary" information networks.

Blind travelers cannot read schedules and maps nor can they see the signs indicating appropriate bus stops and waiting places. Although the blind use the telephone information services, they often need additional information, i.e. the number of steps from a major corner to the correct waiting place. Seattle transit information operators provide this detailed information to travelers who identify themselves as blind. In addition, Seattle and several other cities, with the assistance of local Lighthouses for the Blind, are attempting to draw braille maps of the transit system.

Many blind travelers cannot read braille and there is some dispute as to whether braille maps and information guides are worthwhile. Some groups advocate taped cassettes that can be given or loaned to eligible users. The cassettes could give system information, route and schedule information, vehicle descriptions and bus stop locations in terms meaningful to the blind, and a general description of the area or areas served by the transit system. Several agencies at the state level that deal with the blind have prepared such cassettes in conjunction with local transit operators. Such cassettes could also be used by those with speech difficulties, in training programs for the retarded, and by anyone who wished to learn about the area's transit services.

Blind travelers with canes also need some environmental cues, such as textured surfaces or unusual signposts to facilitate their identification of appropriate bus stops. A totally blind individual can negotiate an environment with which he or she is familiar. Many blind people are trained in the mobility technique called "shore-lining." If the environment has relatively defined landmarks and a relatively straight path along a surface, the person can trail his or her cane partly on one surface and partly on another to ensure a correct line of travel. Transit systems could help by inventorying landmarks near transit stops (or obtaining information from local groups dealing with the blind) and making that information part of the telephone information service and/or taped cassette. In addition, where the terrain and other factors permit, a straight line to the stop can be marked by varying street surface textures.

A significant number of people who are legally blind have some ability to distinguish shapes, to differentiate between strong contrasting colors, and even to see colors. According to the 504 Transition Plan for Daytona Beach, Florida, large signs showing stops and correct route information utilizing strong color contrasts (such as white on black or black on white) would help a number of partially sighted people to locate the bus stop and identify the bus route or vehicle. Also large route numbers placed on both sides and backs of buses could help the partially sighted identify the correct bus. Wherever possible, bus stops should be placed where they can be colored in contrast to the street surface.

Some people with vision difficulties, particularly the elderly, can read large type. Large-type maps and bus schedules available to the public in general and posted permanently at major stops would assist travelers with vision difficulties.

People with speech impairments may not be able to ask for assistance; deaf travelers cannot take advantage of the additional information provided by telephone information services. Many agencies are installing teletypewriters (TTY); the use of TTYs appears to be increasing as the number of deaf and speech-impaired people owning terminals increases. Four of the six major systems in the San Francisco Bay area provide this service; AC Transit will give TTY users information on all the other major transit systems in the region. AC Transit is considering training at least one customer service representative in each of its walk-in offices, and also some drivers, in the use of sign language for the hearing impaired.

Retarded travelers have different difficulties in receiving and retaining system information. They often suffer from lack of visual acuity, conceptual problems, and inadequate verbal skills. A number of travel training programs have been extremely successful in helping the mildly and moderately retarded in identifying appropriate buses and stops, transferring, and traveling independently. In 1972 the President's Committee on Retardation suggested that over 98 percent of the 5.4 million retarded individuals classified as mildly or moderately retarded would benefit from training in the use of both dependent and independent travel modes. An additional 150,000 individuals currently institutionalized could be returned to community living if properly trained in the use of transit.

The programs for the retarded have been modeled on transit training programs for the blind, and both programs include developing identification skills, learning improved pedestrian travel techniques, handling money, and gaining familiarity with the route of proposed (and regular) travel.

Many programs for these handicapped groups contain onsite training sessions in order to develop experience with real situations and frequent trips to reinforce previous lessons. During the training phase some transit systems grant complimentary passes to the instructors and students. The Los Angeles SCRTD is inaugurating a program to lend transit coaches to agencies conducting travel training for the blind.

En Route Travel

Both handicapped and nonhandicapped travelers often need supplemental information while en route. Some bus systems provide travel information offices in busy locations. The usefulness of these services could be improved for handicapped travelers if personnel were trained to recognize the special needs of various disability groups. Such a program is being undertaken by several systems including Oakland's AC Transit and Washington, D.C.'s WMATA.

In addition to stop location and scheduling information, travelers aboard buses often need assistance in recognizing their stop or transfer point. Another aid to both handicapped and nonhandicapped travelers is the growing use of public address systems both inside the bus and at stops. Drivers are able to announce the stops, thus aiding riders in recognizing where to alight. Drivers can also announce bus numbers and route information to persons on board or waiting at stops, and warn of danger. Such announcements would help the blind, the speech impaired, those too shy or frightened to ask, and the retarded.

Some systems are considering the placement of more ef-

fective signs, including route information, on the *sides* of buses. It is often difficult even for a nonhandicapped traveler to find the desired bus when buses are lined up close together at a busy stop.

