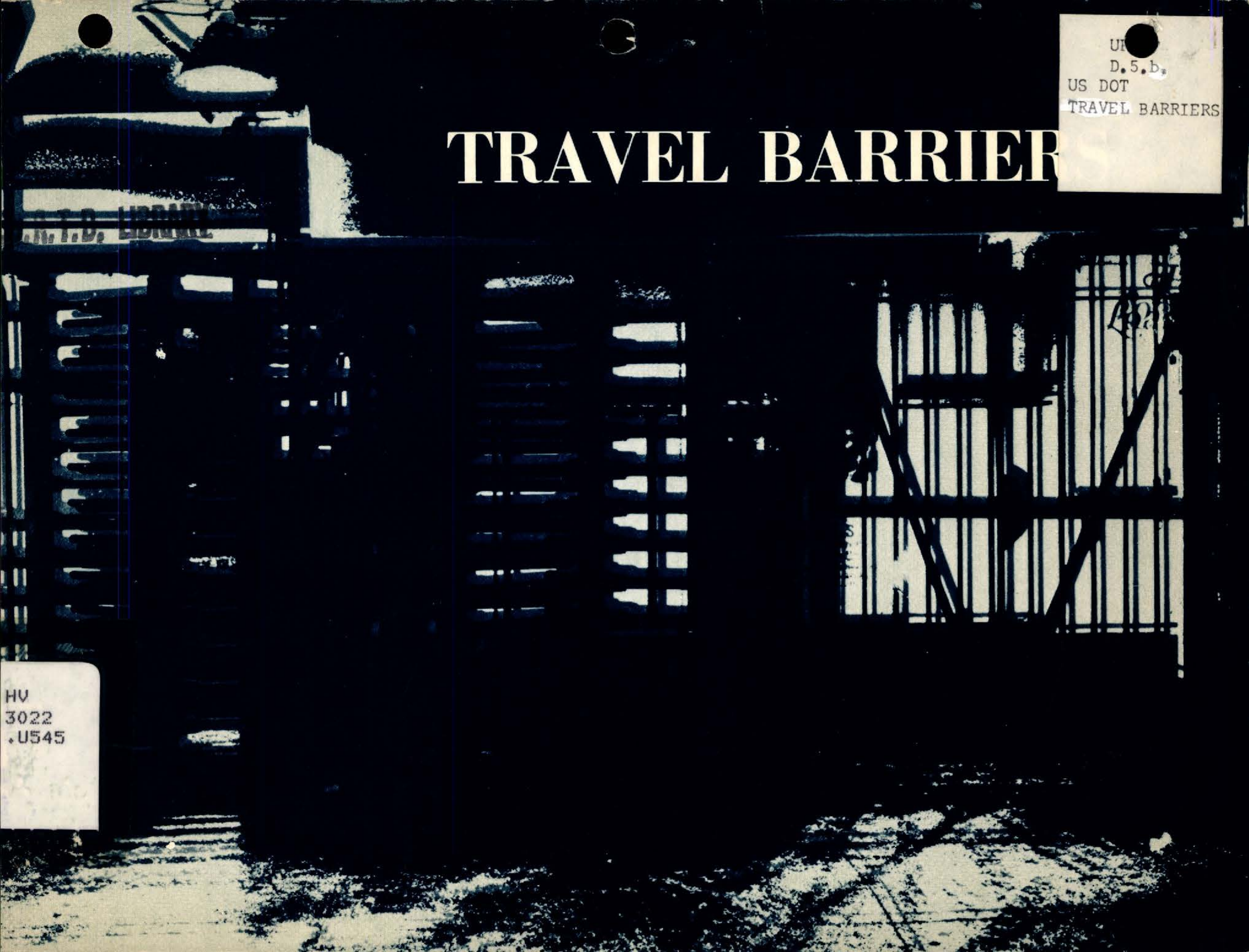

TRAVEL BARRIER

U.S. Department of Transportation
Office of the Secretary
Washington, D.C.
May 1970

TRAVEL BARRIERS

DEPARTMENT OF TRANSPORTATION

OFFICE OF THE SECRETARY

Washington, D.C. 20590

introductory statement by secretary

There must be within our society a continuing universal awareness that transportation for the handicapped is good business, good government and good human decency.

The Department of Transportation is backing its awareness of the problems of transport for the handicapped with resources and funds.

The first of our projects is the completion of this study on "Travel Barriers."

The barriers which this study spotlights are those which keep handicapped people from participating fully in our society.

If we can increase the availability of the handicapped to our society then the nation and our economy will be further enriched.

The following study is one of our first contributions, but I assure you it is only the beginning of our efforts to provide suitable, economical transportation for this nation's handicapped.

John A. Volpe

preface

This report summarizes the findings of a research program sponsored by the Office of the Secretary, U.S. Department of Transportation, as a result of its concern for the accessibility of public transportation to all Americans. A fuller discussion of the methodology, findings and recommendations of the study central to this program has been published in a report entitled *Travel Barriers* which is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia, 22151 (PB #187 327, $3.00 per copy). Local communities should refer to the complete report when undertaking detailed planning of system changes. The research study was supported by a contract with Abt Associates Inc. of Cambridge, Massachusetts.

The research study consisted of an initial review of the most relevant literature in the fields of rehabilitation and transportation, a survey of the transportation needs, detailed problems and suggestions of 211 chronically handicapped people statistically selected, and an analysis of alternative solutions by a team of social scientists, systems analysts and designers. A novel part of each interview was a film questionnaire depicting the actions required for traveling in a train, airplane, bus, taxi or self-driven automobile. The film was used to ask the handicapped respondents about their own ability to perform the very actions they were watching in the film. The survey design was based on an analysis of information about the national distribution of chronic conditions provided by the National Center for Health Statistics, U.S. Department of Health, Education and Welfare.

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I. indentifying the handicapped

Many of the nation's physically handicapped are unable to take advantage of the economic and social opportunities of their community, even though they may possess valuable vocational skills, an ability to learn, and a full human capacity for enjoyment of social and personal relationships. For the nation as a whole, this is a waste of its most valuable resource: people. For the individual, influenced by a society that holds productive activity and personal autonomy in highest esteem, it can mean a life of loneliness, self-criticism and despair. Why?

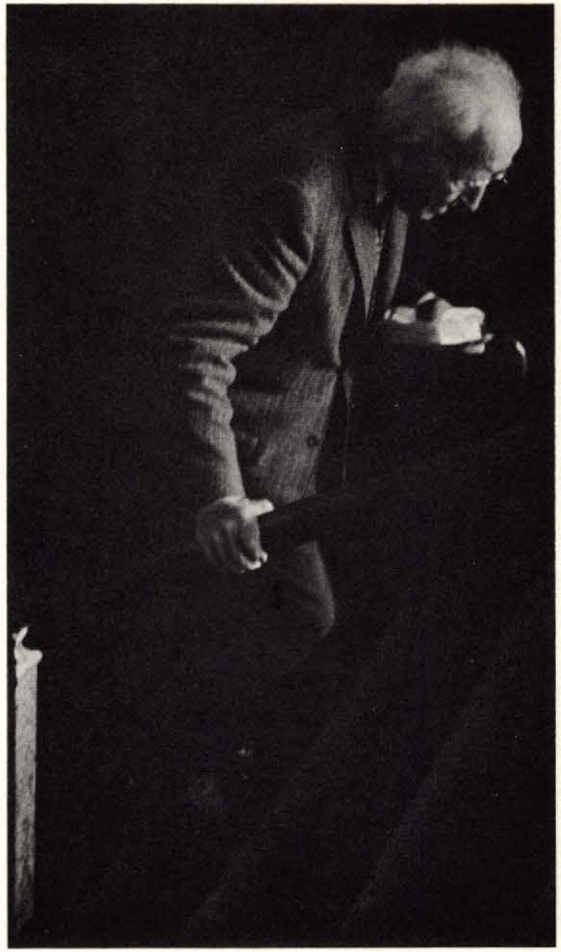
Many handicapped people who have looked for employment have been discouraged by the attitudes of potential employers, while others have found that their job skills are no longer marketable. Some have sought help from understaffed and underfunded agencies which have all too often failed them, others have never asked for help—out of fear, or shame, or a simple lack of information about what help was available. A significant number of handicapped people have been frustrated in their attempts to find or hold jobs, obtain regular medical care, improve their education, shop in competitively priced markets or even to take part in everyday social activities because of poor transportation. A transportation system which bars the physically handicapped from its use discriminates against a population which has an equal right to participate in all the opportunities offered by the community. But only where access to those opportunities are equal, are the opportunities themselves truly equal.

who are the handicapped?

Estimates prepared by the National Center for Health Statistics indicate that there are approximately 6 million physically handicapped whose mobility is limited as a result of a chronic or long-term medical condition. This group is of major national interest, because improvements in the quality of public transportation are likely to result in the most significant changes in their lives.

The largest segment of the population that consistently experiences difficulty with public transportation is the aging. These 15 million citizens are unique among the handicapped because their disability result as much from the natural process of aging as from the effects of a chronic medical condition. There are at least another 4.6 million people at one point in time whose mobility is limited by a serious but short-term illness or injury. Still others are excluded from use of the system by over or undersize, or pregnancy. When all of these groups are combined, they total nearly 44 million people with limited social and economic opportunities who would benefit significantly in time savings, comfort and convenience for the duration of their handicap if transportatiòn were improved.

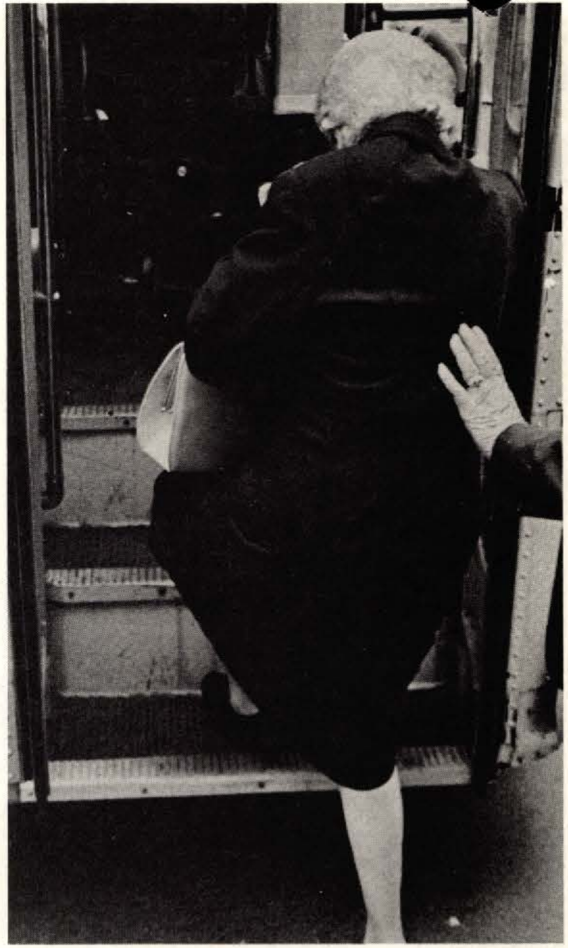
A significant group of handicapped travelers include anyone who has ever been frustrated in his use of public transportation by the circumstances under which he was traveling. Some of these handicaps are voluntarily assumed and are seldom thought of as disabilities, like the shopper who carries bulky parcels on the bus, or the airline



passenger who totes his suitcase abroad. Other handicaps arise from social roles and are not themselves voluntary. Every child who is too short-legged to climb steps safely or too irresponsible to find his own way through a terminal is handicapped. A mother struggling to guide a toddler through a subway turnstile is handicapped by her responsibility toward him. Although the handicaps experienced by most people will be no more serious than these, the public's willingness to use mass transportation is undoubtedly influenced by just such trying encounters. Clearly, the design and operating changes which could be made to a transportation system to accommodate the chronically handicapped could also improve the quality of transportation for the rest of the population.

what is a handicap?

A skier with a broken leg, a paralyzed veteran, an elderly grandmother, a businessman with two suitcases and a blind student are all handicapped in their ability to use public transportation. For a traveler, then, a handicap is an inability to perform one or more of the actions required by existing



transportation systems at a comfortable level of proficiency.

Although all of these people are handicapped in different ways, they share a number of common disabilities which limit their ability and willingness to travel. The following disabilities functionally relate a multitude of handicaps to diverse and complex travel systems:

Wait standing
Go more than one block
Go up stairs
Go down stairs
Go up/down inclines
Stoop, kneel, crouch
Lift and carry weights
  up to ten pounds
Reach
Handle or grasp
Move in crowds
Identify visual cues
Identify audio cues

While there are certainly other important disabilities, these serve as a basis for developing and organizing guidelines for upgrading all transportation systems.

