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Cost Analysis of Alternative Transportation Systems for the Handicapped

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COST ANALYSIS OF ALTERNATIVE TRANSPORTATION
SYSTEMS FOR THE HANDICAPPED

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Project for Cost Benefit Analysis and Evaluation of Rehabilitation Services

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CONTENTS

FOREWORD

The transportation needs of the disabled are receiving increased attention in the 1970's. Mr. Jones' paper is one of the first attempts to estimate and compare the costs and benefits of the alternatives for increasing the mobility of the disabled. Too often in the past the legitimate concern for improving the transportation access of the disabled has prompted planners and program designers to opt for highly expensive adaptations of existing transportation systems even when cheaper alternatives providing even better transportation for many more disabled citizens were available. Mr. Jones' research analysis provides a helpful review concerning the transportation needs of the disabled, and his analysis and recommendations provide both useful information and excellent guidance for future planning and program design.

This paper was written by Mr. Jones in conjunction with a larger study of the nonemployment impacts of Federally-sponsored rehabilitation programs. Increased mobility was seen as a major benefit enjoyed by many disabled participants in such programs. The lack of mobility was seen as one of the major impediments to individuals sustaining employment and other gains they might achieve from rehabilitation. The studies have been funded by a grant from the Social and Rehabilitation Service of the U.S. Department of Health, Education and Welfare.

Portions of Mr. Jones study were provided at no cost to the Urban Institute consortium of research groups in their comprehensive study of the needs of the severely disabled, a study mandated by Congress and also funded by the Social and Rehabilitation Service.

The paper presented here is taken from the thesis submitted by Mr. Jones in partial fulfillment of the requirements for the Master of City Planning professional degree in the Department of City and Regional Planning at the University of California, Berkeley. Mr. Jones is currently engaged in doctoral studies in the Department of Urban Studies and Planning at the Massachusetts Institute of Technology.

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ABSTRACT

There are approximately 7,600,000 persons in the U.S. who suffer chronic mobility limitations as a result of physical disabilities. This paper discusses various ways of improving the mobility of these individuals, and analyzes the impact and cost of each alternative. The alternatives discussed are: curb modification, wheelchairs, modified automobiles and vans, fixed-route transit systems, demand-responsive systems, and mobility counseling.

The paper concludes that a national mobility-improvement program should include curb modification, door-to-door transportation service, the phasing-in of the "transbus," limited subsidies for modified automobiles and vans, and the provision of power wheelchairs and mobility counseling to those persons needing them. The analysis indicates that such a program would cost approximately $5.6 billion in the first five years and would return substantial social and economic benefits, including a $6.4 billion increase in the earnings of the handicapped.

The paper also concludes that retrofitting subways and buses, and building accessibility into new subway systems, are not cost-effective solutions to the mobility problems of the handicapped.

ACKNOWLEDGMENTS

The preliminary results of my research were originally reported in the Comprehensive Needs Study of the Severely Handicapped, prepared for the U.S. Department of Health, Education and Welfare by The Urban Institute (the prime contractor) and Berkeley Planning Associates (one of the subcontractors). Both of these organizations contributed significantly to this paper.

I am especially grateful to Todd Everett (Berkeley Planning Associates) for his generous assistance and invaluable contributions during the entire period of my research. I am also very grateful to Frederick C. Collignon (University of California) without whose encouragement and assistance this paper would not have been written.

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INTRODUCTION

In 1970 Congress enacted Section 16 of the Urban Mass Transportation Act, which states in part that "...handicapped persons have the same right as other persons to utilize mass transportation facilities and services..." Although Congress has recognized the need for changes in our transportation systems, the implementation of this policy has proceeded quite slowly. As late as 1974, Falcocchio stated in his book, Transportation and the Disadvantaged, that "...we have seen an almost complete neglect of [the handicapped] by the government."[1]

Of all disadvantaged groups, the handicapped are the most seriously transportation disadvantaged. They are restricted in their use of transportation services not only by their physical or mental disabilities but also by concomitant economic disabiiities. Being handicapped usually also means being poor, since the handicapped's ability to earn a living is impaired and they incur high medical expenses and other disability-related expenses. Thus, the handicapped need low-cost transportation as well as physically accessible transportation. But very little accessible transportation is available, and the combination of accessibility and low cost is practically nonexistent. This means that many handicapped persons are effectively barred from employment, social and recreational activities, and educational pursuits. Most important, it means they are denied the independence and the ability to participate in and enjoy the normal activities of daily living which they desire and are otherwise capable of achieving.

Although it is true that adequate transportation will not by itself overcome all of the barriers to independent living, it is an essential first step in integrating the handicapped into society, a step without which other efforts may be fruitless. It is not uncommon, for instance, for an individual to go through a costly vocational rehabilitation program and then find that mobility barriers make it difficult or impossible to get to work. (According to a study by Abt Associates, 14 percent of the persons who complete a vocational rehabilitation program and obtain employment, later become unemployed because of transportation problems, and 16.5 percent of all persons who have received vocational rehabilitation services are unemployed because of transportation problems.[2]) Likewise, the removal of architectural barriers from stores or sports arenas is of no benefit to the person trapped at home by mobility barriers.

The mobility barriers to which I refer are situations in the environment or within various modes of transportation which seriously impede or prohibit the handicapped from traveling between one location and another. Many of these barriers result from the physical or operational characteristics of transportation systems. Physical barriers include such things as level changes, long walking distances, inadequate protection from weather, unreachable or inadequate supports in vehicles, and lack of space for wheelchairs. Operational barriers include sudden acceleration, short pedestrian signals, infrequent schedules, and complex routing. There also exist psychological barriers such as the handicapped's lack of self-confidence, inadequate expectations, and anxiety about crowds, safety and time pressures. In addition, there is the economic barrier previously mentioned. The handicapped are much poorer than the general public (52 percent of the handicapped have annual incomes of less than $4,000 compared with 21 percent of the total population[3]) and they must pay more for transportation than the nonhandicapped. Transportation expenses of forty to sixty dollars per week are not uncommon, since the handicapped are often restricted to expensive specialized transportation services.[4] For instance, 14 percent of the trips taken by the handicapped are by taxicab compared with 2 percent of the trips by the nonhandicapped,[5] and the proportion of taxicab trips by the severely handicapped who are unable to use public transit may be as high as 35 percent.[6]

The removal of these mobility barriers could have a profound impact on the lives of the handicapped. A survey of handicapped and elderly persons by Abt Associates indicated that if an accessible transportation system were available at "no cost" these persons would make 50 percent more medical trips, 82 percent more shopping trips, 85 percent more church trips, and 111 percent more social/recreational trips.[7] In another survey by Abt Associates, 13 percent of the unemployed handicapped said they were unemployed because they had no way to get to work; 16 percent said their unemployment was due to the high cost of transportation; and 42 percent said it was too difficult to get to work and back.[8]

The need for removal of mobility barriers and the various policy issues involved are not extensively discussed in this paper, since they have been the focus of much of the literature within the past few years. What has been missing in the literature is an effort to estimate the costs of alternative solutions to the mobility problems faced by the handicapped. This paper attempts to fill that void by presenting basic cost estimates which provide a starting point from which more sophisticated cost analyses may proceed. In the first chapter the handicapped population is identified and categorized according to various mobility criteria. The second chapter discusses alternatives which may improve the mobility of the handicapped and presents the unit-cost of each alternative. In the third chapter, population data from the first chapter and unit-cost data from the second chapter are used to calculate aggregate cost estimates for each alternative. These costs are then summarized in Table X at the end of Chapter 3. Immediately following Table X are tables which present the costs of five possible national mobility improvement programs. Chapter 4 is a brief discussion of the benefits which might be realized if a national program were implemented. The last chapter presents the policy issues and conclusions which arise from this study.

CHAPTER I

THE TRANSPORTATION HANDICAPPED

The transportation handicapped are those persons who have some chronic or acute (temporary) condition which makes it more difficult, or impossible, for them to travel and use various transportation services than would otherwise be the case. Chronic conditions include such disabilities as blindness, paralysis, and arthritis. An acute condition is one which lasts less than three months, such as a broken leg. In addition to the chronically and acutely disabled, there are at any given time millions of persons who are voluntarily transportation handicapped, i.e., persons pushing baby carriages, carrying bulky packages, etc. This study concentrates on ways of improving the mobility of the chronically handicapped; however, as will later be seen, many of the alternatives discussed would also improve the mobility of the acutely handicapped and even the voluntarily handicapped.