Complementary information services provided en route could help travelers by using different colors or distinct symbols to mark buses, stops, and transfer points. Such symbols could be memorized by the retarded and they would also be useful to nonhandicapped children and to travelers who do not speak English. Animal symbols are used in the Mexico City subway to indicate stops for those who are illiterate. A similar approach could be used on bus systems in the United States.

The Los Angeles SCRTD is using its Bus Stop Information Program to evaluate information cubes for bus stop poles that will contain route, fare, and schedule information. Many systems have placed permanent maps and system information guides mounted on poles or displays at busy bus stops. These permanent displays could also be color-coded for children and the retarded and they could be textured and include maps with braille or large type for the visually impaired.

On-board cues for the visually and hearing impaired can currently be purchased; e.g., special, illuminated "stop requested" signs to augment buzzers, and audible and visual signals on rear door exits. The Chicago Transit Authority is purchasing a number of buses with these features.

Some travelers, particularly the blind, have difficulty if the bus doesn't always make the same number of stops or if it doesn't always stop at exactly the same place. Some systems, for example, allow drivers to stop at any safe place along a route at the request of the passenger; this may disorient some passengers who have learned to recognize their stop by counting the intermediate stops. In such systems, drivers could assist passengers in recognizing stops by calling out the name of the approaching stops. Blind people and others who need this assistance could sit near the front of the vehicle to hear the driver. The Chicago Transit Authority has drivers announce each stop.

The amount of driver assistance required by company policies and work rules may affect the ease with which a number of handicapped travelers could use bus systems. Verbal assistance at stops and en route information help to assuage anxiety and fear experienced by the handicapped.

Difficulty in Waiting At Stops

Many travelers dislike waiting at unprotected stops. Providing shelters and protection from the weather, as well as benches or seats, would meet the needs of both the handicapped and the non-handicapped. Most measures that increase the security and comfort of handicapped users at stops will do the same for the nonhandicapped.

Difficulty in Standing in Moving Vehicles

Many handicapped travelers have difficulty in standing on moving buses and maneuvering through crowded vehicles when boarding or alighting. Many systems provide special preferred seating near the front of the bus for the handicapped; some of this seating is decreased when wheelchair securement systems are provided. While preferential seating may be only of marginal value to some handicapped riders, it is important to the semi-ambulatory and others. In a study by Grey Advertising (*32*), 48 percent of the handicapped surveyed indicated that there were not enough seats in buses and 29 percent said that this was one factor that prevented them from using buses for their transportation.

Some systems require the driver to wait until all handicapped travelers are seated before leaving the stop. The driver can also encourage nonhandicapped travelers to make way for handicapped travelers who are boarding or alighting. This provides only marginal benefit and generally has a negative impact on other travelers.

Some vehicle modifications such as nonslip floors, padded handholds, additional stanchions and grab-bars near the front of the bus, and lighting and striping in the stairwells can improve boarding and make standing slightly easier on a moving vehicle for a number of travelers.

Difficulty in Sitting in Moving Vehicles

Currently, there is no generally accepted solution to this problem. Some systems have experimented with different seat designs, but the results are inconclusive.

Difficulty in Boarding and Alighting

It is estimated that wheelchair lifts are useful to 6 to 20 percent of the handicapped population, depending on whether the agency allows nonwheelchair travelers to use the lift (and depending from which national study the data are drawn).

Probably, more generally useful than wheelchair lifts on buses to both the handicapped and nonhandicapped are other design features currently available or technically possible (*1*). These include features that facilitate entrance into the bus either by lowering the floor or first step temporarily or permanently, or by making the door wider and taller, or by some combination of both types of modifications. The usefulness of these features, as exemplified by the Transbus specifications and the kneeling bus, has been ignored in the parallel Transbus and 504 controversies. The possible application of these features warrants further attention.

The kneeling feature has not been popular with transit systems and not widely known or requested by travelers. Yet, this feature and the low-floor bus appear to have widespread application to the boarding problems of many nonhandicapped travelers as well as those with disabilities.

Difficulties in Paying Fares

Mobility limitations prevent some travelers from placing money into the proper fare collection device. Although this problem arises on buses, it is more significant on rail transit systems where the inability to pay through the proper collection device will either prohibit system entry or exit.

A simple solution is for the driver to assist in paying the fare if the rider can handle money, as is the practice in the Los Angeles SCRTD. San Diego Transit forbids drivers

to handle money; the system requests the traveler to send the fare to the company later.

Some form of prepayment or pass system might be devised where drivers are not permitted to assist the traveler or for travelers not able to handle money. One transit system instituted a free-fare policy, but handicapped groups objected, feeling it was demeaning.

At present there are no well-known modifications to fare collection devices for buses to handle the various mobility limitations of the diverse transportation-handicapped population.

Another problem with fares is a traveler's inability to calculate the appropriate fare because of mental or emotional limitations. Three options are direct driver assistance, a prepayment system, and a pass system. Training courses for the retarded have helped many educable persons to overcome this difficulty.