II. travel by the chronically handicapped

The chronically handicapped (excluding the aging) presently travel about half as much as everyone else, with the greatest difference between the two groups being in the number of social and recreational trips and the number of work trips. On a typical weekday they took about one third as many trips for these purposes as did the able-bodied in the same geographic area. The able-bodied also took about 2.5 times as many shopping trips as the handicapped.

The handicapped are less likely to combine several different purposes into a single trip. Since they tend to tire more easily, especially when traveling, more of their trips are oriented toward specific destinations. A comparison of the number of trips taken at various hours of the day by the handicapped and able-bodied shows that the handicapped travel most often between 9:00 and 11:00 a.m., rather than between 8:00 and 9:00 a.m.

The handicapped individual's choice of travel mode appears to be influenced by the same factors which affect the mode choices of other travelers, but his alternatives are limited to those modes which do not require difficult or impossible actions. Those who have access to public transportation appear to choose modes by the same criteria as the able-bodied: if they can afford an automobile and are able to drive, they do so. If they are physically able to use public transit, but cannot afford an automobile, then they prefer low-cost modes, namely, buses and subways. If public transit is inaccessible, then the necessity of the trip must be weighed against the inconvenience caused a friend or relative, or against its high cost by taxi.

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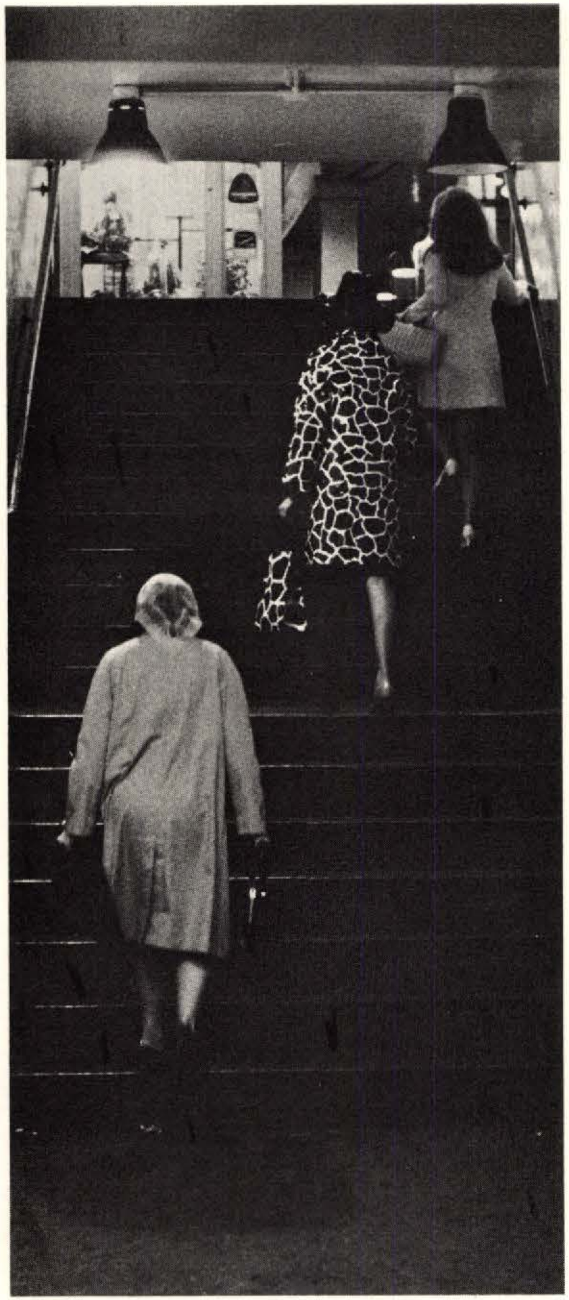


III. travel barriers

kinds of barriers

The handicapped avoid public transit not only because of the barriers in the system, but also out of fear for their personal safety, the inconvenient routes and the difficulty making transfers. While these factors influence all of our decisions to use public transit, they are much more likely to be prohibitive for the handicapped.

Many travel barriers are architectural in nature and comparable to architectural barriers in buildings. In the transportation environment, architectural barriers are compounded by moving crowds and pressures to meet schedules. Many handicapped people note that they might be able to overcome these barriers if it were not for the pressure to move quickly. Since traffic flows are planned so that all passengers are processed through the same course, the absence of alternative routes frequently forces unavoidable barriers onto the handicapped traveler.

The barriers associated with movement—an essential part of the act of traveling—present even more difficulty to the handicapped passenger. Motion in and around the travel environment changes the character of many obstacles so that their effect is even more profound. A well-intentioned support stanchion, for example, can become a serious menace in a lurching subway car.

In addition to the hazards of physical barriers that move, the handicapped also encounter severe problems when trying to cope with some of the secondary effects of travel: acceleration and deceleration, crowd movement, time pressure, and long walking distances. Research indicates that these *movement*-related barriers are even more limiting than the physical obstacles. More than half of the handicapped are unable to maintain their balance in a moving vehicle as it starts, stops or goes around a sharp curve. Sixty-one percent are sufficiently fearful or embarrassed by crowds to avoid public transportation entirely. Slightly less than half can cross a street in the time allowed by a pedestrian light. This is roughly the same proportion that cannot climb a long flight of stairs, negotiate bus and train steps, or use a regular escalator.

Each travel mode has a characteristic profile of barriers, although there may be some variation due to local conditions or design. A bus's barrier profile provides an illustrative example. First, the passenger must locate the bus stop and wait, usually standing, until the vehicle arrives. Then he must climb the bus steps, deposit his fare, and locate a seat—all while maintaining his balance as the bus jerks away from the stop. It a seat is available, he has to negotiate the aisle to be able to sit down. When all of the seats are filled, he must ride standing in a crowd with a vertical stanchion or overhead grip to support him. As the passenger approaches his destination, he has to be able to locate his stop, pull the signal cord, and exit down the steps. If a handicapped person cannot perform all of these acts, he simply cannot ride the bus.

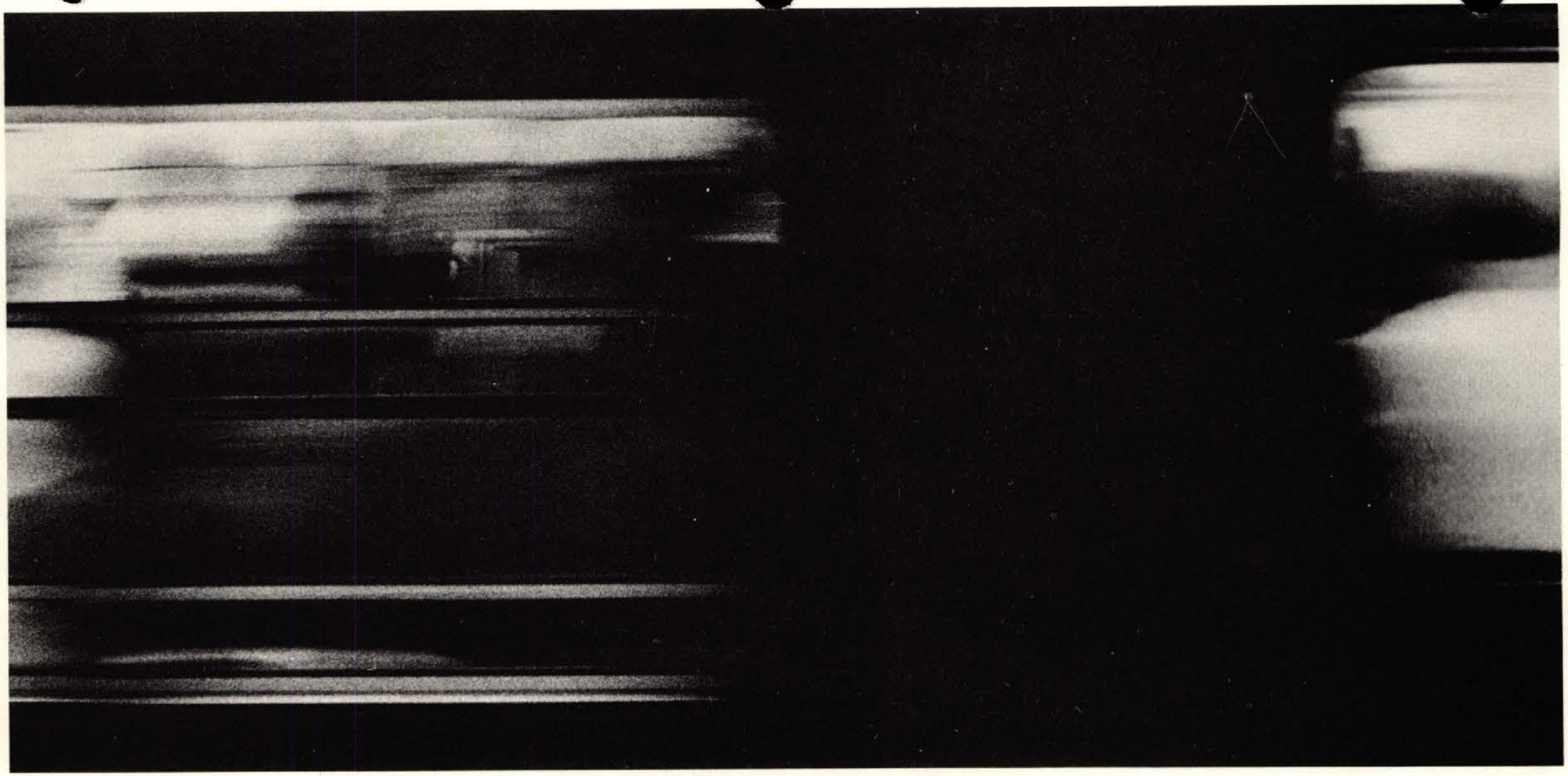
Typical Barriers By Mode

Functional/Mode Disability	Train	Subway	Bus	Airplane
Walk more than one block	Walk from curb through concourse to platform.	Walk from entrance to boarding platform.	Walk from origin to stop or stop to destination	Walk from curb to gate.
Self-propelled level change	Board train via steps.	Enter or exit station.	Board bus via steps.	Board plane via stairs.
Sit down, get up	Sit/rise from waiting room or train seats	Sit/rise from seat in car	Sit/rise from seat in car	Sit/rise from seat in lounge or on plane
Stoop, kneel, crouch	Pick up baggage.	Pick up packages.	Pick up packages.	Pick up baggage.
Reach-handle	Open terminal door. Enter restroom. Grasp hand-rail. Open compartment door. Lift suit-case to rack. Buy or turn in ticket.	Buy token. Operate turnstile. Hold over-head grip. Use exit turnstile.	Signal bus. Deposit fare. Grasp over-head grip. Pull signal cord.	Buy ticket. Handle bag-gage. Fasten seatbelt. Reach overhead switches. Hold oxygen mask. Lower tray table
Carry 10-pound weight	Carry bag-gage. Use overhead baggage rack.	Carry packages	Carry packages	Handle own baggage
Move in crowds	Terminals	Platform and vehicle	Terminal vehicle	Ticket counter, boarding area
Identify visual and audio cues	Read direction signs, clocks. Locate gates, restrooms, seats, exits. Hear an-nouncements and warnings.	Read direction signs. See ar-riving train. Locate plat-form edge. Hear an-nouncements and warnings.	See approach-ing bus. Read bus destina-tion. Locate bus stop, curb, stop. Hear an-nouncements, ask directions.	Locate coun-ters, gates. See schedule dis-plays. Hear P.A. system onboard an-nouncements.
Wait standing	Wait on platform	Wait on platform	Wait outdoors	Stand in boarding or ticket line

acceleration and deceleration in travel

While constant velocity has little or no effect on travelers, acceleration and deceleration, especially when uneven, can cause hazardous encounters between the passengers and stationary parts of the vehicle. Although passenger comfort is very subjective, it is generally agreed that most able-bodied people find it irritating, and sometimes dangerous, to experience acceleration between 0.1g standing, and 0.15g seated. This kind of motion so alters the encounter with the vehicle that any person may be discomforted or injured in a collision with some part of the vehicle which is not normally a barrier. Fifty-five percent of the handicapped report that they have difficulty staying on their feet in a typical subway start, and almost as many indicate that they have trouble remaining standing in an accelerating bus.

The jerkiness frequently associated with the bus, and occasionally with other vehicles, can be attributable mostly to rapid changes in acceleration and deceleration. The roadway on which buses now travel is filled with other vehicles which do not always operate in a predictable manner. This situation, the ensuing impatience of the driver, and occasional idiosyncracies of the



equipment can result in sudden and irregular acceleration and deceleration. Since the size and height of the bus prevents the passenger from viewing road and traffic conditions, he is seldom warned that the vehicle is about to accelerate. This unexpectedness creates anxiety among handicapped travelers and compounds the effects of acceleration and deceleration.