Estimates of the transportation handicapped population vary according to the particular data base and approach used. Table I presents 1975 estimates of the population using the 1970 data provided by the Transportation System Center (TSC) in its publication titled, The Handicapped and Elderly Market for Urban Mass Transit.[9] Table II presents 1975 estimates of the transportation handicapped using 1972 data from the Health Interview Survey conducted under the auspices of the National Center for Health Statistics (NCHS). Table III presents in

TABLE I

Number of Handicapped Persons with Transportation Dysfunctions

United States, 1975

Handicap Class	Under Age 65	Over Age 65	Totals
Noninstitutionalized			
Chronic Conditions			
Visually impaired	525,000	1,606,000	2,131,000
Deaf	191,000	154,000	345,000
Uses special shoes	2,165,000	371,000	2,536,000
Uses cane	487,000	1,916,000	2,403,000
Uses crutches	310,000	161,000	471,000
Uses walker	55,000	388,000	443,000
Uses manual wheelchair	165,000	254,000	419,000
Uses power wheelchair*	37,000	--	37,000
Uses leg or foot brace	200,000	55,000	255,000
Uses artificial leg or foot	113,000	13,000	126,000
Other mobility limitations	1,824,000	1,695,000	3,519,000
Acute Conditions	408,000	101,000	509,000
Institutionalized**	28,000	1,021,000	1,049,000
Totals	6,508,000	7,735,000	14,243,000

*The split between manual and power wheelchairs is based on the FY74 production ratio of Everett & Jennings, Inc., the largest manufacturer of wheelchairs in the U.S. (E & J has approximately 70 percent of the market.) Power wheelchairs are purchased almost exclusively by persons between the ages of 18 and 50.

**Does not include mentally ill or mentally retarded.

Sources: Transportation Systems Center, The Handicapped and Elderly Market for Urban Mass Transit, prepared for the Urban Mass Transportation Administration, October 1973. Figures were updated to 1975 by using U.S. Bureau of the Census, Population Estimates and Projections, Series P-25, No. 493 (December 1972), No. 519 (April 1974), and No. 529 (September 1974). Series F fertility assumptions were used since these are most consistent with latest population estimates given in No. 529.

TABLE II

Number of Handicapped Persons with Mobility Limitations

United States, 1975

Handicap Class	Has Trouble Getting Around Alone	Needs Help in Getting Around	Confined to Home	Totals
Noninstitutionalized				
Chronic Conditions				
Arthritis & Rhuematism	687,000	522,000	250,000	1,459,000
Impairments (except paralysis & absence) of lower extremities and hips	287,000	316,000	108,000	711,000
Heart Conditions	207,000	83,000	286,000	576,000
Cerebrovascular disease	118,000	138,000	156,000	412,000
Paralysis, complete or partial	82,000	140,000	72,000	294,000
Musculoskeletal disorders	139,000	68,000	43,000	249,000
Visual impairments	58,000	99,000	47,000	204,000
Circulatory disorders	97,000	49,000	45,000	191,000
Impairments of back	94,000	50,000	22,000	166,000
Old Age (condition not specified)	45,000	67,000	40,000	152,000
Emphysema	71,000	9,000	70,000	150,000
Mental or nervous conditions	44,000	8,000	69,000	121,000
Hypertension	52,000	*	*	107,000
Diabetes	46,000	*	*	107,000
Malignant neoplasms	*	*	57,000	104,000
Asthma	*	*	41,000	65,000
Digestive disorders	*	*	*	55,000
Varicose veins	*	*	*	46,000
Respiratory disorders	*	*	*	43,000
Other chronic conditions	*	*	*	1,375,000
Acute Conditions	N/A	N/A	N/A	509,000
Institutionalized**	--	--	1,049,000	1,049,000
Totals	2,661,000***	2,115,000***	2,860,000***	8,145,000

* Figure does not meet standards of reliability or precision (more than 30 percent relative standard error).

** Does not include mentally ill or mentally retarded.

*** Does not include acute conditions.

Table II Sources: U.S. Department of Health, Education and Welfare, National Center for Health Statistics, Limitation of Activity and Mobility Due to Chronic Conditions, United States - 1972, Series 10, No. 96, November 1974. Estimates for 1975 were derived from U.S. Bureau of Census, Population Estimates and Projections, Series P-25, No. 493 (December 1972). Fertility assumptions are from Series F. Acute and institutionalized data are from Table I of this paper.

TABLE III

Number of Handicapped Persons with Chronic Mobility Limitations

United States, 1975

Degree of Limitation	Under Age 17	17-64	65 and Over	Totals
Has Trouble Getting Around Alone	74,000	1,413,000	1,174,000	2,661,000
Needs Help in Getting Around:				
Special aid	40,000	493,000	1,001,000	1,532,000
Another person	45,000	186,000	353,000	583,000
Confined to Home:				
Not confined to bed	30,000	522,000	803,000	1,355,000
Confined to bed	9,000	202,000	246,000	457,000
Institutionalized*	N/A	N/A	1,021,000	1,049,000
Totals	198,000**	2,815,000**	4,597,000	7,636,000

* Does not include mentally ill or mentally retarded.

** Does not include institutionalized.

Sources: U.S. Department of Health, Education and Welfare, National Center for Health Statistics, Limitation of Activity and Mobility Due to Chronic Conditions, United States - 1972, Series 10, No. 96, November 1974. Estimates for 1975 were derived from U.S. Bureau of Census, Population Estimates and Projections, Series P-25, No. 493 (December 1972). Fertility assumptions are from Series F. Acute and institutionalized data are from Table I of this paper.

somewhat different form the same data as in Table II, omitting acute conditions.

The totals shown in Table I are considerably higher than those given in Table II. Since the data in both tables were taken from the same NCHS survey, the differences do not have to do with noncomparable data bases, but rather with the fact that the two tables focus on different things. Specifically, Table II contains only those persons who reported that they had a limitation in mobility, whereas Table I contains all of the visually impaired (including the nonseverely impaired), all of the deaf, and all persons who use special aids. However, not all of these persons have limitations in mobility; compare, for instance, the number of visually impaired in Table I (2,131,000) with the number of visually impaired with mobility limitations in Table II (204,000). Also, the fact that a person wears special shoes may not be any indication that he or she is limited in mobility.

In addition, the categories in Table I are not consistent, i.e., diagnostic conditions such as blindness and deafness are mixed with other characteristics such as a person's use of certain aids. This lack of uniformity in the categories may result in double counting; many of the blind for instance use canes. It also should be noted that some double counting of acute conditions probably occurs in Table I since the mobility aids used by persons with acute conditions are included in the totals for chronic conditions. In Tables IV and V, I have distinguished between the chronically handicapped's and the acutely handicapped's use of mobility aids, listing those aids which would appear to be indicators of mobility limitations.

TABLE IV

Number of Noninstitutionalized Handicapped Persons with Chronic Mobility Limitations by Selected Mobility Aids

United States, 1975

Mobility Aid Used	Under Age 65	65 and Over	Totals
Cane	460,000	1,910,000	2,370,000
Crutches	261,000	147,000	408,000
Walker	26,000	381,000	407,000
Manual Wheelchair	139,000	248,000	387,000
Power Wheelchair	37,000	--	37,000
Leg or Foot Brace	194,000	53,000	247,000
Artificial Leg or Foot	113,000	13,000	126,000
Totals	1,230,000	2,752,000	3,981,000

Sources: U.S. Department of Health, Education and Welfare, National Center for Health Statistics, Use of Special Aids, United States - 1969, Series 10, No. 78, December 1972; plus sources listed for Table I. Nonreported conditions are attributed proportionately to chronic and acute conditions; for wheelchairs and walkers the chronic-acute use ratio for crutches is used. The use of each aid by those persons under age 65 with chronic conditions is assumed to be proportional to the total number of persons under age 65 with chronic conditions.

TABLE V

Number of Noninstitutionalized Handicapped Persons with Acute Mobility Limitations by Selected Mobility Aids

United States, 1975

Mobility Aid Used	Under Age 65	65 and Over	Totals
Cane	27,000	7,000	34,000
Crutches	49,000	13,000	62,000
Walker	29,000	8,000	37,000
Manual Wheelchair	26,000	7,000	33,000
Power Wheelchair	--	--	--
Leg or Foot Brace	6,000	2,000	8,000
Artificial Leg or Foot	--	--	--
Totals	137,000	37,000	174,000

Sources: U.S. Department of Health, Education and Welfare, National Center for Health Statistics, Use of Special Aids, United States - 1969, Series 10, No. 78, December 1972; plus sources listed for Table I. Nonreported conditions are attributed proportionately to chronic and acute conditions; for wheelchairs and walkers the chronic-acute use ratio for crutches is used. The use of each aid by those persons under age 65 with acute conditions is assumed to be proportional to the total number of persons under age 65 with acute conditions.

Table IV would seem to indicate that the estimates in Table III are too conservative if one compares the use of special aids. But many of the people in Table III who need the help of another person to get around or who are confined to home but not to bed undoubtedly also use special aids. However, even if one assumes that all of these persons use special aids, the total use of special aids in Table III (3,470,000) would still be less than that in Table IV (3,981,000). This discrepancy is probably in large part due to the fact that the figures in Table IV include occasional as well as frequent use of each aid. Many persons who use a cane only occasionally may not feel, and in fact may not be, limited in mobility or restricted in their use of transportation systems.