Mental Disorientation

Handicapped travelers have fears about becoming lost or abused during travel. They fear being in distress with no aid available and being disoriented with no one to offer advice. To some extent these may be valid concerns. In a recent study of the Washington, D.C., WMATA accessible fixed-rail system, it was found that many stations were not staffed, elevators for the handicapped were locked, signals and visible directions were inadequate, special turnstiles for the handicapped were broken, and the assistance promised the handicapped on the system was generally unavailable. Although the handicapped traveler who conducted the station-by-station research was not in personal danger, he was unable to finish a number of possible trips because he could not get off a platform or out of a station (*27*, Appendix C).

These emotional barriers to travel are difficult to overcome if the transit system lacks the resources or the willingness to deal with these problems. Transit familiarization sessions for elderly, retarded, and handicapped travelers, similar to those given for school-age children, are being provided by some agencies, including the San Mateo transit system. These training sessions may allay the fears expressed by some travelers.

Driver attitude toward travelers with mental disorientation, problems with walking, and other handicaps is important. Many handicapped groups often mention the role of the driver in any consideration of solutions to problems facing the handicapped in transit system travel. The San Francisco MTC recently indicated that rider/driver sensitivity training and passenger outreach "are probably the most important nonhardware expenditures a system can make to aid the handicapped" (*33*).

SUMMATION

Numerous changes could be made to existing conventional fixed-route bus systems to remedy, at least in part, many of the reported problems of the transportation handicapped. These measures could be complementary to wheelchair-accessible, fixed-route service. Alternately, travel training could be provided to the blind and the retarded in lieu of accessible services, perhaps in conjunction with specialized services for the handicapped.

The proposed measures are not without cost; however, their exact cost and the number of travelers, both handicapped and nonhandicapped, that would be aided by the measures are not known. Because of the exact specifications of the 504 regulations, and the controversy they have generated, the efficacy of the measures considered here in meeting the needs of the wide range of handicapped travelers has not been actively considered or widely discussed.

Initially it appears that many of these proposed measures have benefits in terms of increased riding ease and increased ridership, both for the handicapped and nonhandicapped—benefits that appear to outweigh the estimated costs. An analysis of the cost-effectiveness of these measures, whether implemented alone or in conjunction with wheelchair-accessible, fixed-route service, is needed.

A bus trip constitutes a *system* of requirements to the handicapped traveler, who must meet *all* of the requirements if the trip is to be undertaken. Such requirements include walking up steps, moving in a moving bus, negotiating change for the fare, rising from a seat while the bus is moving, identifying the appropriate stop, pushing bus doors open, grasping stanchions, descending steps, and stepping up onto curbs. If any requirement cannot be met, it constitutes a barrier. This barrier or an accumulation of these barriers can prevent the entire system from being "accessible." Partial solutions will probably not increase ridership because a single remaining barrier can make the entire system inaccessible to the transportation-handicapped populace.

CHAPTER SEVEN

SUMMARY OF FINDINGS ON ACCESSIBLE URBAN BUS SERVICE

INTERRELATIONSHIP OF KEY IMPLEMENTATION VARIABLES

Analysis of the physical design standards and technical specifications of lifts and bus-lift combinations and evaluation of the maintainability and reliability of LE buses need to be performed in the context of key operating, maintenance, and service policies and procedures under which the lifts are used. These policies also affect ridership.

Most transit agencies operating LE buses have had difficulties, particularly operational and maintenance problems, which were often addressed, at least initially, by design and technical changes. The operational policies of most transit systems developed in an ad hoc manner, as a response to these problems as they arose.

The early history of the implementation of LE buses has influenced subsequent system responses and, perhaps, ridership response as well. Therefore, it is important to understand the impact of operational and management policies on the costs and effectiveness of such accessible services. In particular, it is useful to understand how various system policies or attitudes can affect implementation problems.

IMPLEMENTATION PROBLEMS

As transit systems have gained experience with the many facets of operating LE vehicles, they have developed more routine, and at the same time more comprehensive, service, maintenance, and operating practices and procedures. They have turned more frequently toward nondesign, policy-oriented solutions to operational problems. Transit systems that are only now beginning to implement their accessible service, such as Oakland's AC Transit and Houston's MTA, have the benefit of reviewing a wide variety of experiences and practices of other systems and developing a set of comprehensive policies based, in part, on the experience of others.

Most implementation problems can be addressed in several ways: (a) design changes, (b) better and continuing driver training, (c) stricter control of the stops at which the lift may be used, or (d) changes in the routine maintenance programs. A number of functional problems in the operation of LE vehicles are better addressed by policy and procedural changes than by design changes. These policy changes include driver training, user training, special preventive maintenance programs, and positive system support.

Driver Training

Effective driver training could address a number of functional problems. Most transit systems reported, almost without exception, that the most significant factor in how well a lift operates in revenue service is how well the driver is trained to operate the lift. Every agency interviewed said that driver skill and attitude were responsible for 50 to 90 percent of the operational experience of LE vehicles *regardless of the lift or bus involved*. Inadequately trained drivers create many operational and maintenance problems.