Acceleration not parallel to the direction of travel results in sudden movements of the vehicle in unanticipated directions. Curves and uneven surfaces produce most of these forces, and they, too, are hard to control. Thirty-seven percent of the handicapped doubt they could walk to a rest room in a moving train, and 21% are unable to do so in an airplane. Hand grips and overhead poles offer little support against the bumps and jolts characteristic of most urban transit, and approximately half of the handicapped are not able to ride standing with a typical grip to hold.

long walking distances

The corridors and tunnels found in most long distance transportation modes make demands which handicapped persons often cannot meet. The long walking distances in rail and air terminals are barriers for persons with limited strength, low energy, sensory deprivation, and impaired balance. These difficulties are frequently compounded by the need to move quickly and the complications of handling baggage.

crowd movement

The irregular, dense, and usually hurried pedestrian traffic in most travel situations is a physical menace to many disabled travelers as well as a source of apprehension. About one-third of the handicapped are frightened or upset by crowds of strangers, which can be attributed in part to the fear of actual physical impact with rushing passengers. Although the dangers of accidental injury, physical assault, and social embarrassment are possible in all crowds, those in transportation situations are distinguished by the difficulty of withdrawing or avoiding them. The social pressure implicit in a situation in which the slower moving handicapped person may feel that he is impeding others can also be upsetting. The desire to maintain a schedule and to avoid delays motivates the handicapped, like all other travelers, to proceed as quickly as possible through the trip. Since the disabled traveler dislikes being late just as much as anyone else, he can be swept along by the crowd into unexpected travel barriers.

requirements for body configuration and articulation

Both medical conditions and orthopedic aids can alter a person's form so that he cannot use public transportation. Since transportation facilities are designed to accommodate a mythical average man, almost any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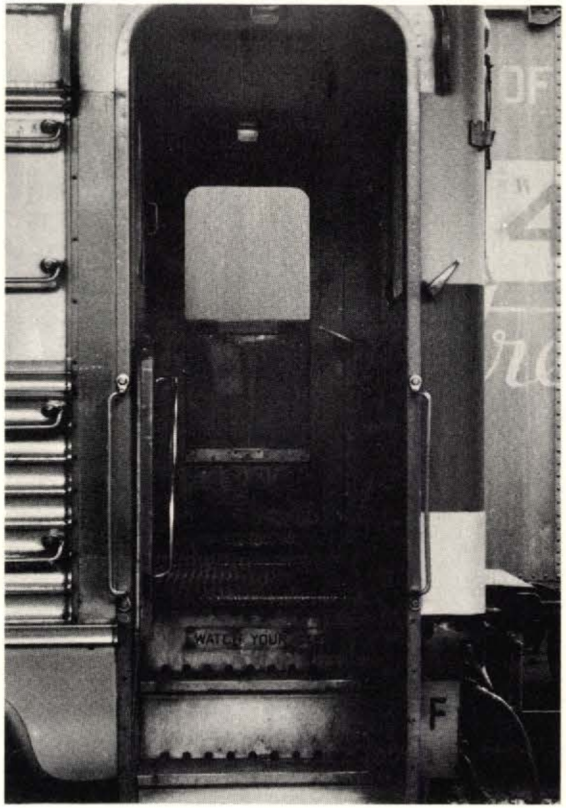
atypical body configuration exceeds the tolerances of the equipment. A man in a wheelchair is barred from passing through a turnstile simply because his chair makes him too wide. Someone using crutches encounters similar problems with narrow passageways, compounded by his inability to make free use of his arms. Victims of muscle and joint diseases are frequently unable to flex their knees well enough to climb stairs. These are just a few of the ways in which transportation systems present barriers to people with unusual sizes and shapes or limited articulation.

sensory requirements

Use of public transportation requires that the traveler regularly receive and process information about routes and schedules, as well as occasional emergency information about delays from traffic conditions or equipment failures. Much of the information that guides the traveler is transmitted by signs and loudspeakers, and little use is made of other senses. When one of these senses is impaired, travel information is no longer communicated, and problems are immediately created for the blind and deaf.

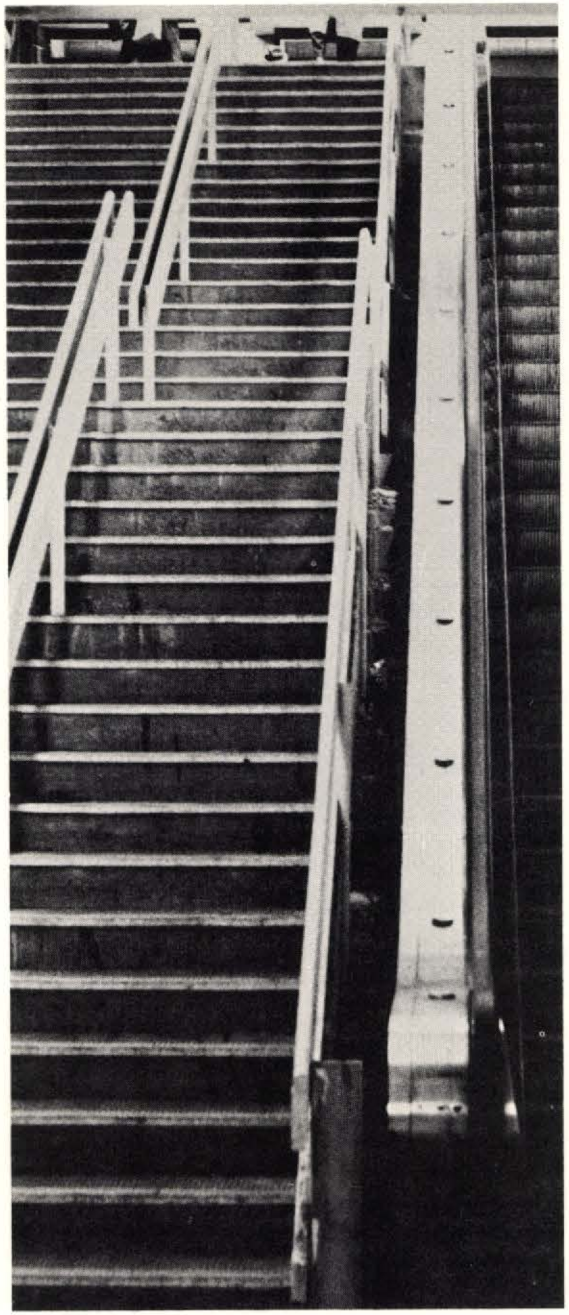
the problem in the future

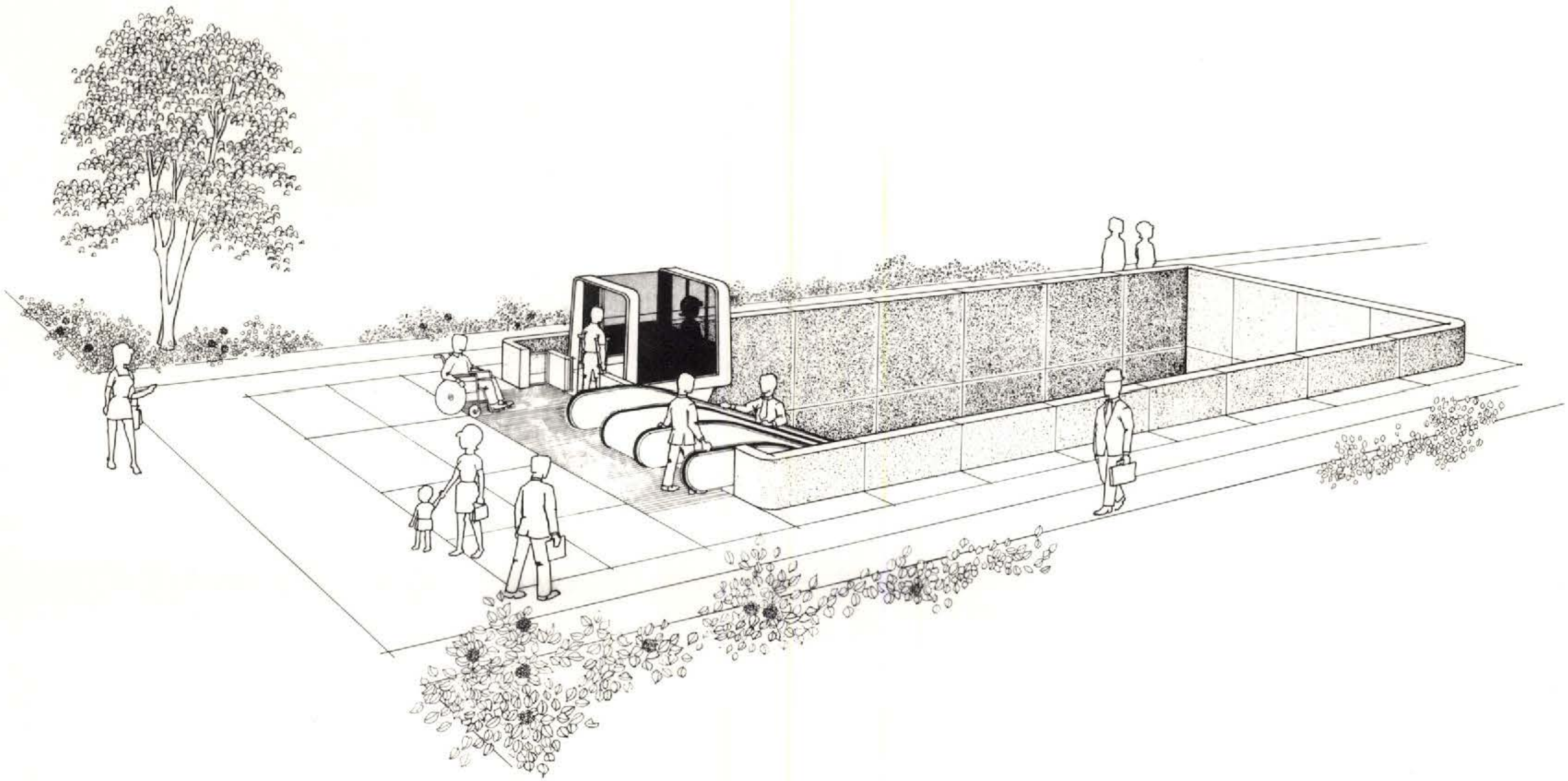
It is conservatively estimated that by 1985 nearly 5.2. million chronically handicapped citizens will be unable to go up or down stairs, steps, or in many cases inclines, well enough to make use of current forms of public transit. When those with short term disabilities are included, the number is even higher. Changes will therefore be required in vehicle entrances to make buses and subways accessible. The limb articulation nec-

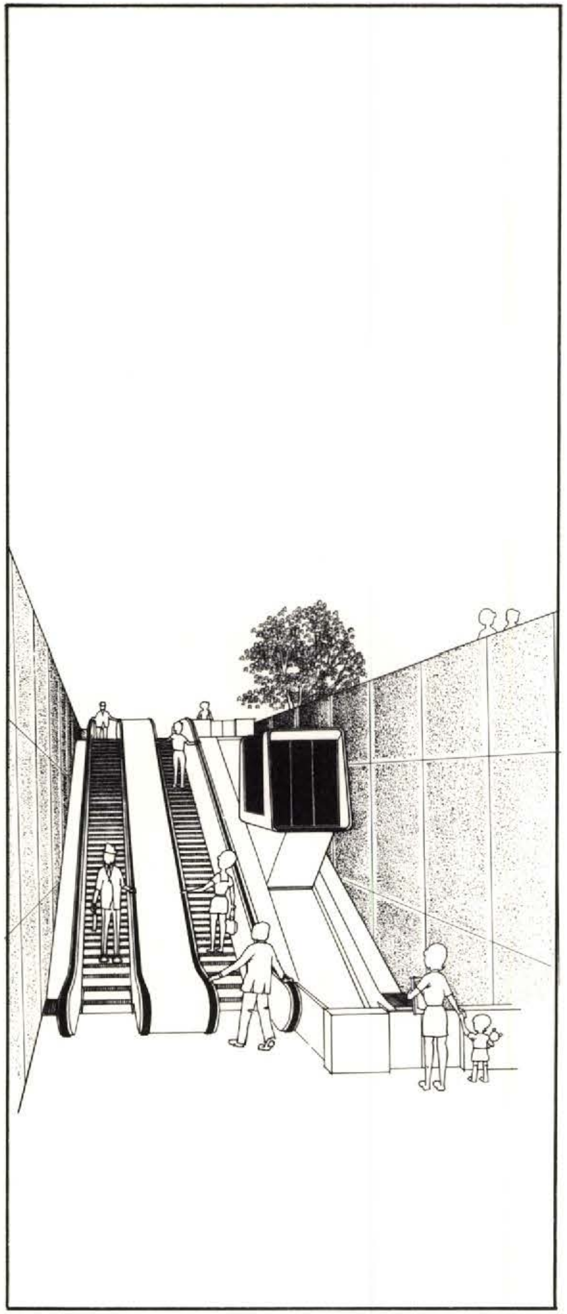


essary to reach, handle and grasp will limit the ability of at least 2.4 million people to open vehicle doors, lift baggage, grasp overhead supports, use handrails, and handle small change. The difficulty of sitting down and standing up while in a moving vehicle, or of transferring safely from a stationary position to a moving one (as in an escalator) will be experienced by some 3.7 million chronically handicapped in 1985. This is especially important in vehicles where acceleration begins before the passenger is seated. Transfers between modes will be difficult for more than 4 million in 1985, since they generally require that the pas-

senger be able to go the equivalent of a block or more, and that he be able to wait until the vehicle is ready for him. Another 3 million handicapped will be unable to lift or carry parcels and packages. For physical and psychological reasons, 4.5 million citizens will experience difficulty moving in crowds. At least a million people will be unable to identify audio and visual cues, and countless others will avoid using public transit because they are uncertain about stops, routes and schedules. Now is the time to begin planning new transportation systems and improving old ones which are accessible to this segment of the population.