Table V should not be interpreted as representing the number of persons with acute mobility limitations since many persons with acute conditions do not use mobility aids. Table VI represents one method of estimating the acutely transportation handicapped population; however, it does not include all conditions causing acute disability and many of the individuals included could not be considered transportation handicapped. For the purposes of this study, TSC's data has been used to estimate 509,000 persons with acute mobility limitations.

The 1966 Social Security Survey of Disabled Adults indicates that the handicapped population of the U.S. is much larger than is indicated by the NCHS data. However, it is difficult to extract from the Social Security data the number of handicapped who are transportation handicapped. It therefore is not clear that the actual number of transportation handicapped would be any higher using the Social Security data base rather than the NCHS data base. For this reason, and since the

TABLE VI

Number of Noninstitutionalized Persons with Acute Conditions Other Than Illness

United States, 1971

Acute Condition	1971 Incidence	Average # of Days Restricted Activity per Incident	Average # of Days Confined to Bed per Incident	Average # of Persons at Any Given Time Restricted in Activity But Not Confined to Bed
Fractures & Dislocations	6,482,000	19.20	5.50	243,300
Sprains & Strains	14,142,000	5.41	1.25	161,200
Open Wounds & Lacerations	18,731,000	3.12	.79	119,600
Contusions & Superficial Injuries	13,199,000	3.80	1.23	92,900
Other Injuries	13,597,000	5.07	2.25	105,000
Totals	66,152,000	5.72	1.74	722,000

Source: U.S. Department of Health, Education and Welfare, National Center for Health Statistics, Current Estimates from the Health Interview Survey, United States - 1971, Series 10, No. 79, February 1973.

NCHS survey is more recent, the NCHS data has been used, even though it may understate the population to some degree.

Based partly on the NCHS data and partly on the TSC report, Figure 1 presents my estimates of the numbers of chronically handicapped who can and cannot drive and who can and cannot presently use public transit.* Figure 1 indicates that there are 727,000 urban handicapped persons who could use existing transit service if vehicle modifications were made and 585,000 who could use public transportation if it operated within two blocks of their homes. An additional 485,000 persons need both expanded service and modified vehicles.

In addition to the urban handicapped population, there are 3,360,000 transportation handicapped persons living in nonurban areas. Of these, 1,149,000 could use public transportation if it were provided and an additional 952,000 could use the service if it were operated with modified vehicles.

The "cannot go out" population in Figure 1 is comprised of those persons who are institutionalized or confined to home (see Table III). It should be noted, however, that there is demand for improved transportation service among the institutionalized population. Many persons are

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*The primary data source for Figure 1 is the TSC report. However, TSC used a chronically handicapped population of 13,752,000 compared to the estimate of 7,636,000 used in this study. To reconcile this the difference of 6,116,000 is assumed to represent the least handicapped and the percentage of those 6,116,000 who are drivers is assumed to be the same as the national percentage (55 percent) of those over 64 (the handicapped - over 50 percent of whom are elderly - have driving characteristics similar to the elderly). Applying the rate of 55 percent to the 6,116,000 it is estimated that 3,364,000 of the persons included in TSC's estimate but excluded from Table II are drivers. Subtracting this number from TSC's estimate of 4,126,000 handicapped drivers, it is estimated that Table II included 762,000 drivers. This represents 10 percent of the chronically handicapped population used in ([illegible]) institutionalized because of their need for special medical treatment or other personal services at particular times of the day but are quite capable of independent travel at other times if provided with appropriate transportation service. It is also quite likely that many persons are confined to home due to the lack of suitable transportation.

In summary, the number of handicapped persons who could benefit from improved transportation includes 6,232,000 chronically handicapped, many of the 509,000 acutely handicapped, some of the 1,404,000 persons in institutions or "confined to home but not to bed," and millions of the voluntarily handicapped. In the next chapter various ways of improving transportation for these persons are examined in detail.

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this study, which appears to be quite reasonable considering that it is a much more severely handicapped population than TSC's population, which has a 30 percent driver rate.

TSC's "can use/cannot use" percentages also have been adjusted to reflect the nature of the population used in this study. TSC's "can use" estimate of 72 percent has been applied to the handicapped driver population since it is known that most but not all handicapped drivers can use public transit. However, for the nondriver population 30 percent instead of 72 percent was used. This was calculated by taking TSC's estimate of 5,022,000 chronically handicapped who cannot use transit, subtracting from it this study's estimate of the number of drivers who cannot use transit (214,000), and then dividing the result by this study's estimate of 6,872,000 nondrivers. The resulting percentage seems to be about what one would expect for this population.

CHAPTER II

ALTERNATIVES

The transportation disabilities of the handicapped range from minor difficulty in walking long distances to being permanently confined to bed. The wide range of mobility problems presented by these disabilities does not lend itself to solution by any single alternative. The best solutions will vary from city to city and from individual to individual. Solutions involving fixed-route transit systems may be the most feasible in those cities which presently have extensive transit service and which have traditionally sought transit solutions to transportation problems (e.g., San Francisco, Boston, New York). In large, automobile-oriented* cities (e.g., Los Angeles, Salt Lake City, Jacksonville), as well as in small cities and rural areas, solutions involving demand-responsive systems or personal vehicles may be more feasible. This type of differentiation, however, gives only a general idea of where the major emphasis should be placed. The individual needs of the handicapped will vary so widely in any given locality that in most cases a combination of alternatives will be needed.

There are obviously hundreds, if not thousands, of modifications which would improve the usability of various transportation systems. These include minor modifications, such as more grab handles inside

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*For a discussion about this distinction see: The Handicapped and Elderly Market for Urban Mass Transit.

buses and increased pedestrian time in traffic-signal cycles, and modifications designed to meet the needs of specific types of disabilities, such as audio signals for the blind. However, this paper takes a rather broad brush approach to mobility problems and discusses more generalized alternatives. These alternatives are designed to overcome the mobility problems common to a wide range of disabilities. None of these alternatives nor any combination of them would provide an ideal transportation system for the handicapped, but they do have the potential for overcoming the most serious mobility barriers and for providing a basic, accessible transportation system to which marginal modifications can easily be added. These alternatives, which are discussed in the following sections, are: curb modification, wheelchairs, automobiles and vans, fixed-route transit systems, demand-responsive systems, and mobility counseling.

CURB MODIFICATION

Curbs are an insurmountable barrier to most individuals in wheelchairs, to many persons who use walkers and braces, and to numerous other handicapped persons. Curbs are also, at best, an inconvenience to those persons pushing baby carriages and shopping carts. The significance of this barrier is well illustrated by the fact that, despite the millions of dollars spent making the San Francisco BART system internally accessible to the handicapped, many of them still cannot use it because curbs prevent them from getting to and from the stations.

Since persons in wheelchairs are the ones most obviously impeded by curbs, there have been some efforts to overcome this barrier by developing a curb-climbing wheelchair (see next section). However, the only approach which has gone beyond the prototype stage and which benefits all persons impeded by curbs is the construction of curb cuts or curb ramps.* This approach has been used in relatively few cities thus far, but in some of those it has been used quite extensively. Minneapolis, for example, had constructed over 10,000 curb cuts as of April 1975.[10]

In cities where extensive curb-modification programs have been instituted, the usual approach has been to modify all curbs in heavily traveled areas, to modify selected curbs in other areas to provide barrier-free paths to shopping areas, etc., and to build curb cuts into all new curbs. Also, most cities have chosen to cut existing curbs rather than ramp them, even though it is more expensive,** since ramps protrude into the street and interfere with traffic, drainage, and street cleaning. There also is the danger of slipping off a ramp since it is basically a convex pathway, whereas a curb cut is a concave pathway. Using curb cuts, Minneapolis has experienced "...no problems of safety, snow removal, water drainage, or street cleaning", according to Minneapolis

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*A curb "cut" is a ramp built into a curb and the adjacent sidewalk, creating a scooped-out effect in the sidewalk. A curb "ramp" is a ramp built from the curb out into the street; the curb and the sidewalk themselves are not modified.

**The experience of the City of Berkeley, California indicates that ramping costs approximately $50 and that cutting costs between $150 and $200. (Economies of scale reduce the cost per cut to the $150 figure when a major curb-cutting program is undertaken.) The ramping cost includes approximately $10 of materials and 7 hours of labor. The cutting cost includes approximately $25 of materials (one-half yard of concrete) and 26 to 30 person-hours of labor with a four-person crew. Building a curb cut into a curb when it is originally laid costs no more than conventional curbing. (Gene Davidson, Engineering Office, Department of Public Works, City of Berkeley, California, personal communication, October 1974.)

Alderman Vern Anderson.[11] Of course, when a sidewalk is so narrow that a curb cut would interfere with normal use of the sidewalk, it may be necessary to use a ramp or a combination curb cut-curb ramp.