Effective driver training and retraining programs would address the three following areas.

Damage to the Lift

Drivers should be trained to prevent (a) cycling the lift too far and damaging it and (b) approaching the stop at potentially dangerous angles, thus damaging front-door lifts by hitting the curb. Also, drivers should be trained to deal with minor malfunctions and user difficulties relative to the lift.

Schedule Delays

Drivers should be trained to operate the lift rapidly and with ease and could be trained to be quick and responsive to the handicapped passenger. Additionally, drivers could be asked to keep better ridership records in order to identify regular riders and change the schedule or modify service to meet those needs.

Unjustified Boarding Denials

Drivers could be sufficiently trained to reduce their motivation to deny boardings when lifts were functional and to be more conscious of the needs of the handicapped so they would be less inclined to refuse service to these passengers.

User Training

Most systems noted that pretravel training and information services to the handicapped and to the general public about the handicapped services were helpful in addressing a number of problems. User training programs, particularly the hands-on type using mock-up or sample equipment, can address two major problem areas.

Schedule Delays

Trained users are relatively fast in boarding and alighting and they can assist the driver if he has forgotten how to

operate the lift or if there is a minor malfunction. An informed public is more likely to assist handicapped travelers, at least by making way for them as they maneuver toward the securement area, and is more inclined to vacate the securement area before being or when asked by the driver.

Poor Ridership Response

Better informed users are less anxious about and more likely to use the lift more often and are more likely to trust the system and make supportive travel and residence location decisions. When users become regular riders, the schedules can be modified accordingly, thus lowering schedule interference.

Preventive Maintenance Programs

Some transit systems have found that once the types and causes of lift malfunctions are known, on-the-road maintenance and general repair time can be reduced by monitoring certain components in a preventive program.

The characteristics of such programs vary with the type of lift used. Both fleet operations and manufacturers experience a learning process. Transit systems with limited experience in operating and maintaining lifts are more likely to encounter greater problems and take longer to solve them compared to systems with more experience in using and maintaining LE vehicles in general or one lift or a specific bus-lift combination in particular. Preventive maintenance programs evolve as transit systems gain such experience.

Supportive Management

The transit systems that have had the least overall problems and those with the best ridership response are those where support for the successful implementation of LE vehicles exists at all levels of the system. Not all transit systems that have had low ridership or major maintenance difficulties have lacked support for the accessible service program, but these components often are associated. A number of observers have noted this phenomenon, which is sometimes easy to recognize but difficult to document. Management attitude, especially at the operational and maintenance levels, affects some service variables. Supportive and positive management attitude can address two important problems of low ridership and maintenance.

Low Ridership

If a transit system believes that at least some handicapped people will ride the system, it may be willing to have user training programs and to provide advertising and information about accessible service. A positive attitude by the transit system might convince handicapped people that the system would be reliable and respond to the needs of the transportation-handicapped traveler.

If drivers believed that accessible service was important to the transit system employing them, they might endeavor to keep better ridership records. Also, these drivers might be less inclined to deny boarding when the lift was really operational.

Severe Maintenance Problems

Some transit systems address lift problems only when the entire bus is disabled, because they believe that the lift will not be used. This may add to long-term maintenance problems. Also, some systems keep inadequate parts inventories for wheelchair lifts, which can affect out-of-service time on LE vehicles. If drivers believed that their transit system's management cared about the accessible service offered to the transportation handicapped, they might be more willing to report minor lift problems.

SUMMATION

Ridership response to most wheelchair-accessible, fixed-route services, as they are currently provided, has not been high. Few systems have many lift-assisted boardings. Most transit systems indicate that they have a few individual riders who account for many of those trips.

The ridership response by the transportation handicapped is related to (a) the reliability of the service provided, (b) the information about service use and availability that has been distributed, (c) routes served with LE buses and the level of service provided, and (d) other alternatives in the community that are available to meet the transportation needs of the handicapped. The record of many transit systems is less than satisfactory. Those systems that do have a good record, however, tend to have greater ridership by the handicapped relative to the amount of accessible service provided, although that ridership is high in relative and not absolute terms.

Some evidence exists that handicapped ridership may be high along some routes and corridors. Most ridership on systems with greater use of the wheelchair lift has been concentrated on just a few routes. This suggests that wheelchair-accessible, fixed-route service that would attract riders could be provided along major line-haul routes and perhaps on express routes, rather than systemwide.

The costs of providing wheelchair-accessible, fixed-route service, while not entirely clear, are high. Given low ridership response by the handicapped, some systems are showing costs per passenger in excess of $2,000 or $3,000. However, the nation's most successful system, Seattle, shows costs that are high but are competitive with alternative transportation providers in the community.

Until the ridership response to reliable and high level accessible service becomes clear, it will not be possible to precisely determine the cost effectiveness of providing accessible service in urban areas. It will not be inexpensive, but neither will the alternatives often considered to meet the transportation needs of the handicapped be inexpensive.