IV. design and operating guidelines

potential benefits of barrier free transportation

The most severe effects of a chronic handicap are felt in the area of employment. Thirty-six percent of the national chronically handicapped population, aged 17 to 64, are members of the labor force, compared with about 71% of the non-handicapped population of the same age. In our work-oriented society, the unemployed person not only loses income, but also a sense of personnel worth as a result of his being unemployed. When the educational attainment of a handicapped person is low, his employment opportunities are even more limited.

The employment of the handicapped is inhibited by many factors, of which one is poor transportation. Although all of these conditions must be changed before most unemployed handicapped persons could return to work, transportation problems take on added significance once the decision to seek work has been made. The employed handicapped appear to be more conscious of transportation more relevant than do people who are not part of the labor force. About 30% of the unemployed handicapped who are looking for jobs identify transportation as one of the major contributors to their unemployment, and almost 70% of this group would return to work if their transportation were no longer a problem. These results indicate that 13% of the chronically handicapped population of working age, or some 200,000 people, would enter the work force if their transportation problems were solved.

The minimum yearly economic benefits (total yearly increase in goods and services) that would result from eliminating travel barriers in and around metropolitan areas has been estimated at $824,000,000, or an average of about $3,887,000 for each major metropolitan area. These estimates exclude the benefits of time savings for the acutely handicapped or the benefits of improved access to educational and vocational training. They also omit all transfer payments, such as increased tax revenues and lower welfare payments. Unfortunately, cost benefit analysis is inadequate to account for the social and psychological aspects of self-sufficiency, the social benefits of equal opportunity, or the true costs of continuing to allow travel barriers to further handicap the handicapped. As a result, these dollar estimates are extremely conservative.

planning new systems

A number of cities across the country are now in the process of designing and planning new fixed-rail transit systems. If the physically handicapped are to be given an opportunity to use public transportation, these new systems must be planned from the beginning with this population's special requirements in mind. The specifications set forth by the American Standards Association for public buildings are equally appropriate for transportation terminals. However, as indicated above, there are a number of other factors unique to transportation which must be given special at-for different denominations of bills and coins.

mechanized fare collection

The sale of tickets by vending machines at each stop, and automatic collection of tickets or tokens throughout the trip would speed passenger boarding and reduce harrassment to the bus driver. Bus fare could be collected by automated ticketing-vending machines stationed at the curb. The machine could issue a highly visible pass, perhaps with an adhesive back for attachment to clothing. Alternatively, the machine could simply count the number of tickets sold between buses for each route and signal the number to the driver or to a receiving mechanism in the bus. If the number of passengers was greater than the number of transactions made, the driver would ask all new passengers to show their passes.

special ticket lanes

Airlines and passenger trains should provide special ticket lines during peak periods for aging and handicapped travelers, as well as for mothers with young children. This would reduce crowding and anxiety about delays for the people who are most affected.

passes

Any means to reduce the actual number of ticket-selling transactions would help save time and control crowds. Since most trips are actually round trips, round-trip tickets could be sold—perhaps at some reduction in cost. Similarly, a shopper might buy a "day-tripper" pass which would let him ride as often as he wanted on buses and subways, at a saving to him if he made more than the average number of trips. A prepayment card would permit a traveler to buy a ticket for a certain value which would diminsh with use.

credit cards

A credit card could record the user's passage and trip cost for a central accounting system which would bill him monthly. The card itself would require an automated rapid-reading system, so that the user could insert his card at one end of the toll channel and reclaim it at the other. Temporary cards with magnetic ink or tape messages would be available at a daily rate for sporadic riders. More permanent cards might be coded in such a way that the machine would recognize their expiration date. Cards with electromagnetic recording code strips could be recorded at regular intervals.

fare collection gates

A more efficient fare collection and passenger counting system could borrow techniques from highway toll booths, where social embarrassment is the main sanction against a driver's failure to pay. An approaching passenger would activate a double swinging gate by moving across a pressure sensitive floormat and depositing his fare. After passing through a channel wide enough for a wheelchair or person on crutches, the passenger would close the gate by stepping on another pressure-sensitive mat. During peak travel periods the gate would remain open, while the pressure mats would ensure that each set of successive steps was accompanied by deposit of the proper fare. A simple timer could hold the tention in planning new systems. Now that we have a better understanding of what modifications are required, there is no excuse for neglecting the needs of this segment of the population.

The cost of desiging and engineering many of the most critical improvements will initially be high, but once new technology has been developed, the implementation costs will probably be no higher than the cost of present barrier-ridden systems. Furthermore, there are a number of designs which can be implemented for almost no cost at all. Careful and timely planning for new facilities will avoid the higher costs of future modifications for the handicapped.

In the mind of the local system manager or planner, the decision to invest in a transit system which is accessible to the handicapped is largely dependent on the additional revenues which he expects to receive. Although the number of physically handicapped who might use the system in a given city may be small, the guidelines proposed would make the system so much more attractive that many who are not now riders would also find it more comfortable and convenient to use.

removing barriers in existing systems

Although each transportation mode has its own profile of travel barriers, many of the barriers are common to more than one mode and can be eliminated by similar solutions.

These barriers and solutions are described first, followed by those that are unique to a particular mode. In some cases, specific design changes are discussed in detail and illustrated. These guidelines are intended to stimulate transportation system designers, planners and operators to reconsider the actions required of all passengers, and will need further research and testing before they can be incorporated into legislation.

fare collection

Much of the delay which encourages passengers to rush is caused by bottlenecks around fare collection and ticket-selling areas. Subway turnstiles, airline boarding gates and other fare collectors are designed to slow a person's travel until he demonstrates possession of a coin, token or ticket. Within the vehicle, the boarding passenger generally deposits his fare in a coin box, often obtaining change from the driver. This procedure adds to passenger delay, enhances anxiety about being late, and increases the desire to rush. Delays due to payment for trips could be greatly reduced by reconsidering the whole process of fare collection.

dispersal of fare collecting

Fares collected while people are waiting for the vehicle, during the trip itself, or even after the trip, would help to reduce bottlenecks in the trip. Mechanical collection facilities might be available throughout the trip so that a passenger could make the transaction at whatever point was most convenient for him. Many of these transactions could be automated with the development of a truly workable change-making machine gate open for a preset period, and if no one else passed through at the end of that time, the unit would return to its normally closed position. Each person moving through the unit during the period when the gate was open would set the interval timer back to zero, ensuring that the gate would remain open for at least one more interval. The passenger intent on a free ride will find ways to cheat the toll-gate, just as he now evades the turnstile. However, the accessibility it provides the disabled and the increased convenience to all passengers nevertheless makes it an attractive improvement.

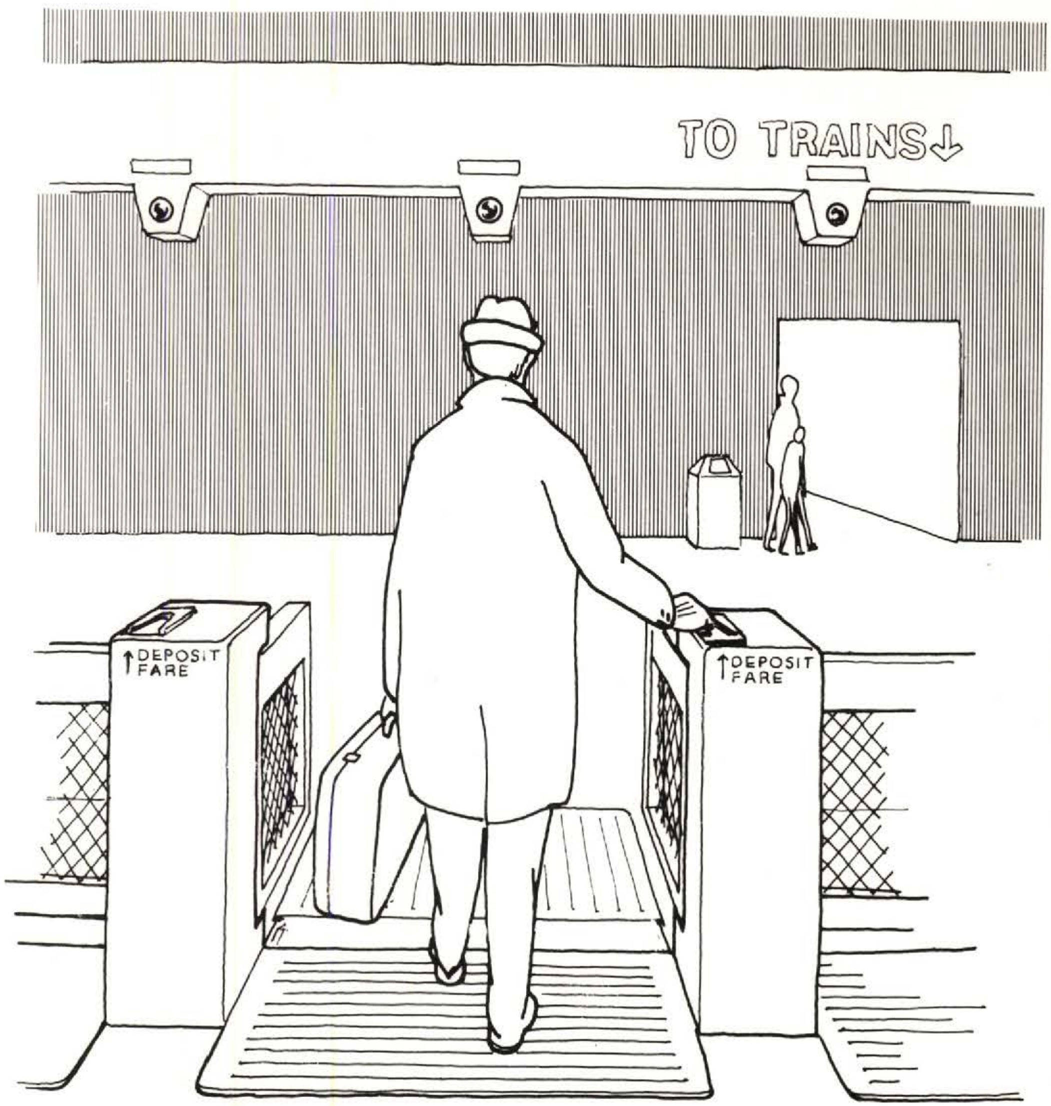
improved coin receiver

Another factor causing bottlenecks at turnstiles is the coin or token slot. Present designs require that the passenger place his coin precisely into a slot only slightly larger than the coin itself. This is difficult for anyone wearing gloves, and an even greater problem for those with poor coordination or muscle control. Since the passenger must come to a complete stop to deposit his fare, he slows a whole line of people at rush hour.

A shaped coin receiver capable of accepting a coin over a larger area and from a number of positions would be a better solution. The nearly-flat panel could be mounted on the top surface of the toll-gate column with a wide flat area at the end toward an approaching passenger. With one motion, he slaps the coin on the surface and slides it forward in the direction of his movement. The surface which the coin contacts guides correct coins into the proper slot and rejects incorrect coins.

departure time information

Accurate and timely information at each station about the departure of the next bus



FARE COLLECTION GATES (REPLACE TURNSTILES)

IMPROVED COIN OR TOKEN RECEIVER

or train would eliminate much of the unnecessary hurrying characteristic of the travel environment.

illuminated status board

A passenger entering a station would pass by an illuminated read-out sign showing departure information. For example, he might read that a train had just departed on line A, that one was in the station and about to leave on line B, but that the train on line C would arrive in three minutes. He could then pace himself to arrive at the platform without needless rushing for a minimum of waiting time.