In a few cities curb modification has been delayed at the urging of the blind. Level changes are important location indicators for the blind, and when there is no discernable difference between the sidewalk and the street a potential safety hazard exists. This hazard has been reduced in some cities by offsetting the curb cuts so that they are not directly in line with the main flow of sidewalk traffic. This, however, does increase the hazard to the user of the curb cut since the offset location may require entering the street outside the normal crosswalk. In Figure 2, for example, if curb cuts "A" and "B" were offset to positions "C" and "D" the user would lose the protection of the crosswalk unless it were widened.

Partly because of the hazard to the blind, but primarily because of the expense, most cities have limited their curb cutting to four cuts per intersection (see Figure 2) rather than eight (see Figure 3). Although this provides complete access, it exposes the persons using the curb cuts to greater danger from vehicular traffic. In Figure 2, for example, to cross from corner "I" to corner "II" with the pedestrian signal a user of the curb cuts would have to make part of the trip in the street on which traffic is flowing. (The path from corner "I" to corner "II" is indicated by the dotted line in Figure 2). At the intersection of lightly traveled streets one curb cut per corner may be sufficient. But at busy intersections two curb cuts per corner probably are needed.

It is possible to reduce the exposure to traffic using one curb cut per corner if the curb cut is located on the apex of the corner (see Figure 4). However, such a location is more of a hazard to the blind than an offset location, and it still places the user dangerously close to the traffic stream.

Curb modification is an essential element in any mobility-improvement program. Unless curbs are modified many of the handicapped, particularly those in wheelchairs, will continue to be unable to cross the street to visit their neighbors and, perhaps equally important, they would be unable to utilize fully the transportation modes discussed in the next four sections.

WHEELCHAIRS

Due to the physical strength and stamina requirements on the user, many of the handicapped cannot propel a manual wheelchair, and those who can normally use them for travelling only very short distances, usually of no more than a block or two. Electric powered wheelchairs, on the other hand, are often used for intermediate distance travel of up to a few miles* as well as for short distances. In addition to increasing the range of travel, the development of the power wheelchair has provided a means of independent travel for many quadriplegics and other previously homebound persons. Of course, the utility of a power wheelchair is somewhat dependent upon the local terrain and climate. The flat terrain of south Florida, for example, is more amenable to

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*The typical power wheelchair will travel four to five miles at three miles per hour on a battery charge and there are advanced models on the market which will travel up to 25 miles at nine miles per hour on a single battery charge. (Everett & Jennings, Inc., wheelchair manufacturers, personal communication, Los Angeles, California.)

wheelchair use than the hills of San Francisco or the icy sidewalks of northern cities.

Although wheelchair technology has continued to improve, it has not kept pace with the mobility demands placed upon the power wheelchair and, consequently, the wheelchair has not made a totally successful transition from an indoor to an outdoor vehicle. Mechanical failure and the resultant immobility while waiting (frequently as long as a week) for repairs to be made is commonplace, and of course exposure to the weather is a continual problem for the user.

Recent research efforts have included attempts to develop a curb-climbing wheelchair and a wheelchair which can be mechanically lifted into the driving position in an automobile, but to date the results have not been promising and the cost appears to be quite high. The development of one prototype in California indicates that curb-climbing capability would add about $2000 to the cost of a manual wheelchair (typical cost is about $500) and $1500 to the cost of a power wheelchair (typical cost is $1500 to $2000 depending upon the accessories needed).[12] The initial estimates for a design being developed at the University of California in Berkeley, which permits an automobile to be driven by a person sitting in a wheelchair, are that the wheelchair would cost approximately $4000* and that the cost of the mechanical lift to be installed on the automobile would be approximately $3000.[13] Although cost is certainly an inhibiting factor, the greatest concern of wheelchair users is that adding additional mechanical equipment onto a wheelchair

*The high cost of such a wheelchair is due to the fact that it must be able to be mechanically collapsed sufficiently to fit inside an automobile while the user remains in the wheelchair.

will increase the likelihood of breakdowns, a very serious problem for those who suddenly find themselves immobilized in the middle of a downtown sidewalk.

Only 8 percent of the wheelchairs now in use are power wheelchairs (see Table I), but the number has been increasing as individuals in manual wheelchairs and other handicapped persons discover the convenience of the power wheelchair and as the environment becomes more accessible. Many individuals who previously used walkers or leg braces, for instance, have switched to power wheelchairs because they are physically less demanding. However, when there are environmental barriers to wheelchair use, this physical comfort can be gained only at the expense of mobility.

Closely related to the power wheelchair but somewhat more advanced in performance is a variety of small electric and gasoline powered vehicles of the "golf cart" category. In addition to having a much greater range than the power wheelchair and being able to negotiate steeper grades, these vehicles are capable of sufficient speeds to allow them to be driven on city streets, whereas the power wheelchair is restricted to sidewalks. Also, some of these vehicles are enclosed so that they provide protection from the weather.

These vehicles are used by individuals who have difficulty walking but who are able to walk from where they park the vehicle to their final destination, and by individuals who cannot walk but who can get from the parking space to their final destination by using a collapsible manual wheelchair which they carry in the vehicle with them. Attempts to design a vehicle of this type, onto or into which a wheelchair can be ridden, have not yet been successful.* Therefore, this type of vehicle is not presently a viable alternative for persons confined to wheelchairs.

Although this type of vehicle does have some advantages over the power wheelchair, it lacks most of the advantages of an automobile. Its size and lack of acceleration make it unsafe in heavy city traffic, and it is not suitable for highway travel. It also does not offer as much protection from weather as an automobile, nor the speed, range, or hill-climbing capability. As will be noted in the next section, the persons who can use this type of vehicle are the same ones who can use an automobile equipped with $225 hand controls. The major reason that some handicapped persons use golf-cart type vehicles rather than automobiles has little, if anything, to do with the fact that they are handicapped; it is strictly a question of cost. (The smaller vehicle costs about the same as a power wheelchair, although some models do approach the cost of an inexpensive automobile.) They cannot afford an automobile; thus they must forego some of the advantages of the automobile and accept a lower level of mobility.

Obviously, many of the handicapped cannot function independently without wheelchairs. However, to achieve an adequate level of mobility the handicapped must also have access to modes of transportation which can be used for longer distances, such as the automobile or public transit. These modes are discussed in the next three sections.

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*The limiting factor has been that when a person sits in a wheelchair in a golf-cart type vehicle the center of gravity is raised to the point where the vehicle becomes very unstable.

AUTOMOBILES AND VANS

The land use patterns in the United States, particularly in places such as the Los Angeles Basin, have made the automobile almost synonymous with mobility. This is especially true for many of the handicapped. In areas where public transportation is inaccessible or nonexistent, a personal vehicle is often the only means of independent travel. Although this alternative is not available to many of the handicapped, such as the blind, some of the handicapped can drive a regular automobile with little or no difficulty even though their ability to walk or use public transportation may be limited. However, there also are many persons who can drive only modified vehicles and consequently, as the technology improves, modified automobiles and vans are becoming more common means of intermediate and long distance travel.

Due to the diverse disabilities among the handicapped population, modified automobiles and vans are often very personalized vehicles. Modifications range from minor changes in the foot pedals, to hand controls, to foot controls, to mouth controls, to experimental electronic sensor controls attached to the driver's neck. However, omitting minor modifications such as the addition of a steering wheel spinner knob, there are three basic types of modified vehicles. The first, and most common, is an automobile equipped with hand controls. This type of vehicle is used by the handicapped who have lower-extremity disabilities, including those persons in wheelchairs who can transfer from wheelchair to automobile. The modification costs approximately $225 unless the user also has upper-extremity disabilities in which case more complex controls, costing up to $300, are used.[14]

The second type of modified vehicle is a van which can be driven by an individual sitting in a wheelchair. At the present time, those persons confined to wheelchairs (e.g., quadriplegics) are limited to this type of vehicle since an automobile cannot be driven from a wheelchair. The necessary modifications cost anywhere from $4700 to $6600, depending upon the degree of upper-extremity disability of the user.[15] Typical modifications include a power lift, automatic door opener, hand controls, electric wheelchair tie-downs, lowered floor, raised roof, dual battery system, and a seat which slides into the driving position so that the van can also be driven by a nonhandicapped person.