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APPENDIX A

504 TRANSITION PLANS

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APPENDIX B

SAN MATEO OPERATOR'S COMPLIANCE EVALUATION

OPERATORS COMPLIANCE EVALUATION: 504

POLICY/PRACTICE	ACCESSIBILITY OBJECTIVE	STATUS SEPT. 1979	ACTIVITY	TIME TABLE
1. a) Safety policies b) Emergency procedures	A safe driving record is essential to the District's Driver of the Month program. All drivers are instructed in the safe carrying of E & H passengers.	Safety policies are part of operator training; SamTrans also has short and long-term Emergency Transportation plans.	E & H passengers comprise 14% of SamTrans total ridership.	
2. a) "Sensitivity" training b) Safety training	The handicapped community assists SamTrans in ongoing training of drivers and E & H riders.	A six weeks' training program, 40 hours in the classroom and 200 hours in the field, includes 3 hours' work with the lift bus, evacuation training, fire training, and passenger sensitivity training.	SamTrans is currently involved in training films for E & H passengers.	
3. Accommodations for a) Human companions b) Other companions c) Mobility aides	Additional bus shelters will be installed with coordinating curb cuts; larger and more readable schedules and bus stop signs are in process; an electronic destination sign on all new buses will benefit E & H riders.	E & H persons ride at reduced fares; escorts accompanying handicapped persons ride at reduced fare; seeing eye and hearing guide dogs are permitted on buses; a Porta-Printer for the deaf has been installed in the Telephone Information Center; 100 bus shelters and several hundred benches have been installed in the county.	SamTrans is helping to train escorts for passengers on fixed-route and Redi-Wheels buses.	
4. Coordination: a) Of Operator's services b) With adjacent operators c) With paratransit d) With other modes	San Mateo County Paratransit Coordinating Council is conducting a Social Service Transportation Needs survey to determine unmet transit needs.	SamTrans established and provides staff for a 24-member Paratransit Coordinating Council; coordinates its own fixed-route service with the District's curb-to-curb Redi-Wheels service and with all other known transit providers in the county.	SamTrans plans to increase Redi-Wheels productivity by 5 to 10% per year.	

POLICY/PRACTICE	ACCESSIBILITY OBJECTIVE	STATUS SEPT. 1979	ACTIVITY	TIME TABLE
5. Social Service Agency Interface		SamTrans' E & H Program was designed in ongoing coordination with all known Social Service Agencies in San Mateo County. Input is also provided via the Transit District's 15-member Citizens Advisory Committee.	SamTrans is involved in an ongoing public information exchange with all physicians, social service, and health care agencies in San Mateo County via newsletters, public presentations, and public and private training sessions.	
6. Marketing Program	SamTrans hopes to reach all E & H persons in San Mateo County with public information and training on all available transit and paratransit services.	Equivalent of 2 full-time staff persons are involved in E & H marketing. A Self-Identification Program begun in 1977 has identified some 4,000 E & H persons who are now registered for Redi-Wheels service.		
7. Rental & Procurement a) Vehicles b) Facilities	a) All vehicles utilized in Mainline service will be lift-equipped by 1982. b) Redi-Wheels control room will be accessible by 1982.	24 lift-equipped buses in fixed-route bus service since July 1978.		100 lift buses ordered for delivery in 1980 for total of 139 accessible buses.

OPERATORS COMPLIANCE EVALUATION: 504

POLICY/PRACTICE	ACCESSIBILITY OBJECTIVE	STATUS SEPT. 1979	ACTIVITY	TIME TABLE
8. Involvement with Existing Operators	SamTrans, as a forerunner in the development of accessible service, will continue to share its experiences and expertise with transit operators, nationwide.	SamTrans' General Manager has been elected 1980 chairman of the California Assn. Publicly Owned Transit Systems (CAPOTS); SamTrans Paratransit Coordinator has been named 1980 chairperson of the RTA Committee on Elderly and Handicapped.	The SamTrans system is designed to work in conjunction with all public and private transit operators in the Bay Area.	
9. Regulatory Reforms	On April 27, 1977, the SamTrans Board resolved to provide fully accessible service at the earliest practical date.			SamTrans system will be 60% accessible by September 1980.
10. Management Supervision	SamTrans highest priority in the development of routes and services is in those areas where transit is the only viable alternative for concentrations of E & H, youth, low-income, and others with no access to a private automobile.	SamTrans' General Manager conceived the E & H program and committed the District to total accessibility; managerial supervision and involvement follow under his direction.		
11. a) Maintenance b) Security	SamTrans will have 4 different lifts in operation by 1981; the Transit District's E & H Technical Advisory Committee will be reconvened to test the lifts as the new buses arrive.	a) Advance design guard rails on all new buses. b) Total of 55 maintenance workers, including 24 mechanics. c) Fixed-route buses have American seating restraint system and neoprene cushions are in all new buses; Redi-Wheels buses have 3 separate restraint	Management is attending UMTA-sponsored seminars on security; radio communication system now in process will be equipped with silent alarm sys-	

OPERATORS COMPLIANCE EVALUATION: 504

POLICY/PRACTICE	ACCESSIBILITY OBJECTIVE	STATUS SEPT. 1979	ACTIVITY	TIME TABLE
12. a) Labor Agreements b) Work Rules		No special concessions for operators of lift buses.	Union contract currently under negotiation.	
13. Insurance	All elderly and handicapped persons have equal coverage under Transit District policy.	$50 million coverage, including a $25,000 deductible.		