Hardware for such a system could be inexpensive read-out tubes of shaped-filament ("Nixie tubes"), activated by a simple timer and triggered by a pressure or magnetic-sensing switch on the track. Sensors would be required at each platform, timers and signal generators could be centralized in each station, and read-out boards would appear close to each station entrance.

television display

Television displays similar to those presently found in airline terminals should be adopted by other modes which have large terminal complexes. They should take advantage of the medium's ability to present greatly different kinds of information at varying intervals in a way that is not now done. A series of screens in terminal corridors should show the departure schedule for all routes, directions to platforms, directions to equipment, and emergency or delay notices on a time interval basis.

pedestrian directional information

Much of the rushing, stopping, bunching and generally unpredictable movement in pedestrian traffic flow arises from every passenger's difficulty orienting himself. Although the physically handicapped are not necessarily more easily confused than others, they suffer more from the confusion and rushing of other passengers and expend a higher percentage of their total energy correcting mistakes in direction.

visual indicators
Information personnel, telephones and maps along major passages, and clearly marked routes and exits should be evident in all transportation systems. While these communicators are not new, they have not been used to the extent necessary, and are frequently poorly lit and badly located for maximum visibility.

floor texture pathways
Little use has been made of senses other than sight in providing directional information to travelers. Tactile stimulation can communicate information to all passengers, whether or not they are physically handicapped. Floor materials of different resiliences and textures could help guide the sightless, as well as control the speed and direction of able-bodied pedestrians. Important information could be conveyed without bombarding the visual senses. Some use has already been made of this technique in motor vehicle travel lanes.

audio signals
Sound has been used in the past in the form of voice communication, which is easily masked by crowd noises and garbled by poor reproduction. A pulsed, non-verbal sound of a carefully selected pitch could convey information by means of its interval and stereophonic effect. In a terminal complex each passage leading to a specific platform might have a characteristically pitched sound "traveling" along it by sequenced stereophonic reproduction from speakers along its length. The pulse would seem to move down the passage, with the speed of its apparent movement varying to indicate the nearness of the departure time for the vehicle at that platform. This sound pulse system would provide the blind, illiterate, and non-English speaking population with valuable guidance information.

crowd movement

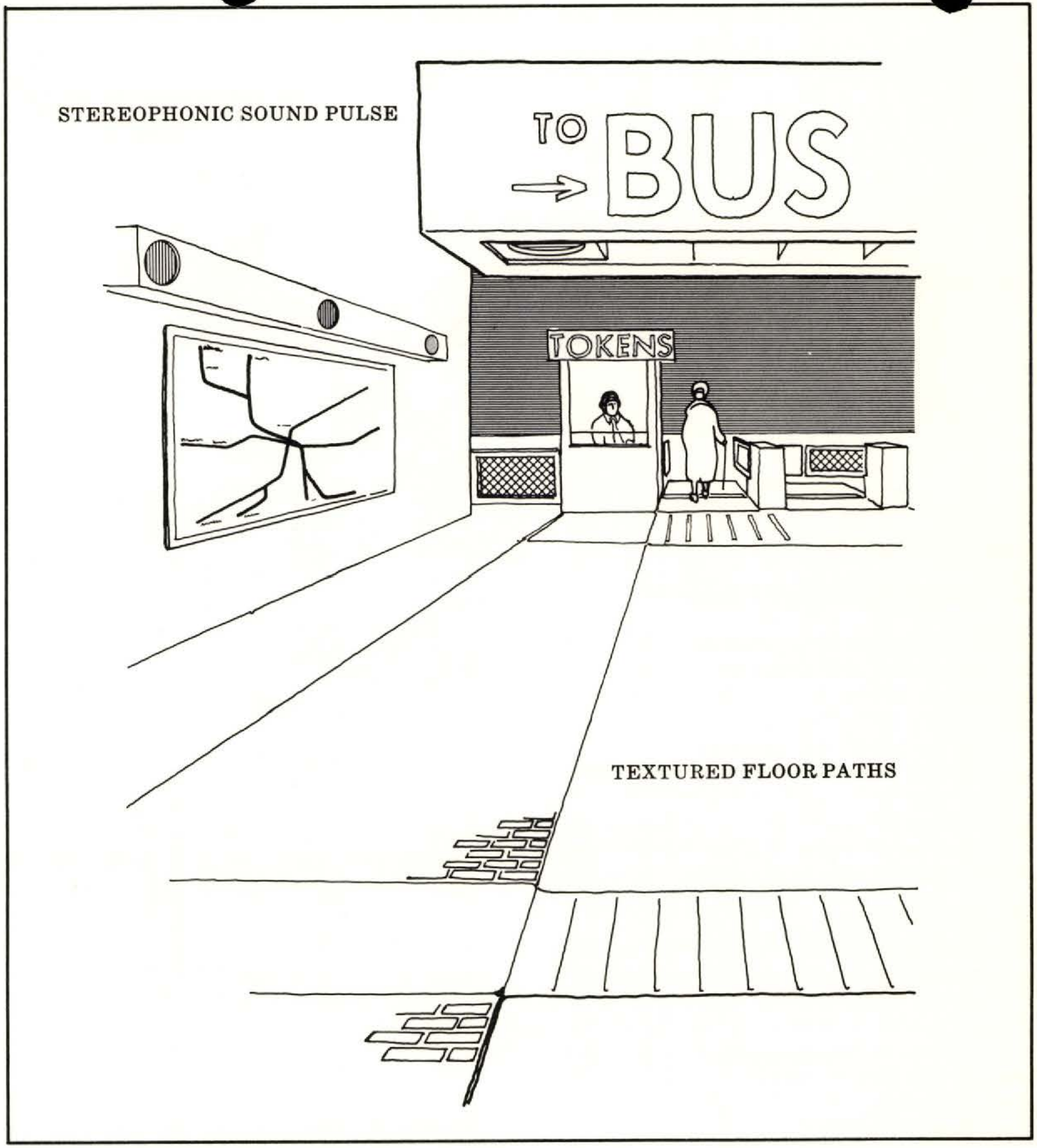
In addition to the ideas discussed under *Fare Collection*, improved boarding procedures and special directional travel lanes would contribute to a more orderly movement of peak hour crowds.

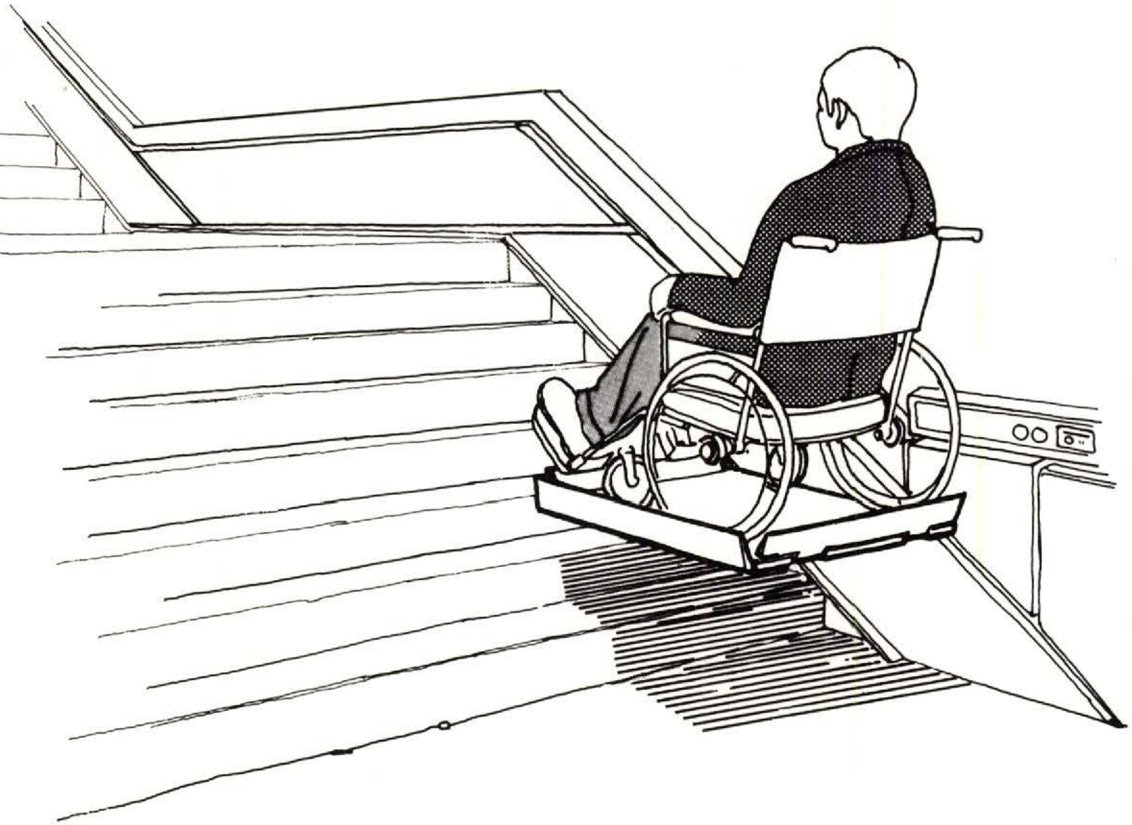
boarding procedures
At the boarding gate or platform, the rush

for choice seats and the bottlenecks created by narrow entrances generally cause crowds to form. Seating priority for the handicapped would minimize this effect. Separated entrances and exists should be a design feature in all new vehicles, and separate paths for entering and exiting passengers should be indicated in existing systems. Corridors should also be clearly divided to separate opposing traffic streams. Street and platform markings for the transit driver would help him stop at the same place, and eliminate last minute sprints to the vehicle entrance.

special travel lanes

Special travel lanes for slower passengers would minimize the delay and ensuing impatience of more mobile travelers. This would not only make the handicapped's travel more comfortable and less anxious, but would reduce the social pressure to rush.





POWERED LIFT INSTALLED IN EXISTING STATION STAIRS

guidelines for level changes in stations

As many as 45% of the chronically handicapped population have difficulty changing platform levels by stairs, steps, ramps or escalators. Considerable progress has been made toward identification and removal of barriers in public buildings, and access to these buildings could be greatly enhanced if comparable improvements were made in transportation systems. In some cases the necessity of level change can be eliminated or reduced by improving predominant passenger traffic flows and reorganizing major terminal facilities. More frequently, however, mechanically powered devices will be necessary.

escalators

The escalator shares with the moving sidewalk the problem of being extremely difficult to board for persons who have poor balance or cannot move quickly. At least 25% of the physically handicapped have difficulty using a typical escalator—more than half of the people who express difficulty with long stairs. Hence the escalator, while a solution to the level change problems of some handicapped is a new barrier to others.

elevators

Hardly anyone has difficulty using an automatic elevator, and careful attention to such details as location of control buttons will assure accessibility for the handicapped. Elevators, however, are very expensive and difficult to install in older buildings without existing shafts. One possibility might be to install the elevator outside the terminal. Since they are the only level change device accessible to all travelers they should be built in *all* new terminal facilities.

inclined elevators

Few alternatives to the conventional elevator are successful at meeting the needs of all travelers. One which shows promise is under development by the Rehabilitative Services Administration of the Department of Health, Education and Welfare. It operates in a standard escalator channel, and can either be installed in a new station, or replace equipment in an older facility. It is seven feet by five and one half feet, and carries ten to fifteen people standing or several wheelchairs.

ramps

Ramps, while necessary for people in wheelchairs, are not universally acceptable to the handicapped population, especially those who walk with canes, crutches or braces. It is very difficult to maintain one's balance on a ramp while using these aids, and ramps of the recommended 1:12 ration are simply too long to be installed within most travel complexes. Ramps with powered assistance to engage a wheelchair firmly and propel it upward or retard its downward roll might be considered further, but they are generally not reasonable alternatives either to stairs, escalators or elevators.

stair-lift

A stair-side lift platform could be installed in the stairways of existing stations. The unit could have a flat platform which would hinge down from its normal storage position against the wall of the stairway. Summoned by a disabled person using a coded pass or key, this lift platform would move in its folded position to the level of the person requiring it. There it would be opened, so the traveler could walk or wheel onto the platform and start the unit moving either up or down.

The fore and aft edges of the platform should be hinged ramp surfaces which spring up at an angle when the platform is in use, protecting anyone who failed to lock his wheelchair from rolling off. They would also serve as pressure-sensitive safety edges to stop the moving platform instantly if it encountered any resistance, including unwary pedestrians. The platform would be equipped with an audible warning signal, and its path would be clearly marked on the stairs. The passenger would be able to stop the lift at any time by means of a large emergency button within easy reach. After the passenger disembarked, the platform would fold against the stairs wall to wait for its next user.