The third type of modified vehicle is similar to the second type in that it is designed for individuals in wheelchairs. The only difference is that this type of vehicle is designed to be driven from the regular driver's seat rather than from a wheelchair, which requires that the user have the ability to transfer from the wheelchair to the driver's seat. This type of vehicle is used by many individuals who could drive an automobile equipped with hand controls. The reason they use a van instead of an automobile is that at each end of their journey they need their wheelchair, which, unless it is a collapsible manual model, will not fit into an automobile. The modification cost of this type of vehicle is significantly less than the cost of the second type since modifications such as electric tie-downs, lowered floor, raised roof, and a sliding seat are not needed. The elimination of these modifications reduces the cost to approximately $3000.[16]

An alternative for those persons who are confined to wheelchairs and who are unable to drive is a modified van designed to be driven by a nonhandicapped family member or other attendant. (The nondriving handicapped who are not confined to wheelchairs can usually be assisted into and out of regular automobiles.) The modifications needed include a power lift, mechanical tie-downs, and possible minor floor and roof modifications, depending upon the model of van used. The cost of these modifications ranges from $1000 for a vehicle designed for rather infrequent use to $2000 for a vehicle designed for heavy duty use in public transportation.[17]

When considering whether or not to provide personal vehicles to handicapped persons, one question which often arises is what impact would additional handicapped drivers have on highway safety. This question was investigated at a symposium in 1969, conducted by Judge Sherman Finesilver of the University of Denver Law School, and it was reported that "physically disabled drivers are among the most safety conscious and have as good or better safety records as all drivers."[18]

FIXED-ROUTE TRANSIT SYSTEMS

For most of the handicapped who are capable of independent travel, the automobile is not an alternative mode of independent transportation. This group of handicapped persons includes those under driving age, the blind, profound mental retardates, some severe and moderate mental retardates, some epileptics, and numerous other individuals. For these persons and the many others who, although capable of driving, do not wish to drive, the only alternative means of independent travel is some type of transit system (e.g., fixed-route, dial-a-ride).

However, fixed-route transit systems are not physically accessible to many of these persons, and many others can use such systems only with difficulty. At the present time there is not a single fully accessible fixed-route bus or surface rail system in the United States. As for subway systems, only the latest ones are accessible to the handicapped. San Francisco Bay Area's BART system is fully accessible* and Washington D.C.'s Metro is expected to be. It is interesting to note, however, that it took a court order to make the Metro accessible and that the issue of accessibility of the Baltimore subway has been the subject of judicial proceedings.

Programs to improve the handicapped's access to transit systems have not been initiated at the local level because there is no economic incentive for a city or transit company to provide the service, and the handicapped usually do not have the organization or numbers to be a strong political force. The social benefits of improving the mobility of the handicapped usually are not considered by local governments and agencies. Their decisions are based primarily upon financial considerations. Consequently, some local transit companies will admit privately that they do not want to serve the handicapped because "they are more trouble than they are worth."

There obviously are numerous modifications which would improve transit service. Inadequate coverage, infrequent service, crowded conditions, general complexity, sudden acceleration, and inadequate protection from weather at transit stops all reduce the usability of transit for the nonhandicapped as well as the handicapped. Some of these problems

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*The main feature which makes BART accessible is escalators and elevators in each station. However, it also has such refinements as braille symbols on elevator door casings indicating street or platform level and special parking facilities with wider-than-usual stalls located near the stations.

can be, and in some communities are being, alleviated by expanded service, bus-stop shelters, and exclusive bus lanes (bus lanes reduce the incidence of acceleration associated with stop and go traffic). However, the major barrier to the use of transit by the handicapped, particularly the handicapped who can go out but cannot presently use transit, is the level change required to climb into a bus or to walk down to a subway boarding platform. Because of this barrier, individuals in wheelchairs, most people who have rheumatism or arthritis in their knees or hips, many people who use mobility aids such as walkers and braces, and numerous others are physically barred from "public" transit.

The "transbus," now being developed under the auspices of the U.S. Department of Transportation, offers the possibility of reducing or eliminating the level change barrier in bus transit. Three prototypes of this bus are now being tested in regular city use, and production models should be available in two to three years. The prototypes all have lower steps (first step is 10 inches instead of standard 14 inches, interior step is 7 inches instead of standard 10 inches), improved visual and aural information systems, and wider doors, and they are designed to reduce the jerk of acceleration.[19] Reducing the riser height of the steps does greatly increase the accessibility of a bus,* but to provide access to all handicapped persons, steps would have to

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*A relatively small change in height has a great impact on the amount of effort required to climb steps. "A riser height increase of 37.5 percent, from 6 inches to 8.25 inches, [results] in an increase in energy cost of 96 percent in ascending, and 58 percent in descending." (J.J. Fruin, Pedestrian Planning and Design, MAUDEP Press, New York, 1971.)

be completely eliminated. To meet this need, two of the models are testing a power (hydraulic) lift and one is equipped with a low-slope ramp. All of the models provide space for passengers in wheelchairs and wheelchair tie-downs. The cost of eliminating the level-change barrier is estimated to be between $1000 and $2000 per bus.*[20]

The alternative to phasing in a new barrier-free bus, which would take 15 to 20 years at the transit industry's current replacement rates, is to retrofit existing buses with power lifts. (Ramps are not feasible because the height of existing buses would necessitate a prohibitively long ramp.) It is estimated that a large scale retrofitting program, including the installation of wheelchair tie-downs and other minor modifications, would cost approximately $7000 per bus or streetcar.[21] Although a great deal more expensive, this alternative does have the advantage of making systems immediately accessible. However, it does not offer the benefit of lower steps, and most people who can struggle aboard a bus, albeit with difficulty, probably would be reluctant to request that the lift be operated for them. Retrofitting would benefit those persons in wheelchairs, but it would provide little or no improvement for the much larger group of people who have difficulty with high steps.

Regardless of which alternative or combination thereof is used, it must, for practical purposes, involve 100 percent of a system's vehicles for the system to be considered accessible. Making only a portion of a bus system's vehicles accessible does not significantly

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*Whether this equipment is to be required as standard equipment or is to be offered as an option to the buyer is, in the terms of one of the project's consultants, "a hot political issue."

increase the usability of the system. In normal operation bus systems do not assign specific vehicles to specific routes or schedules. To do so would greatly increase dispatching cost and reduce vehicle productivity. Therefore, even if 50 percent of a system's vehicles were accessible, it still would be impossible for a transit company to advise a handicapped person when the next accessible vehicle would be coming by his or her home or even if an accessible vehicle would be on that particular route at all that day. Therefore, the alternative is to achieve immediate accessibility by retrofitting an entire fleet, or to achieve accessibility in 17.5 years (average fleet replacement time) by phasing-in a new barrier-free bus, or to achieve accessibility in some period of time between zero and 17.5 years by using a combination of retrofitting and phasing-in.

Eliminating the level change barrier in subway stations requires the installation of escalators or elevators. Elevators are a more desirable solution since over 50 percent of the persons who have difficulty with stairs also have difficulty with escalators.[22] Capital cost estimates for this improvement are $0.6 million per new station and $1 million per existing station.[23] The addition of construction labor cost and annual maintenance cost would, of course, significantly increase the total cost.

DEMAND-RESPONSIVE SYSTEMS

Regardless of the modifications made to fixed-route transit systems, there will always be some handicapped persons who require door-to-door service. Demand-responsive systems are those which provide an on-call, door-to-door service. This includes systems such as taxicab, handicab, and dial-a-ride. These systems offer much the same advantages as personal automobiles and vans: they reduce walking distances and exposure to weather and crowded conditions, and there is no problem with routing or complexity. Also, if interfaced with existing transit, these systems can make fixed-route transit accessible to those persons able to use, but unable to get to such transit.

In many communities door-to-door service is provided by local service organizations and special interest groups, such as the American Cancer Society, the Easter Seal Society, community hospitals, medical clinics, and senior citizen groups. However, these services are usually available only for emergency trips and certain other essential trips. Also, most of the services cater to specific types of disabilities and have strict eligibility requirements. Although these groups do provide a needed and worthwhile service, their lack of coordination and their fragmentation of the market often result in duplication of efforts, and their limited resources are greatly overtaxed by the demand.

Most handicapped persons, except many of those confined to wheelchairs, can be transported in taxicabs. The fare, of course, is significantly higher than the fare for public transit. A handicab is usually equipped to handle all handicapped persons, including those in wheelchairs and even gurneys, but the fare is much higher than the taxicab fare. A typical handicab fare is $4.50 minimum for the first 30 blocks;[24] a typical taxicab fare for the same distance is $1.90.[25] Dial-a-ride fares are typically flat fates of $0.50 or less.[26]

In addition to using vehicles equipped to handle wheelchairs and gurneys, handicap systems usually offer door-through-door service, i.e., the drivers will assist individuals into and out of buildings. This is an important service for the severly handicapped who need assistance but have no attendant available. However, because of the time required and the additional insurance cost, most other systems do not permit their drivers to go into homes.

The primary difference between taxicab and dial-a-ride services is that taxicab systems provide the users with exclusive use of the vehicle, whereas in dial-a-ride systems the vehicle is shared with others. This shared-ride characteristic reduces the passenger-trip cost of dial-a-ride systems. To further reduce the per passenger cost, these systems usually use larger vehicles (e.g., vans or mini-buses) in order to spread the cost among more passengers.