APPENDIX C

SEATTLE BUS ZONE ACCESS IMPROVEMENT PROGRAM

METRO
Municipality of Metropolitan Seattle
Exchange Bldg. • 821 Second Ave., Seattle, Washington 98104

Subject: The Bus Zone Access Improvement Program

On April 20, 1978 the Metro Council resolved that all future transit coaches purchased by the Municipality would be accessible; that is, capable of loading and unloading a person in a wheelchair. In order to establish operational procedures and straighten out unanticipated problems, Metro is putting ten accessible diesel coaches into service on September 16, 1978. Metro's Disabled Citizens Advisory Committee and CTAC recommended that these buses be placed into service on Routes #6 and #16; #107 and #253. This recommendation was accepted by the Metro Council.

An essential component of accessible bus service is the accessibility of the bus zones. Clearly if a person in a wheelchair cannot get to or use a bus stop - or the area served by that bus stop such as a shopping center - an accessible bus is of diminished use. Therefore, "The Bus Zone Access Improvement Program" is an important part of accessible bus service.

Design specifications, jurisdictional arrangements, contract procedures, and improvement criteria established during the Ten Accessible Bus Pilot Project will serve as the basis

for continuing improvements needed as accessible bus service is implemented. The first major step in this direction begins in January/February 1979 with the arrival of Metro's new trolley fleet. All 109 trolleys will be accessible. Sometime in the fall of 1979 Metro anticipates the arrival of 121 to 162 accessible diesel coaches which will go into service on various routes throughout the County.

The purpose of this document is to identify the physical elements of the bus zone access improvement program in sufficient detail to serve as the basis for discussion between Metro and affected jurisdictions. The result of these discussions should be agreement on under what conditions and by whom certain improvements should be made. For example, what improvements should be made before accessible service begins, and to what extent can certain improvements become a part of ongoing CIP and LID projects? In this regard the arrangements arrived at in connection with the 10 accessible bus pilot program (September 16) may serve as prototypes.

I.

Bus Zone Access Improvement Program

Priority Scheme for Making Elderly and Handicapped Public Accommodation Improvements to Metro Bus Zones

The priority rating describes the particular zone; safe access improvements may or may not be needed:

1. Priority 1 Bus Zones - Improvement Criteria:

   Zones that are part of an existing CIP or LID, or provide access to:

   - shopping centers or business districts;
   - major transfer points;
   - stops serving four or more routes;
   - group homes, high-rise housing, apartment/ condominium complexes;
   - park-and-ride lot;
   - to rectify unusually dangerous situations.

2. Priority 2 Bus Zones - Improvement Criteria:

   Zones providing access to:

   - non-isolated fully developed residential areas;
   - medium/low density commercial areas;
   - areas under intensive development.

3. Priority 3 Bus Zones - Improvement Criteria:

   - low density or scattered residential development;
   - transfer points in low density but not isolated areas of the system.

4. Priority 4 Bus Zones are those zones that are so removed or isolated that improvments will not be made as part of the system accessibility program. Improvements made to priority 4 bus zones will be made under one of the following three provisions:

   - programmed CIP or LID or other improvement program;
   - self identification process where disabled person needs the improvement to access the system;
   - the zone is being modified for other reasons.

March 28, 1979

The Honorable Stanley P. Kersey
Mayor
City of Auburn
20 "A" Street N.W.
Auburn, Washington 98002

Dear Mayor Kersey:

On April 20, 1978, the Metro Council made substantial policy commitments by resolving that public transportation will be available to elderly and disabled persons. Consequently, I am anxious to implement a system which will enable each passenger to use public transportation without measurable difficulty or unreasonable cost to passengers or taxpayers.

The first and most important step in developing this system is removing as many barriers as possible. Therefore, the purpose of this letter is to enlist your support for a "Bus Zone Access Improvement Program" which will offer mobility to elderly and handicapped residents of King County by the end of 1980. Two developments of this program have already transpired:

1. A FAUS-funded demonstration program has been authorized for Routes 6, 16, 107 and 253, comprising the jurisdictions of Seattle, King County, Washington State Department of Transportation, Renton, Medina, Clyde Hill, Bellevue and Redmond. Advertisement will take place within the next few weeks.

2. In lieu of using FAUS funding for the balance of the system, Seattle and King County have made commitments to implement the program in the 1979/1980 biennium with their own Capital Improvement or LID projects.