WAITING SHELTERS AT BUS STOPS

guidelines for waiting situations

Just as the hurried pedestrian movement of most travel systems creates difficulties for many handicapped persons, so do the waiting situations which so often follow the rush. Protection from bad weather, insurance of personal safety, and comfortable seating are critical to persons whose physical conditions lessen their tolerance for discomfort.

shelters from inclement weather

The degree to which waiting areas are exposed to bad weather is a decisive factor in the use of public transportation systems by the physically handicapped. Shelters provided at bus stops and taxi stands must protect travelers from wind, rain, snow, and spattered mud. Since many people with respiratory ailments cannot tolerate the sudden temperature changes that occur when entering on overheated bus from the cold outdoors, the shelter should be equipped with infra-red heaters which would add to the comfort of all passengers. The design and placement of the shelters should prevent them from trapping the people waiting in the splash of passing vehicles. Shelter structures should have route and schedule information systems and in some cases ticket-vending machines. Whatever the design of the shelter, it should have reserve space for a wheelchair.

personal safety provisions in waiting areas

Handicapped persons appear to be more conscious of hazards to their personal safety than are the able-bodied. The outside walls of bus shelters should be transparent to allow passers-by to see inside, reducing the dangers of both personal attack and vandalism. Shelters should be well lighted inside and out to prevent anyone from hiding in or behind them. This would also permit reading while waiting.

passenger convenience in waiting areas
Architectural barriers should be removed from waiting room areas, in compliance with the recommendations of the American Standards Association. Restroom should include at least one toilet compartment that is large enough to accomodate a wheelchair or person on crutches, and equipped with sturdy handrails in appropriate locations. Sinks and other conveniences should be within easy reach, generally not more than 40″ above the floor. At least some drinking fountains should have a side mounted hardware accessible to children and travelers in wheelchairs. Public telephones, too, should be within easy reach.

seating in waiting areas
Waiting and boarding areas should provide comfortable seating for all physically handicapped passengers. Arm rests should be placed so that weak persons or those with poor balance can easily sit and rise again. Chair backs and seats should be relatively straight, perpendicular to one another and parallel to the walls and floor, to make them easier for the disabled to use. Chairs should either be firmly mounted on the floor or walls, or have non-slip feet to prevent their sliding away from a person lowering himself with the support of the arms. If a bench is used instead of individual units, sturdy vertical stanchions running straight up from the front edge of the bench will provide a gripping surface over a wide range of heights.

guidelines for long walking distances

The long walking distances in most major terminals are difficult or impossible for about 16% of the handicapped. Three solutions are to shorten distances whenever possible, to provide personal locomotion for necessarily long distances, and to avoid needless walking by increasing pedestrian directional information.

auto parking and stopping
Long distances from parking areas, especially at airline terminals, add to the distance that must be covered within the building. Reserved parking spaces for disabled drivers have already been adopted at many locations. The cars of elderly and handicapped travelers, which in some states are identified by specially lettered license plates, could be turned over to parking attendants at the terminal door. Where parking is available only at considerable distance from the terminals, frequent and rapid barrier-free transportation should be provided from the parking lot.

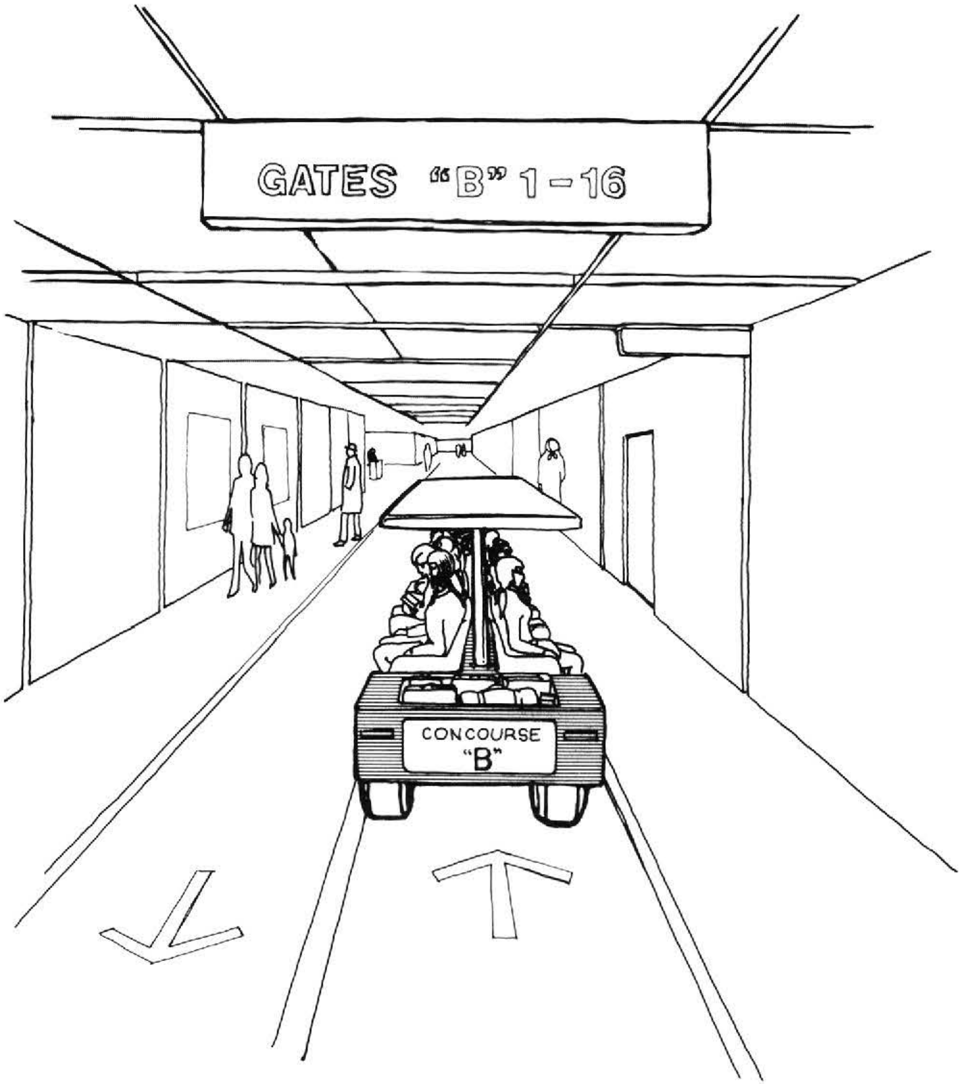
in-terminal transportation
Where long distances in terminals cannot be eliminated, some form of transportation within the building is desirable. Moving sidewalks have been installed in some terminals, which do assist most able-bodied passengers and their hand baggage. However, boarding poses problems similar to the escalator, and about 25% of the physically handicapped have difficulty using either of them.

Another suggestion for moving people within sprawling terminal complexes is an internal vehicular system to carry both passengers and their hand baggage to the boarding gate. These might be small, electrically-driven trains of rubber-tired vehicles similar to the Balade trains at Expo 67 in Montreal. The vehicles should be designed so that passengers can sit down and get up quickly to avoid delays at boarding areas and should have ample luggage compartments. These could be used in most existing terminals and would share the halls with passengers on foot, with the help of marked vehicle lanes.

bus redesign

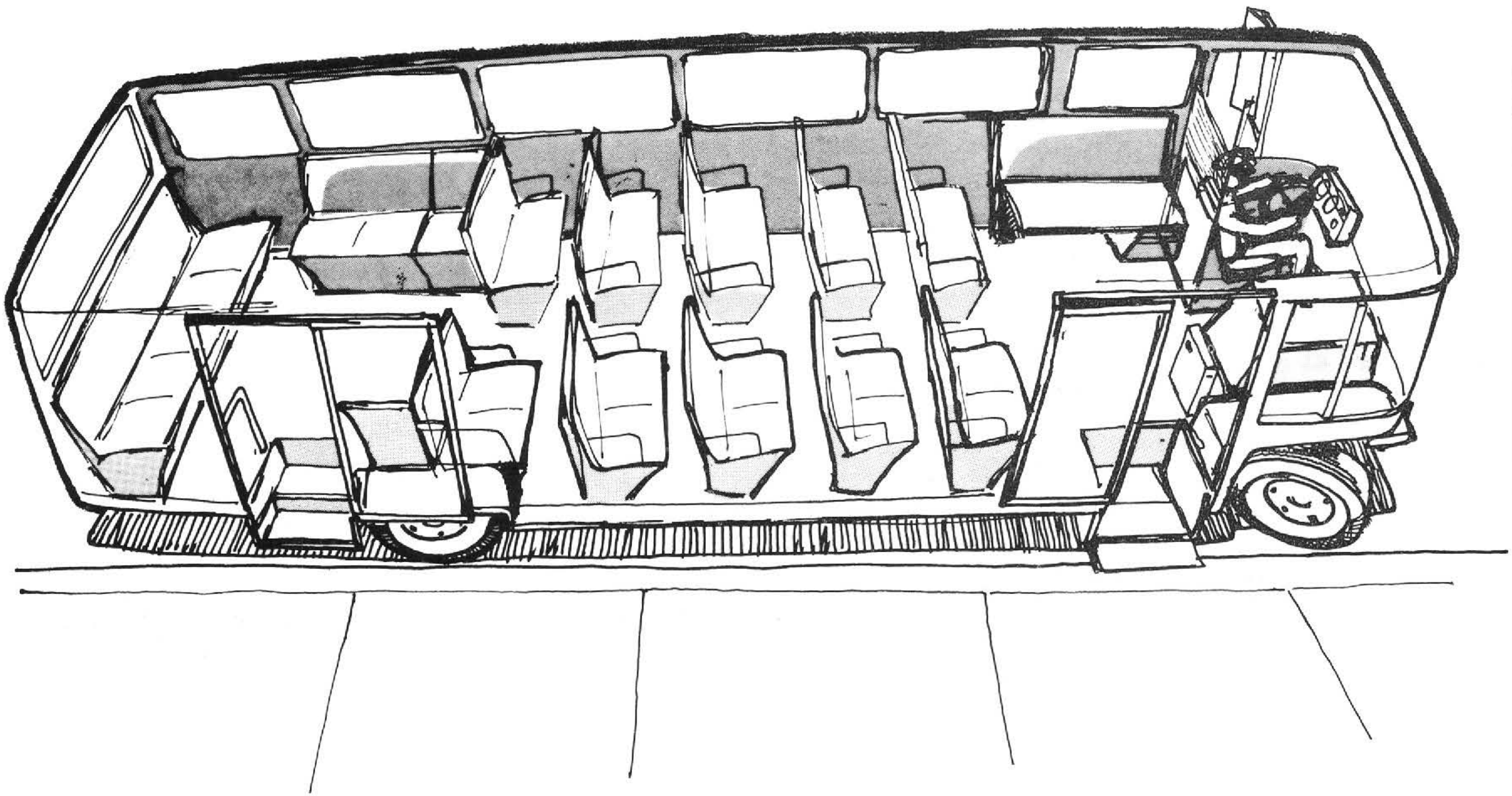
A significant amount of exploratory bus design work has been recently carried out by General Motors, the major bus manufacturer. The experimental RTX bus uses smaller tires to lower the vehicle, lowered entrance steps, and a number of other features which make the vehicle more attractive for all passengers. However, most of the changes in the RTX appear to be modifications of existing bus components(stairs, tires, seating, etc.), when a major rethinking of the overall design seems to be required.