If a taxicab system replaced some portion of its fleet with larger vehicles and operated them on a shared-ride basis, the cost per passenger-trip would be the same as in a dial-a-ride system. However, this is not to imply that a taxicab system could profitably provide, or even break even on a dial-a-ride service at typical dial-a-ride fares. Almost all existing dial-a-ride systems, like fixed-route transit, operate at a loss. The average operating cost of dial-a-ride systems is $1.90 per passenger-trip.[27] Therefore, with a fare of $0.50, an average subsidy of $1.40 per trip is required. The subsidy required for a taxi-based dial-a-ride system, however, would be less than that required for a separate dial-a-ride system since the dispatching and overhead cost could be spread over a larger base. Also, a taxi-based system could use the vans in regular taxicab service when they were not needed in dial-a-ride service, thereby increasing vehicle productivity.

The difference in cost between a taxicab and a small van is approximately $2000. Modifying the van so it can be used by persons who cannot climb the steps would increase the total capital cost difference to $4000 (see section on vans). The operating cost of a van is not significantly higher than that of a regular taxicab.

The accessibility of existing dial-a-ride systems varies widely. The system in Richmond, California uses shortened but otherwise unmodified buses and thus is inaccessible to anyone who cannot board a regular transit bus. The ten systems in Michigan use vans and at least one van in each system is equipped to handle the handicapped, including those in wheelchairs.[28] The system in St. Petersburg, Florida serves only the aged and the handicapped, and all of its vehicles are equipped to handle wheelchairs.[29] Of the 41 dial-a-ride systems operating in the U.S. in December 1973, 19 were accessible to the handicapped.[30] Although it varies among cities according to local demand, the experience has been that if 10 percent of a system's vehicles are accessible to the handicapped and the handicapped are given priority use of the modified vehicles, they can be given the same service in terms of wait and trip time as the nonhandicapped.[31]

As of May 1974 there were 48 dial-a-ride systems operating in the U..S, and the number is increasing rapidly.[32] Michigan, for instance, plans to institute new systems at the rate of one per month for at least the next year.[33] Taxicab service is much more widespread of course. There are over 3400 communities in the U.S. now served by taxicabs.[34]

The handicapped's desire for door-to-door service is indicated by a Mark Battle and Associates study in which 66.4 percent of the sample of 217 handicapped persons said they would use public transportation more often if door-to-door service were provided. This is particularly revealing in view of the fact that 35.9 percent of the sample lived less than one block from a bus stop and 30.4 percent lived only one to two blocks from a stop.[35]

MOBILITY COUNSELING

Thus far the discussion has concerned the hardware components of a mobility-improvement program. However, no less important than the hardware is the knowledge and psychological preparedness to use it.

Mobility counseling is designed to help the handicapped overcome the psychological barriers to increased mobility. Many individuals are confined to their homes not by their physical disabilities but by their fear of crowds and embarrassment about their disabilities. Due to physical barriers in the environment, many others have forgotten or never learned the benefits of mobility. As Hale Zukas has stated so well:

> If such a person were asked where he would go if he could, he is likely to say he would go outside to get some sun and perhaps go around his immediate neighborhood. It is even conceivable that he would respond to this question by saying that he could not think of any place he would like to go. Incredible and pathetic as such a response may seem, it is understandable when viewed in the larger context. People who have been immobile for many years simply have no idea of the impact mobility can have on their lives.[36]

Assuming that mobility counseling could be provided at the same hourly labor cost as other rehabilitation services, the cost would be approximately $7.00 per hour (based upon the average hourly wage of experienced rehabilitation counselors in the United States).[37] This hourly cost does not include any additional overhead expenses which may result from the provision of counseling services.

SUMMARY

In this section a brief summary and conclusion is presented for each alternative previously discussed.

Curb Modification. The mobility of many individuals stops at the first curb. Any program to improve the mobility of these individuals must include, almost as a prerequisite, curb cutting. However, there does not appear to be a need to embark on a costly program of wholesale curb cutting. Cutting curbs in all heavily traveled areas and as needed in other areas of a city to meet local needs provides an adequate level of mobility. All new curbs of course should have curb cuts built in.

Wheelchairs. Achievement of even a satisfactory minimum level of mobility for many persons requires access to power wheelchairs. Provision of this basic aid should be part of any mobility-improvement program.

Automobiles and Vans. Although personal vehicles offer the greatest mobility, it appears that in most cases adequate mobility can be provided much less expensively. However, depending upon individual circumstances, personal vehicles may be the best solution in some cases, particularly when public transportation is inadequate or nonexistent and where there is insufficient demand to justify a demand-responsive system (e.g., in rural areas).

Fixed-Route Transit Systems. Retrofitting buses is much more expensive than phasing-in new buses but it does provide more immediate accessibility. However, current technology limits retrofitting to the installation of a power lift, which does not seem to be the best solution. A completely redesigned bus, such as the "transbus," with a lower floor and an automatic ramp, is preferable. A lift might have to be lowered and raised several times at one stop; a ramp remains in place while everyone boards and therefore does not slow down schedules. In fact, using a ramp would premit faster service since much of the time now spent at stops is a result of the difficulty people have climbing steps. (With a ramp, wheelchair passengers could board a bus almost as quickly as the other passengers, and it would be rare that there would be more than one or two wheelchair passengers on any particular schedule.

Retrofitting subway systems is probably the least cost-effective method of improving mobility, and building accessibility into new subway systems is only slightly more cost-effective. Subway systems improve the mobility of the handicapped in the same manner that they improve the mobility of the nonhandicapped (i.e., they are faster than surface systems), but adequate mobility for the handicapped can be achieved at much lower cost by the modification of surface systems.

Demand-Responsive Systems. Regardless of the modifications made to fixed-route transit systems, there will always be some handicapped persons who require door-to-door service. Therefore, demand-responsive systems of some type should be made available in all communities. In small communities it probably is the only public transportation service needed. In large communities it perhaps should be supplemented by accessible fixed-route systems.

Mobility Counseling. As with curb cuts, mobility counseling should be an integral part of any program to improve the mobility of the handicapped. Regardless of what is done to the physical environment, without counseling some of the handicapped will continue to be psychologically confined to their homes.

CHAPTER III

AGGREGATE COST ESTIMATES

Using the unit-cost estimates from the preceeding chapter, aggregate cost estimates are calculated in this chapter for each of the alternatives previously discussed. These cost estimates are then presented in summary form in Table X at the end of the chapter. Following Table X are five tables which illustrate what a comprehensive national program might cost. All costs are in terms of 1975 dollars.

CURB MODIFICATION

Assuming that a square mile is typically 12 blocks by 20 blocks and that 4 curb cuts per intersection are made, a city with costs comparable to Berkeley's could completely eliminate the barrier posed by curbs at a cost of $144,000 per square mile. However, complete elimination is not necessary to meet the basic needs of the handicapped. Berkeley, a city of 10.6 square miles with a relatively high percentage of handicapped persons, has met the basic needs at a cost of approximately $120,000 (in 1975 dollars) by cutting curbs in the downtown area and in residential areas to the extent necessary to provide paths to the downtown area. To permit freer participation by the handicapped in the housing market, Berkeley plans to spend an additional $100,000 for curb cuts over the next few years.

If we assume that basic mobility could be provided throughout the country at the same per capita cost ($1.03) as that incurred by

Berkeley, a national curb cutting program would cost $210.3 million. A different approach, using Berkeley's cost per square mile ($11,321), gives a total cost for the urbanized area of the U.S. (35,018 square miles) of $397.2 million. Since Berkeley has a relatively high population density (11,011 per square mile) the per capita calculation probably understates the total cost. On the other hand, while the urbanized area calculation omits many small towns, it probably over-compensates by including many square miles of undeveloped land. A reasonable cost estimate might be an average of these two computations, i.e., $303.8 million. A more extensive program, such as the one Berkeley plans to complete within the next few years, would cost a total of $557.0 million.

A national curb cutting program would reduce the environmental barriers in the areas where the 2,675,000 urban handicapped who "can go out" live (see Figure 1).

WHEELCHAIRS

Due to the early stage of development and relatively high cost of advanced wheelchair designs, such as those with curb climbing capability, the consideration of wheelchair alternatives in this study has been restricted to the provision of standard power wheelchairs to those persons who do not now have them but whose mobility could be improved if they were provided with them.

Data on the demand for power wheelchairs are virtually nonexistent. However, in a recent survey conducted by the Urban Institute the number of handicapped who said they did not now have but needed a power wheelchair was 42 percent greater than those who had power wheelchairs.[38]

(The small sample size in the Urban Institute survey makes the reliability of these results questionable. Nevertheless, since these are the only data available, they are used in the cost calculations.) These data indicate that there is existing unmet demand for approximately 53,000 power wheelchairs (see Table I). Applying the same percentage to the estimated annual U.S. production of power wheelchairs* suggests that there is additional excess demand for approximately 10,000 power wheelchairs annually.

Using an average power wheelchair cost of $1,750 (see Chapter II), it would cost $91.9 million to meet the current excess demand and $17.8 million to meet the future annual excess demand.