We are requesting that all other jurisdictions within the Metro service area make similar improvements on routes serving their area. Basically, these include: wheel chair curb ramps, landing pads, walkways, and bus pull-outs.

The Honorable Stanley P. Kersey
March 28, 1979
Page Two

John Earley (447-6381), Chief of Facilities Development, or David Charhon (447-6363), Facilities Development Planner, are available to coordinate this program with your representatives. Metro would like to see these improvements included with your planned Capital Improvement Project (CIP) or Local Improvement Districts (LID).

Thank you for considering this request. I am confident that a cooperative effort will produce an efficient system offering integrated transportation services and facilities, particularly to the elderly and handicapped members of your community.

Sincerely,

Neil Peterson
Executive Director

NP:gk
Enclosures:
1. Priority I Improvements (requested for completion by the end of 1980).
2. Priority II Improvements (to be completed by the end of 1982).
3. Criteria for Priority I Improvements.
4. Specifications for Improvements.

cc: Pat Nevins

APPENDIX D

EXAMPLES OF SERVICE INFORMATION FOR RIDERS

5L	5L OPERATES MONDAY THROUGH FRIDAY ONLY—EXCEPT HOLIDAYS											
	BART Daly City	F Street & El Camino Colma	Westborough & El Camino South SF	San Bruno & El Camino San Bruno	Millbrae & El Camino Millbrae	Burlingame & El Camino Burlingame	Fourth & El Camino San Mateo	Hillsdale & El Camino San Mateo	Ralston & El Camino Belmont	San Carlos & El Camino San Carlos	Brewster & El Camino Redwood City	Palo Alto Depot
SOUTHBOUND	FARE ZONE ♦ 2	2	2	3	3	3	4	4	4	4	5	5
32 daily trips: Daly City, Colma, South SF, San Bruno, Millbrae, Burlingame, San Mateo, Belmont, San Carlos, Redwood City, Atherton, Menlo Park, Palo Alto. Routed via El Camino	6 26a	6 34a	6 40a	6 46a	6 54a	7 05a	7 12a	7 23a	7 29a	7 33a	7 39a	8 00a
	6 56a	7 05a	7 11a	7 18a	7 27a	7 39a	7 46a	7 57a	8 03a	8 07a	8 14a	8 35a
	7 26a	7 35a	7 41a	7 48a	7 57a	8 09a	8 16a	8 27a	8 33a	8 37a	8 44a	9 05a
	Then every 30 minutes until											
	5 56p	6 05p	6 11p	6 18p	6 27p	6 39p	6 46p	6 57p	7 03p	7 07p	7 12p	7 33p
	6 26p	6 35p	6 41p	6 48p	6 57p	7 09p	7 16p	7 27p	7 33p	7 37p	7 42p	7 59p
	6 56p	7 04p	7 10p	7 16p	7 24p	7 35p	7 42p	7 52p	7 58p	8 02p	8 07p	8 24p
	7 25p	7 33p	7 39p	7 45p	7 53p	8 04p	8 11p	8 21p	8 27p	8 31p	8 36p	8 53p
	8 25p	8 33p	8 39p	8 45p	8 53p	9 04p	9 11p	9 21p	9 27p	9 31p	9 36p	9 53p
	9 25p	9 33p	9 39p	9 45p	9 53p	10 04p	10 11p	10 21p	10 27p	10 31p	10 36p	10 53p
	10 25p	10 33p	10 39p	10 45p	10 53p	11 04p	11 11p	11 21p	11 27p	11 31p	11 36p	11 53p
	11 25p	11 33p	11 39p	11 45p	11 53p	12 04a	12 11a	12 21a	12 27a	12 31a	12 36a	12 53a
	12 25a	12 33a	12 39a	12 45a	12 53a	1 04a	1 11a	1 21a	1 27a	1 31a	1 36a	1 53a

the lift

makes Metro accessible

Look for this symbol...

You Can Use The Lift

If you are physically unable to climb bus steps you may use the lift. (Example: those using wheelchairs, crutches or those who have a heart condition). Bring a friend if you need assistance in getting on or off the lift. Metro drivers will give you verbal instructions to use the equipment, but must remain in the driver's seat to operate lift controls.

To Catch The Bus

Look for the symbol (in the upper right hand corner of this bulletin) denoting lift-equipped buses. Wait near the front of the bus zone so the driver can see you.

Getting On

1. When the bus arrives, allow other passengers to get on or off, then tell the driver you want to use the lift. Wait **five** feet from the front door as the lift is lowered.
2. When the short ramp on the front of the lift drops down, you can board. Move on to the platform facing either direction, however, for ease in situating wheelchairs in tie-down area Metro recommends backing onto the lift to be in position to back into tie-downs.
3. *Wheelchair Passengers* - set your brakes while riding the lift. The ramp will swing up to form a safety gate as the lift is raised.