The first target of a thorough redesign should be the height of the interior floor which is presently necessitated by drivelines, engine components, suspensions, and large wheels. Jounce room for the suspension of the solid rear axle connecting the back wheels is also a limiting factor. These problems suggest that the power train and accessory components should be relocated and that suspensions and wheel sizes should be changed. A front-mounted engine, driving the steering wheels as in a front-wheel drive automobile, would only have to share



ELECTRIC INTERIOR BUS IN TERMINAL

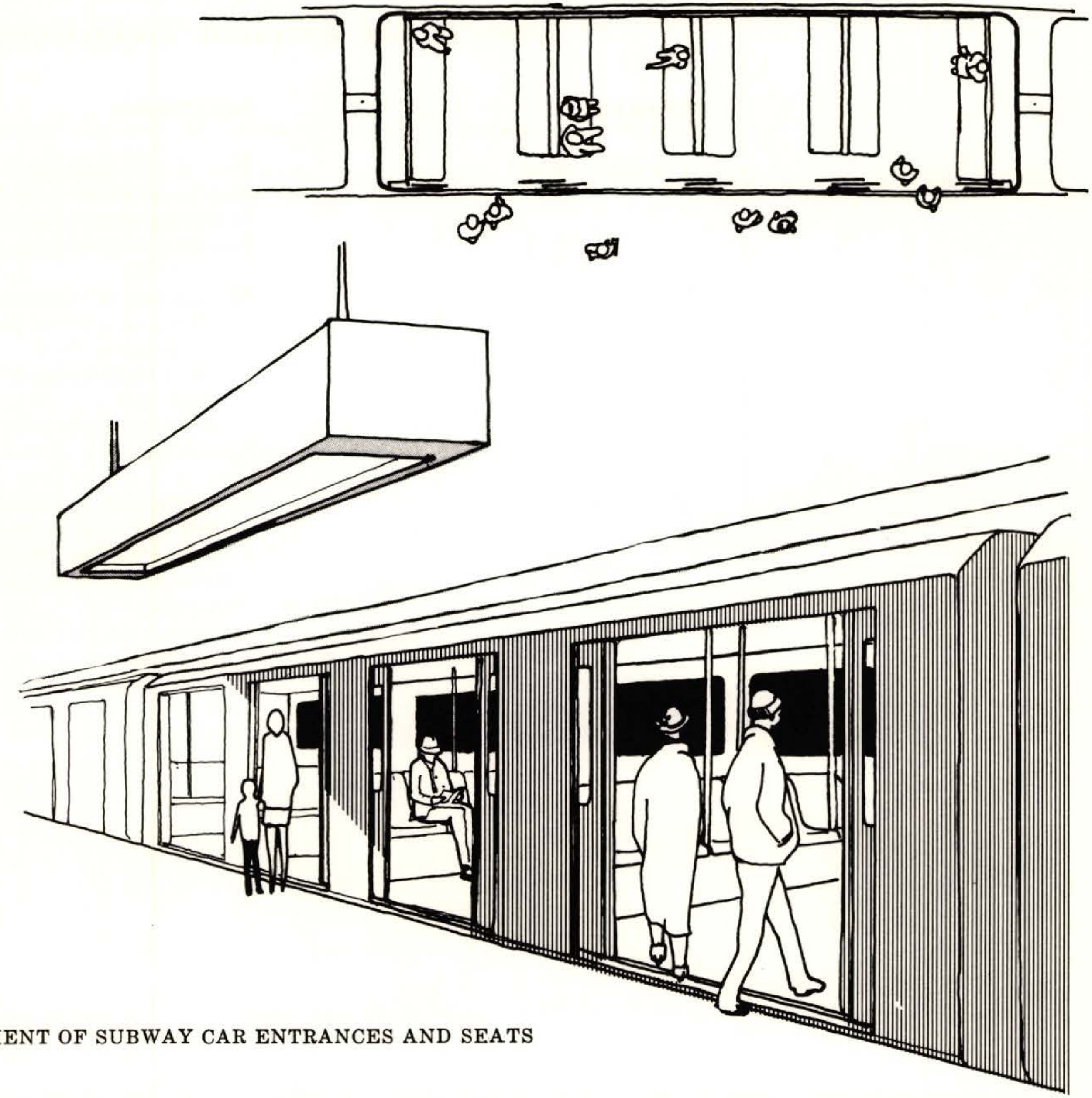
space with the driver and the entrance area. Smaller tires, independently suspended at the rear, requiring no cross-axle, would permit the floor to be lowered between them.



CONCEPT SKETCH: Urban Transit Bus

Subway and Elevated Train Guidelines

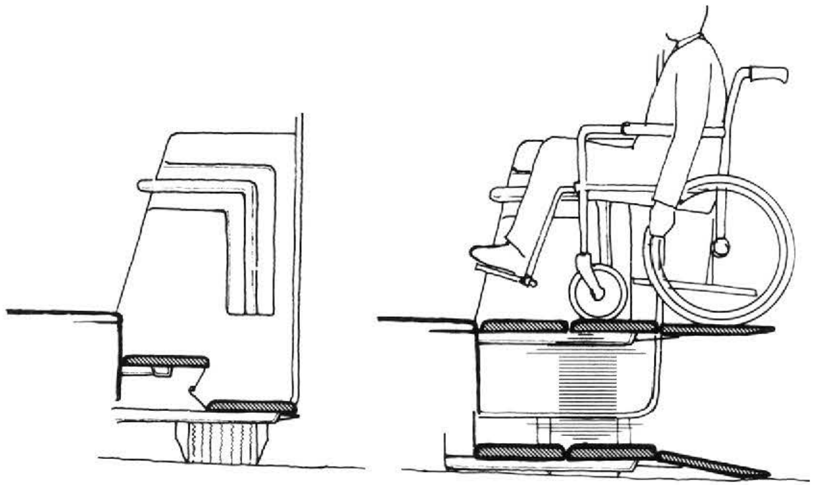
PROBLEM	SOLUTIONS
Sway, stop/start	New car suspension Improve roadbed and track Improve design of vehicle interior Improve smoothness of vehicle operation, switching Mechanical or electronic governor to regularize rate of acceleration and deceleration Vertical stanchions, within reach of every seat Prohibit standees near entrances Rearrangement of seats
Entry, exit bottlenecks	Redesign fare turnstile to eliminate push-bar, widen channel Pressure mats to open fare gates when coin is deposited, automate doors at exits Improve coin receiver to eliminate precision movements

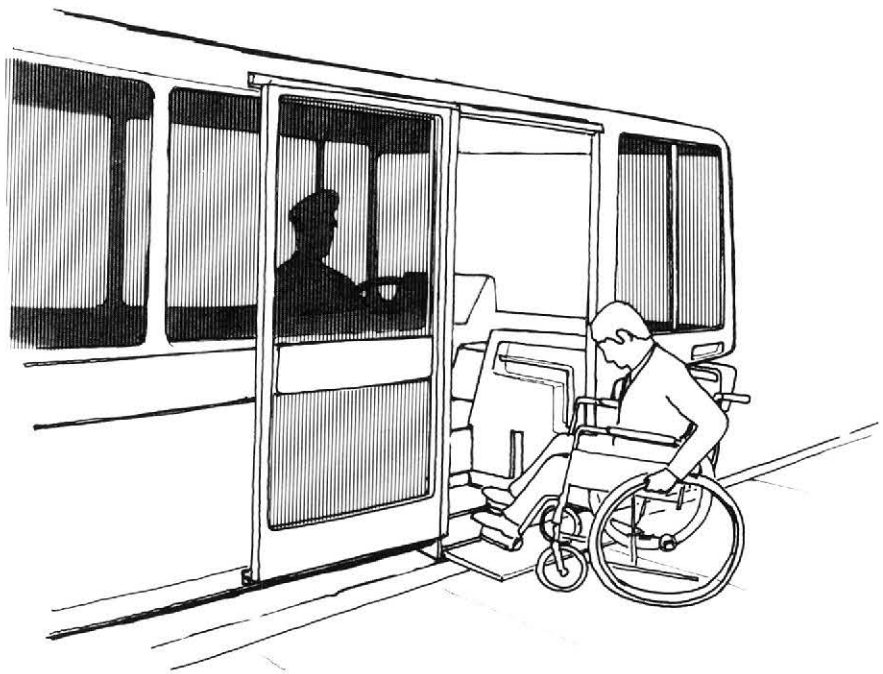


IMPROVED PLACEMENT OF SUBWAY CAR ENTRANCES AND SEATS

Bus and Trolley Guidelines

PROBLEM	SOLUTIONS
Sudden Movement	Special bus lanes to control traffic Pad hard interior surfaces to reduce accidental injuries Vertical floor-to-ceiling stanchions
Crowds	Limit bus seating Smaller buses with more frequent service Redesign fare turnstile to eliminate push-bar, widen channel Pressure mats to open fare gates when coin is deposited, automatic doors at exits Improve coin receiver to eliminate precision movements Modify bus to lower entrance, mechanize steps, add ramp or lift Provide raised platforms at bus stop Major redesign of bus
In-vehicle barriers	Pad hard interior surfaces Provide vertical stanchions for all seats Reserve seats near entrance Provide open space for wheelchair Widen aisles to ASA standards





POWERED LIFT IN
BUS FUNCTIONS AS
STEPS AND PLATFORM

Air Travel Guidelines

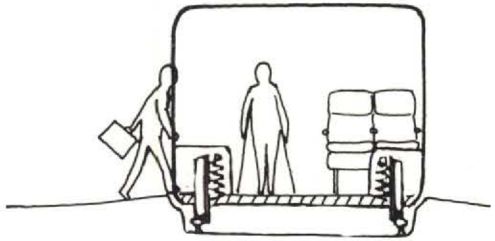
PROBLEM	SOLUTIONS
Terminal distances	Passenger transit systems in special lanes down all long corridors Mobile lounges Concentrate ticket counters Curb-side and parking lot baggage check Incorporate ASA standards in design of all new terminals
Enplaning/deplaning	Enclosed boarding walkways Height-adjusting mobile lounges Stair lift in boarding stairway
Baggage	Curb-side or parking lot check-in Baggage delivery to cabstand and parking lot Hand baggage storage on plane within easy reach
Plane interior barriers	Widen aisles and doorways to ASA standards Tie-down location near entrance for wheelchair Lower controls and call button Distinguish controls tactilely from each other Redesign washroom to include: Sufficient space for wheelchair Handles or rails for toilet transfer Application of ASA standards

Train Travel Guidelines

PROBLEM	SOLUTIONS
Terminal distances	Passenger transit systems in special down all long corridors Mobile lounges Concentrate ticket counters Curb-side and parking lot baggage check Incorporate ASA standards in design of all new terminals
Sudden Movement	Improve tracks and roadbeds Redesign car suspension Track-triggered curve warning system Vertical stanchions at intervals on aisles, or Handgrips on outer back corner of aisle seats Pad hard interior surfaces
Baggage	Baggage storage within reach of everyone Curb-side or parking lot check-in Baggage delivery to cabstand and parking lot Hand baggage storage on plane within easy reach
Vehicle entry-exit	Wider doors to ASA standards Provide wheelchairs in stations Extend handrails down to platform Provide lifts at each track
In-car Barriers	Apply ASA building standards for aisles, doors Remove outside arms on aisle seats for easy transfer from wheelchair Tie-down space near entrance for wheelchair Redesign washroom to include: Sufficient space for wheelchair Handles or rails for toilet transfer Application of ASA standards

POSSIBLE IMPROVEMENTS IN TRAIN BOARDING

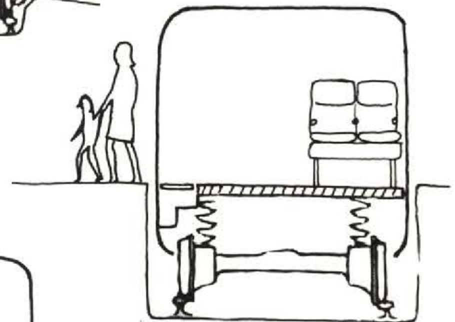
In descending order of probable cost

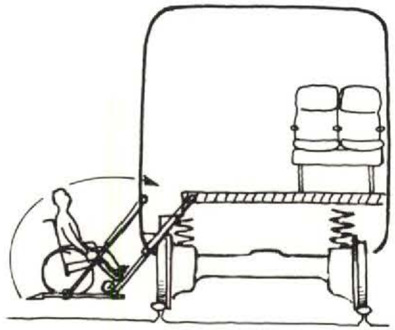


RADICAL RE-DESIGN OF SYSTEM

Lower car floors, reduce or eliminate boarding steps

PROVIDE RAISED PLATFORMS AT ALL STATIONS

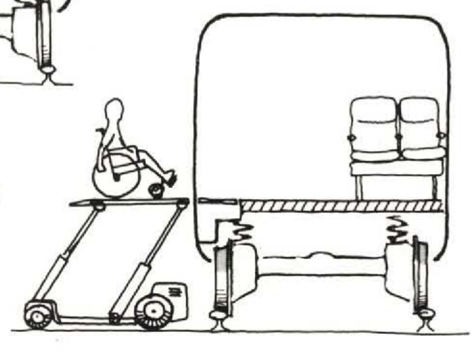




BUILD PLATFORM LIFT INTO CARS

Install in some or all vehicles

PROVIDE PORTABLE POWERED LIFTS AT ALL STATIONS



the alternattive of a specialized system

One alternative to modifying existing transit modes is the creation of a specialized system to serve the needs of all aging and handicapped travelers—even those handicapped by the circumstances of their traveling. While this is no substitute for planning accessibility in new sytems, under some circumstances it may provide the physically handicapped with access to employment, education and recreational opportunities that they might otherwise have been forced to ignore.

The specialized system appears to be desirable for a number of different reasons. First, the most important travel barriers to the handicapped are concentrated at access and transfer points, rather than in or at the vehicle itself. A specially equipped, dynamically-routed system with door to door service has the greatest potential for minimizing this problem and thereby providing travel opportunities for the largest number of handicapped. Secondly, cities of around 200,000 people, which are generally dependent on buses for public transportation, do not in fact have much control over the design of their transit system. The menu of interior components is limited, and consequently it is difficult for them to make their bus system accessible to the handicapped without comparible pressure from other cities in the same situation.