AUTOMOBILES AND VANS

The Urban Institute survey indicates that the excess demand for modified automobiles and vans is 75 percent of the total now in use. Applying this study's estimate of a 10 percent driver rate (see Figure 1) to the transportation handicapped in the Urban Institute sample, we find that 31 percent of the transportation-handicapped drivers drive modified vehicles (this corresponds very closely to the estimate in Figure 1 that 28 percent of handicapped drivers cannot use public transit, since some drivers of modified vehicles -- 9.7 percent if we subtract 28 percent from 31 percent and divide by 31 percent -- can use public transit). Multiplying the estimate of 763,600 drivers by 31 percent, we can estimate that 236,000 modified vehicles are presently being used

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*Everett and Jennings, Inc., who manufactured approximately 5,000 power wheelchairs in 1974, has about 70 percent of the wheelchair market. Assuming they have the same share of the power wheelchair market, total annual U.S. production would be approximately 7,000 power wheelchairs.

by the handicapped. Thus, the current excess demand (75 percent) is 177,500.

Applying the 10 percent driver rate to the users of power wheelchairs, it is estimated that 3,700 of the 236,700 modified vehicles are vans which can be driven from a wheelchair. Since approximately 50 percent of modified vans are designed to be driven from a wheelchair,[39] it is estimated that 7,400 of the 236,700 vehicles are modified vans and that the remaining 229,300 are automobiles equipped with hand controls.

Assuming that the distribution of vehicle types for the excess demand is the same as the distribution of vehicles currently in use, there is current excess demand for 2,800 vans which can be driven from a wheelchair, 2,800 vans which can be driven from the regular seat, and 171,900 automobiles with hand controls.

If we assume that the current annual replacement and growth rate of modified vehicles is the same as the replacement and growth rate of power wheelchairs,* then 44,800 modified vehicles are being purchased each year. Applying the excess demand estimate of 75 percent, it is estimated that there will be future annual excess demand for 500 vans which can be operated from a wheelchair, 500 vans which can be driven from the regular seat, and 32,600 automobiles with hand controls.

Due to the format of the Urban Institute survey questionnaire, it appears that those who said they need a power wheelchair would not have responded to the question regarding the need for a modified vehicle.

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*The 18.92 percent annual replacement and growth rate for power wheelchairs (annual production of 7,000 divided by total of 37,000 in use) includes the replacement of existing wheelchairs and the sale of wheelchairs to new users. This replacement rate assumes zero salvage value.

Therefore, applying the 10 percent driver rate to the excess demand of 53,000 power wheelchairs, it is estimated that there would be additional demand for 5,300 vans which can be driven from a wheelchair if the excess demand for power wheelchairs were met. In addition to this immediate excess demand, if the future annual excess demand for 10,000 power wheelchairs were met, there would be future annual excess demand for 1,000 vans. (These estimates of excess demand are summarized in Table VII.)

To estimate the cost of meeting the demand for modified vehicles the following average costs from Chapter II are used: $262 for hand controls, $3,000 for modifications to a van which is to be driven from the regular seat, and $5,600 for modifications to a van which is to be driven from a wheelchair. For the base cost of the vehicles, I use $5,000 for an automobile and $7,000 for a van, which includes the cost of power steering, power brakes, and air conditioning (often required because of problems the handicapped have with body temperature). The total cost estimates are presented in Tables VIII and IX.

The provision of modified vehicles to persons who could benefit from them, but who do not now have them, would cost an initial $967.8 million plus $182.8 million annually. If only the modification cost were subsidized, the initial cost would be $69.1 million and the annual cost would be $12.8 million. If the excess demand for power wheelchairs and the resulting increased demand for modified vehicles were met, the total cost of modified vehicles would increase to $1034.6 million initially plus $195.4 million annually, and the modification cost would increase to $98.8 million initially plus $18.4 million annually.

Meeting the demand for 183,000 modified vehicles would permit 183,000 of the 6,872,000 nondrivers to become drivers. In nonurban

TABLE VII

Excess Demand for Modified Vehicles

	If Excess Demand for Power Wheelchairs is Not Met		If Excess Demand for Power Wheelchairs is Met	
	Current Excess Demand	Future Annual Excess Demand	Current Excess Demand	Future Annual Excess Demand
Vans Driven From Wheelchair	2,800	500	8,100	1,500
Vans Driven From Regular Seat	2,800	500	2,800	500
Automobiles With Hand Controls	171,900	32,600	171,900	32,600
Totals	177,500	33,600	182,800	34,600

TABLE VIII

Vehicle Modification Cost of Excess Demand
(in millions)

	If Excess Demand for Power Wheelchairs is Not Met		If Excess Demand for Power Wheelchairs is Met	
	Current Excess Demand	Future Annual Excess Demand	Current Excess Demand	Future Annual Excess Demand
Vans Driven From Wheelchair	$15.7	$ 2.8	$45.4	$ 8.4
Vans Driven From Regular Seat	8.4	1.5	8.4	1.5
Automobiles With Hand Controls	45.0	8.5	45.0	8.5
Totals	$69.1	$12.8	$98.8	$18.4

TABLE IX

Vehicle Base Cost of Excess Demand
(in millions)

	If Excess Demand for Power Wheelchairs is Not Met		If Excess Demand for Power Wheelchairs is Met	
	Current Excess Demand	Future Annual Excess Demand	Current Excess Demand	Future Annual Excess Demand
Vans Driven From Wheelchair	$ 19.6	$ 3.5	$ 56.7	$ 10.5
Vans Driven From Regular Seat	19.6	3.5	19.6	3.5
Automobiles With Hand Controls	859.5	163.0	859.5	163.0
Totals	$898.7	$170.0	$935.8	$177.0

areas it would benefit 73,000 of the 858,000 who can go out but could not use transit and 8,000 of the 907,000 who could use transit.* In urban areas where transit is available within two blocks, it would benefit 55,000 of the 655,000 who can go out but cannot use transit and 6,000 of the 693,000 who can use transit. In urban areas where transit is not available, it would benefit 37,000 of the 437,000 who can go out but could not use transit if it were available and 4,000 of the 462,000 who could use transit.

FIXED-ROUTE TRANSIT SYSTEMS

Retrofitting all transit buses in the U.S. (50,108 in 1972) to make them accessible would cost $350.8 million ($7,000 per bus - see Chapter II). Retrofitting all surface rail cars (1,176 in 1972) would cost $8.2 million ($7,000 per car).[40]

Using an average cost estimate of $1,500 per bus (see Chapter II), phasing-in the transbus at the rate of 5.7 percent per year for 17.5 years would cost $4.3 million per year, a total cost of $75.2 million. The annual cost of $4.3 million would be a continual cost since after 17.5 years the older transbuses would begin to be replaced.

A possible combination of these alternatives would be to retrofit all surface rail cars, retrofit 50 percent of the transit buses, and replace the remaining buses by phasing-in the transbus at the rate of 5.7 percent per year for 8.75 years. This alternative would have an initial cost of $187.9 million plus an annual cost of $4.3 million

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*Distribution is according to percentages in Figure 1, except for the percentage of drivers of modified vehicles who can use transit, which is estimated to be 9.7 percent (see first paragraph of this section).

for 7.75 years. The annual cost of $4.3 would continue after 7.75 years as retrofitted buses began to be replaced and, later, as transbuses were replaced.*

Retrofitting approximately 800 existing subway stations at a cost of $1 million per station would cost $800 million. Building accessibility into the approximately 170 new stations now under construction or planned, at a cost of $0.6 million per station, would cost $102 million.[41]

The modification of transit buses would potentially provide a means of travel for 655,000 handicapped persons (see Figure 1) who presently have no means of independent travel. It would also provide an option for up to 72,000 handicapped persons who can drive but cannot now use transit. In addition, it would make the use of transit less difficult for the remaining 878,000 chronically handicapped who have transit available within two blocks. It would also improve the service to the acutely handicapped and to the millions of voluntarily handicapped.

Subway service presently is provided in only 7 or 8 cities, compared with the 1,023 cities served by bus transit, and within those 7 or 8 cities bus transit covers a much larger geographic area than the subways.[42] Therefore, the number of handicapped persons who would benefit from accessible subways is considerably less than the number who would benefit from accessible bus transit.

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*The annual cost of replacing retrofitted surface rail cars is not included in the calculations since they have a much lower replacement rate, which makes the annual replacement cost relatively insignificant. For instance, assuming that accessibility could be built into new surface rail cars for the same cost as the transbus and using a replacement rate of 3.5 percent per year, the annual replacement cost of accessible surface rail cars would be $62,000.

DEMAND-RESPONSIVE SYSTEMS

The capital cost of providing dial-a-ride service for the handicapped by replacing 10 percent of the taxicabs in the U.S. (170,000 in 1974)[43] with modified vans would be $680 million initially plus replacement costs of $510 million every four years (using taxicab industry average replacement rate of 25 percent and salvage value of 25 percent).