   Standing Passengers - stand on the footprints behind the white line, and hold handrails. The ramp will swing up to form a safety gate as the lift is raised.
4. When the lift stops at floor level, move onto the bus. Tell the driver where you wish to get off.

   Standing Passengers - watch your head as you move through the doorway — there is only a five foot clearance.

Tying Down

Each bus has two wheelchair areas near the front. Two kinds of tiedowns are provided to any wheelchair model. Metro recommends that you also have a seatbelt on your chair.

If both tiedown areas are occupied by persons who must remain there, the lift will not be operated. You may not remain in a non-secured wheelchair while the bus is moving.

Clamp Tiedown Instructions:

1. Back into the area and maneuver the rear wheel of your chair into the tiedown clamp. the clamp will automatically close when the wheel hits the plate at the back of the clamp.
2. Lock your wheelchair brakes and fasten the safety belt around you and your chair. You must use both the clamp and the safety belt while the bus is moving.
3. When the bus comes to a complete stop unfasten the safety belt and push down on the knob by your rear wheel to unlock the clamp.

Strap Tiedown Instructions:

1. Ask the bus driver to help you when you get on the bus.
2. Back into the area and lock your wheelchair brakes. The driver will hook the straps onto the frame of your chair.
3. Fasten the safety belt around you and your chair.
4. When the bus comes to your stop, the driver will release your chair from the tiedown.

Getting Off

1. A block before your stop, signal the driver you wish to get off by pulling the cord.
2. Allow other passengers to get off first. When the lift is in position, move to the front of the bus.
3. Move onto the lift platform. *Wheelchair Passengers* - set your brakes. *Standing Passengers* - move to the outer edge of the platform, standing on the footprints. Watch your head as you move through the doorway.
4. When the lift reaches the ground, the ramp will drop down. Move off of the platform.

Bus Fare

10¢ with Reduced Fare Permit
40¢ full-fare, one zone
60¢ full-fare, two zones

Route and Schedule Information:

Route and schedule information is updated regularly in "The Lift Bulletin" which is available in the Customer Assistance Office, 821 Second Avenue, Seattle, WA, 98104. Beginning Feb. 2, 1980, Metro bus timetables will have symbols next to each trip that is equipped with a lift. If you need specific information on lift-equipped buses, call the Metro information operator at 447-4800 (24-hours-a-day).

METRO

Please see attached timetable for schedule information.

STARTING NOW THE BUSES ARE FOR EVERYONE!

Most of us have been seeing the new buses on the streets of New York in the past few months. What you may not know is that these buses are all equipped with wheelchair lifts. Buses, like the one pictured here, have begun to operate the wheelchair lifts on selected routes in Manhattan and Brooklyn. Service is being expanded to other routes throughout the five boroughs as drivers are trained and buses become available.

It's going to be a while before service is available everywhere. However, every day more new buses with wheelchair lifts will be joining our fleet. By early 1982, at least 20% of our entire fleet will be equipped with wheelchair lifts.

Even though the lifts take a few minutes to operate and require a little patience from riders, we think it's well worth it. This is a very important innovation. People who use wheelchairs, or other mobility aids, can now use public transportation.

Lift-equipped buses are presently running on the following routes: The M104, which runs along Broadway and across 42nd Street, the B41, which is the Flatbush Avenue line, the B6, which is the Bay Parkway, Glenwood Road, Flatlands Avenue line, the B44 along Nostrand Avenue, the B46 along Utica Avenue, the B49 along Ocean Avenue, the B68, along Coney Island Avenue, the B8 along 18th Avenue and Foster Avenue and the B36 along Surf Avenue and Avenue Z. Please note: Not all buses on these routes are lift-equipped.

If you want to take one of these buses, wait at the regular bus stop. Look for the bus with the flashing sign on the front that says "Wheelchair Bus." When the driver sees you he'll give you instructions. The lift will raise you up, level with the interior of the bus where there are designated seating areas for you.

Riders will receive special fare envelopes from the driver, and may send fares directly to the New York City Transit Authority. Full fare is 75¢. Half fare (35¢) is available to handicapped persons who have received a half-fare identification card. For more information call: 596-8585.

And to apply for your half-fare ID card, or for free MTA borough maps (please indicate which boroughs)write to:

MTA
Marketing Department
347 Madison Avenue
New York, New York 10017

WE'RE WORKING TO MAKE THINGS BETTER.

YOU CAN HELP.

Metropolitan Transportation Authority

Courtesy Metropolitan Transportation Authority

THE TRANSPORTATION RESEARCH BOARD is an agency of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 250 committees, task forces, and panels composed of more than 3,100 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, and other organizations and individuals interested in the development of transportation.

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The National Academy of Sciences was established in 1863 by Act of Congress as a private, nonprofit, self-governing membership corporation for the furtherance of science and technology, required to advise the Federal Government upon request within its fields of competence. Under its corporate charter the Academy established the National Research Council in 1916, the National Academy of Engineering in 1964, and the Institute of Medicine in 1970.

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