Preliminary analysis indicate that cities of this size can profitably operate a specialized "mini-bus" system for all the handicapped until such time as greatly modified buses or entirely new systems are tested and available. Specialized systems might also be instituted even in smaller cities with additional revenue-generating uses found for the vehicles during slack times, since it is important that the price of the ride be kept at a level that low income people can afford.

Vehicles for such a system would be small (4-5 passenger) "van" type models with flexibly equipped interiors and mechanical devices capable of accommodating a wide range of physical limitations with comfort for the passenger and efficiency for the operator. Skilled drivers are especially important, to minimize discomfort to passengers brought about by rapid acceleration and jouncing.

If such a system is to succeed, lessons should be learned from past efforts which have suffered from insufficient understanding of the nature and potential size of the market, ineffective and inefficient scheduling of vehicles, failure to make the services of the system known to the potential market by imaginative advertising, failure to exploit alternative uses of capital equipment and personnel to absorb overhead costs, and inadequate efforts to involve communities and their institutions in the operation or overhead support of these services. The firm or agency which will both meet the needs of the market and make a profit (or break even, in the case of a public agency) must be willing to risk capital and effort in surveying and analyzing the market, in equipping special vehicles to meet the demand and aggressively selling the services to the handicapped traveler. Research and analysis to date indicate that a specialized system responsive to the service needs and price constraints of the handicapped market can be operated at a profit.

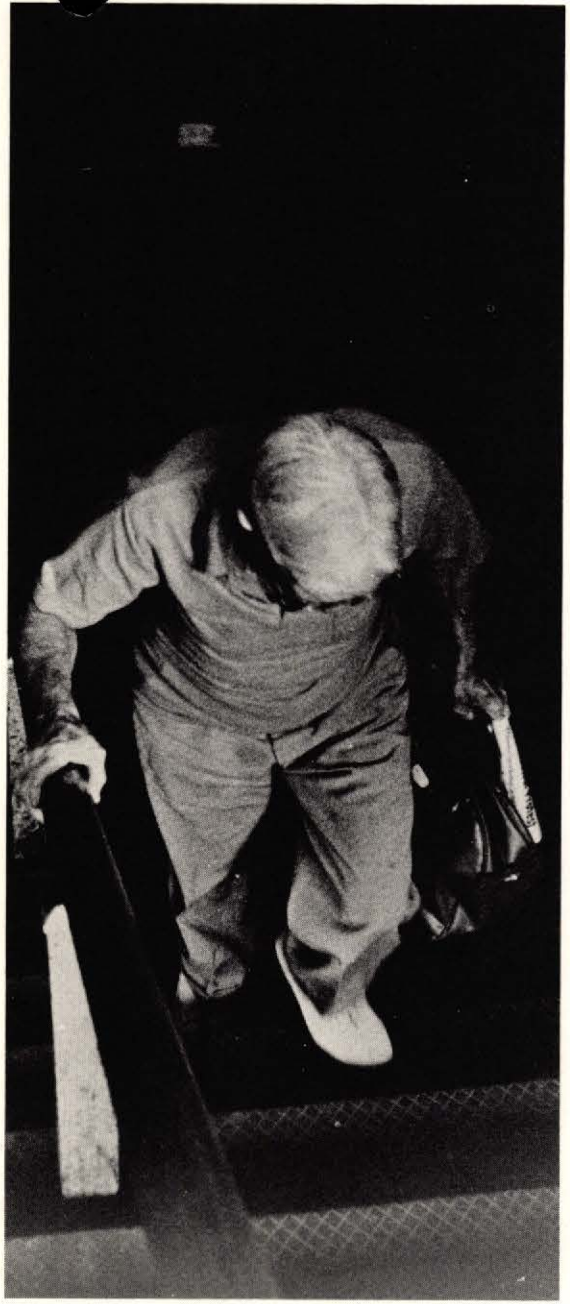
institutional constraints on change

There are presently major problems in implementing both the guidelines for existing modes and the specialized system, and these constraints will need to be lessened before any large-scale changes will take place. The manufacturers of vehicles and their components, the responsible transportation company or authority, and existing federal and state legislation all impede action on the proposed guidelines.

Major changes in vehicle design require a large investment which the manufacturers are not eager to make without guarantees of increased revenues. When a vehicle requires major alteration, as does the bus, the interrelated systems and components must be tested and re-tested in relation to each other as to performance standards. The cost of engineering time becomes a major expense, and hence a principal barrier to change.

The structure of the industry is another deterrent to action. While a larger share of the market might ordinarily be a strong incentive for any manufacturer to invest in product improvements, the largest bus manufacturers are already able to influence the market in such a way that is not advantageous for them to initiate the changes.

There is currently little demand for change being voiced by the local operators of transportation systems. Suffering from the same lack of information as equipment manufacturers, they must be content with the menu of hardware choices offered by the producers, somehow confident that the manufacturer is keeping up with developments in human engineering and product planning.



Federal legislation precluding capital grants for non-routed transportation systems will require amendment to facilitate the implementation of a specialized system on other than a demonstration basis. In some cases, State building codes pertaining to architectural barriers need specific reference to transportation terminals. Informed citizens review boards might be desirable to ensure code enforcement in situations where an assessment of accessibility to the handicapped is left to the discretion of the contractor.

V. selecting and applying the guidelines

All modes of public transportation contain a number of different barriers which impede the travel of physically handicapped and aging persons. Some of these barriers, such as sudden vehicle movement, discourage travel of a large percentage of the chronically handicapped (66%), while others, such as long walking distances, affect smaller segments of the population (16%). Some travel barriers can stop a handicapped traveler in his tracks, even though his trip may have been comfortable and convenient up to that point. Other barriers have a cumulative effect that can be tiring to the point of exhaustion. All of these factors must be considered when planning modifications or new systems that are accessible to the handicapped.

Since the handicapped generally have more than one of the functional disabilities identified earlier, and encounter more than one kind of travel barrier, it is necessary to eliminate the *combination of barriers* which bars the travel of the largest proportion of any local population. Even though long corridors are a problem for about 16% of the chronically handicapped, eliminating the need to walk such long distances will aid only 6% of this population unless other improvements are also made. Why? Because people who do not have the stamina required to walk long distances also have trouble with other actions—climbing stairs, moving rapidly, and waiting in line, for example. In order to make the system accessible to that 16% who cannot walk long distances, it is necessary to eliminate *all of the other barriers* that are associated with the disabilities of the people who make up that 16%.

The process of identifying and evaluating the most important combinations of guidelines is very complex. The Department of Transportation has therefore developed an analytical technique that is already programmed for computerized analysis to aid planners, designers and operators in selecting the set of guidelines most appropriate for their system. The program analyzes data from which the surveys undertaken during the contract research project which was keyed to the *Travel Barriers* film and calculates the relative effectiveness of removing all possible combinations of barriers. This computer program calculates the proportion of the physically handicapped population which would be able to use each transportation mode if each barrier combination were removed. These percentages appear in the following tables as effectiveness indices. To achieve each level of effectiveness, all of the barriers checked must be removed. More accurate effectiveness projections for local situations can be obtained by operating the program with local data. All of the materials necessary to conduct this research in your area are available from the Office of the Secretary of Transportation, 400 7th Street, S.W., Washington, D.C. 20590

SUBWAY BARRIERS

Effectiveness Index	Sudden Movement	Overhead Grip	Rapid Self Locomotion	Long Stairs	Movement in Crowds	Rise from Seat	Escalator	Turnstile	Short Stops	Long Walking Distances
97	x	x	x	x	x	x	x	x	x	x
84	x	x	x	x	x	x	x	x	x	
78	x	x	x	x	x	x	x	x		x
71	x	x	x	x	x	x	x	x		
71	x	x	x	x	x	x		x	x	x
64	x	x	x	x	x	x		x	x	
58	x	x	x	x	x	x		x		
58	x	x	x	x	x			x	x	x
51	x	x	x	x	x	x			x	
49	x	x	x	x	x			x		
45	x	x	x	x	x	x				
37	x	x	x	x	x					

Effectiveness Indices for Removing Selected Subway Barriers

BUS AND TROLLEY BARRIERS

Effectiveness Index	Sudden Movement	Ride Standing	Rapid Self Locomotion	Movement in Crowds	Wait Standing	Short Steps	Rise from Seat	Aisle Width	Long Walking Distances
99	x	x	x	x	x	x	x	x	x
84	x	x	x	x	x	x	x	x	
80	x	x	x	x	x	x		x	x
77	x	x	x	x	x	x			x
67	x	x	x	x	x	x		x	
61	x	x	x	x		x	x	x	
60	x	x	x	x	x		x		x
55	x	x	x	x	x		x		
51	x	x	x	x	x				x
48	x	x	x	x	x				
42	x	x	x	x			x		
35	x	x	x	x					

Effectiveness Indices for Removing Selected Bus and Trolley Barriers

TRAIN BARRIERS

Effectiveness Index	Sudden Movement	Baggage Storage	Rapid Self Locomotion	Long Stairs	Short Steps	Movement in Crowds	Rise from Seat	Aisle	Handrail on Steps	Long Walking Distances
99	x	x	x	x	x	x	x	x	x	x
80	x	x	x	x	x	x	x	x		x
76	x	x	x	x	x	x	x	x	x	
68	x	x	x	x	x	x	x			x
63	x	x	x	x	x	x	x			x
59	x	x	x	x	x	x				x
55	x	x	x	x		x	x			x
50	x	x	x	x		x				
44	x	x	x	x	x	x				
40	x	x	x		x	x		x		
35	x	x	x			x				x
28	x	x	x			x				

Effectiveness Indices for Removing Selected Train Barriers

AIRPLANE BARRIERS

Effectiveness Index	Long Stairs	Rapid Self Locomotion	Baggage Handling	Movement in Crowds	Escalator	Short Steps	Aisles	Long Walking Distances	Seating
94	x	x	x	x	x	x	x	x	x
86	x	x	x	x	x	x	x		x
80	x	x	x	x	x	x		x	x
77	x	x	x	x	x	x	x	x	
77	x	x	x	x	x		x	x	x
72	x	x	x	x		x	x	x	x
68	x	x	x	x		x	x		x
62	x	x	x	x	x			x	x
60	x	x	x	x			x		x
54	x	x	x	x			x	x	
50	x	x	x	x			x		
45	x	x	x	x	x				
40	x	x	x	x					

Effectiveness Indices for Removing Selected Airplane Barriers

VI. conclusions and recommendations

1. The travel barriers which presently pose the most difficulty for the handicapped are the dynamic, movement-oriented barriers which are characteristic of our present transportation systems: acceleration, crowds, time pressure, and jerking. Projections of future disabilities to 1985 indicate that the relative importance of these movement barriers will continue.

The significance of the movement-oriented barriers suggests that the most difficult transportation design and engineering problems will have to be solved before public transit will be routinely available to the physically handicapped. Hence, it is most important that the transportation systems that are now being planned incorporate the guidelines that are suggested here.

2. Although travel barriers which are architectural in nature exclude a smaller portion of the handicapped from public transportation than do the dynamic movement barriers, they are still of crucial importance. Designers of all new transportation systems should consciously eliminate any and all architectural barriers from their plans, and operators of existing systems should carefully review them for possible modifications. The combination of barriers eliminated should be selected so as to maximize the number of handicapped people helped, within the available budget.

3. Since the bus serves more areas than does the subway and would require fewer structural changes to make it accessible, it is the highest priority target for improvement. Unfortunately, a major redesign of the vehicle will be required. To correct the critical problems, such an effort should concentrate on lowering the height of the interior floor, decreasing acceleration, deceleration and swaying; widening the aisles; and supplying additional supports for standing passengers.

4. The success of a program to eliminate travel barriers will be greatly enhanced by an accompanying program to reach a larger proportion of the physically handicapped population with higher quality mobility training in rehabilitation institutions. A mobility program should concentrate on the specific, movement-related requirements of public transportation, such as balance, coordination, and movement in a moving environment. There is also a need for a comprehensive education program and public information campaign on handicapped mobility for the handicapped themselves, their families, the general public, for planners and designers, and for manufacturers and transportation system operators.

5. Since the development of new, accessible transportation systems will require long lead times and will apply to only a limited number of areas, other interim provisions must be made. A specialized, dynamically-routed transportation system for all the handicapped and aging appears to have many advantages which suggest that several demonstrations should be undertaken to test preliminary hypotheses about the price of the ride, driver training, size of the vehicle, extent of service, and effects of aggressive advertising. If such a system could indeed to operated without a loss, it is likely that it could be privately owned and managed, perhaps by an organization of the handicapped.

6. The guidelines given here and described in more detail in the technical report, *Travel Barriers*, should be reviewed by all communities for those which apply to their systems. Following the selection process, communities should outline a course of action and a strategy for applying the guidelines to rectify the problem. Without local community concern and action, the transportation needs of the handicapped will continue to go unmet.

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