If such service were provided for the 73 percent of the handicapped who live in areas served by taxicabs (generally towns larger than 10,000 population) at a one-way fare of $0.50, I estimate that 2,928,000 handicapped persons would make a total of 219,249,000 additional roundtrips per year,* which would require an annual operating subsidy of $613.4 million to cover the difference between the $0.50 fare and the $1.90 one-way trip cost.

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*The nonhomebound handicapped in the Urban Institute survey make an average of slightly less than 4 trips per week. (The average in the Abt survey was 3.94.) However, when local neighborhood trips such as walking to visit a neighbor are removed and when the handicapped who are not transportation handicapped are eliminated from the sample, the average drops to less than 3 trips per week. The distribution of trips per week in the Urban Institute survey is bimodal (modes at 2 and 7), which I have assumed is due to the difference in trip-making between drivers and nondrivers. Using an average of 2 trips per week by nondrivers and 7 trips per week by drivers, the overall average is 2.8 trips per week. (If an average one-way taxicab fare of $1.90 were applied to the TSC data on taxicab fare subsidies, an average of 1.27 trips per week would be obtained; a fare of $1.00 would give 2.4 trips per week.) To determine the number of trips which would be made if a door-to-door service were provided, Abt's estimate of a 72 percent increase was used, which may be slightly off since their estimate is based on a free system, but not a door-to-door system. This estimated increase is applied only to trips by nondrivers, since I assume that drivers are presently able to meet all of their trip needs and, consequently, would not make additional trips. (Abt Associates, Inc., Accessibility of the Metropolitan Washington, D.C. Public Transportation System to the Handicapped and Elderly, Cambridge, Massachusetts, August 1972.)

If the subsidy were provided only for the 2,235,000 handicapped nondrivers who cannot use existing fixed-route transit service (see Figure 1), the annual cost would be $468.6 million. If the subsidy were limited to the 1,581,000 handicapped nondrivers who could not use a modified fixed-route transit system, the annual cost would be $331.5 million.

These subsidy estimates are only for the cost of additional trips. There would of couse be a great deal of modal switching of existing trips but this would entail no additional cost, the existing cost would merely be transferred from one mode to another. In fact, since the dial-a-ride mode would likely be less costly than existing modes used by the handicapped,* modal switching would probably result in a net decrease in per capita transportation costs.

MOBILITY COUNSELING

With the data presently available, it is impossible to estimate either the number of persons needing counseling or the amount of counseling needed. However, if we were to assume arbitrarily that those persons in institutions or confined to home need an average of two hours of counseling per year and that all other chronically handicapped persons need an average of one hour, the total cost of this 10,498,000 hours of counseling would be $73.5 million per year.

It should be emphasized that, due to data limitations, this estimate may be more representative of the relative importance attached to counseling than to the actual cost of a national program.

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*In Massachusetts, for instance, transportation services for children in the special education program can run as high as $40 to $60 per trip. Under Medicaid the cost per trip has averaged $9 plus $0.50 per mile. (Tom O'Brien, MBTA, Boston, Massachusetts, personal communication with Urban Institute, January 1975.)

SUMMARY

Table X presents the annual costs of the various alternatives discussed in preceeding sections. It also shows the number of handicapped persons who potentially would receive immediate benefit from each alternative. Demand responsive service would benefit the greatest number of people (3,485,000), followed by curb modification (2,675,000) and fixed-route transit system modification (1,605,000). Provision of modified automobiles and vans would benefit only 183,000 persons, and provision of power wheelchairs would benefit only 53,000 persons. However, these numbers (except the one for power wheelchairs) include only the handicapped who are classified as "can go out." As previously mentioned, many of the persons in institutions or confined to home would also benefit from improved transportation service. On the other hand, none of the alternatives discussed would benefit the rural handicapped who cannot drive or who do not need a power wheelchair. At the maximum, these alternatives would benefit approximately 50 percent of the chronically handicapped.

In Tables XI through XIV various alternatives are combined to indicate what a comprehensive national program might cost. Retrofitting subway stations is not included in these illustrative programs due to the enormous cost of serving a limited number of people and because alternative transportation modes would be available to these people. However, modification of new subway systems <u>is</u> included in each program even though this alternative also is not cost-effective. But this should not be taken as an endorsement of this alternative; it is merely recognition of the fact that new subway systems <u>are</u> being modified. The provision of automobiles and vans is given low priority in all of these programs, being used only when alternative modes are not available.

TABLE X

AGGREGATE COST SUMMARY

Alternative	Number of Chronically Handicapped Persons Potentially Benefitted In First Year	Cost Per Year for 20 Years(1) (in millions) 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	Totals
Curb Modification: Modest 5 year Program	2,675,000	$ 60.8	$ 65.6	$ 70.9	$ 76.5	$ 82.7	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 356.5
Major 5 year Program	2,675,000	111.4	120.3	129.9	140.3	151.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	653.5
Provision of Power Wheelchairs	53,000	91.9	19.3	21.0	22.8	24.8	26.9	29.3	31.6	34.6	37.6	40.8	44.3	48.2	52.3	56.8	61.8	67.1	72.9	79.2	86.1	949.5
Provision of Modified Automobiles and Vans:																						
Total demand:																						
Modification cost	183,000	98.8	20.0	21.7	23.6	25.6	27.9	30.3	32.9	35.7	38.8	42.2	45.8	49.8	54.1	58.8	63.8	69.4	75.4	81.9	89.0	985.5
Base cost of vehicles	183,000	935.8	192.3	208.9	227.0	246.6	268.0	291.1	316.3	343.7	373.4	405.7	440.8	478.9	520.3	565.3	614.2	667.3	725.0	787.7	855.8	9,464.1
Excess of van base cost over automobile base cost	11,000	21.8	4.3	4.7	5.1	5.6	6.1	6.6	7.1	7.8	8.4	9.2	10.0	10.8	11.8	12.8	13.9	15.1	16.4	17.8	19.3	214.6
Demand in urban areas where transit not available:																						
Modification cost	41,000	22.2	4.6	5.0	5.4	5.9	6.4	6.9	7.5	8.2	8.9	9.6	10.5	11.4	12.3	13.4	14.6	15.8	17.2	18.7	20.3	224.8
Base cost of vehicles	41,000	209.6	43.1	46.9	50.9	55.3	60.1	65.3	70.9	77.1	83.8	91.0	98.9	107.4	116.7	126.8	137.8	149.7	162.6	176.7	192.0	2,122.6
Excess of van base cost over automobile base cost	2,400	4.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.1	2.2	2.4	2.6	2.9	3.1	3.4	3.7	4.0	4.4	48.4
Demand in nonurban areas not served by taxicab:																						
Modification cost	49,000	26.6	5.3	5.8	6.3	6.8	7.4	8.1	8.8	9.5	10.3	11.2	12.2	13.3	14.4	15.6	17.0	18.5	20.1	21.8	23.7	262.7
Base cost of vehicles	49,000	251.2	51.6	56.1	60.9	66.2	71.9	78.1	84.9	92.2	100.2	108.9	118.3	128.5	139.6	151.7	164.8	179.1	194.6	211.4	229.7	2,539.9
Excess of van base cost over automobile base cost	3 000	5.8	1.2	1.3	1.4	1.5	1.7	1.8	2.0	2.1	2.3	2.5	2.7	3.0	3.2	3.5	3.8	4.1	4.5	4.9	5.3	58.6
Fixed-Route Transit System Modification:																						
Retrofit transit buses and phase-in transbus beginning in 2nd year	1,605,000	350.8	4.6	5.0	5.4	5.9	6.3	6.8	7.4	8.0	8.6	9.3	10.0	10.8	11.7	12.6	13.6	14.7	15.9	17.2	18.6	543.2
Phase-in transbus	0*	4.3	4.6	5.0	5.4	5.9	6.3	6.8	7.4	8.0	8.6	9.3	10.0	10.8	11.7	12.6	13.6	14.7	15.9	17.2	18.6	196.7
Retrofit surface rail cars(2)	N/A	8.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.2
Retrofit subway stations(3)	N/A	800.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	800.0
Modify new subway stations(3)(4)	N/A	10.2	11.0	11.9	12.8	13.9	15.0	16.2	17.5	18.9	20.4	0	0	0	0	0	0	0	0	0	0	147.8
Demand-Responsive Systems:																						
Demand in all areas served by taxicabs:																						
Modification cost	3,485,000	680.0	0	0	0	693.8	0	0	0	944.0	0	0	0	1284.3	0	0	0	1747.2	0	0	0	5,349.3
Operating cost	3,485,000	613.9	672.6	736.9	807.3	884.5	969.0	1061.6	1163.1	1274.3	1396.1	1529.5	1675.7	1835.9	2011.3	2203.6	2414.2	2645.0	2897.7	3174.7	3478.2	33,445.1
Demand in nonurban areas served by taxicabs::																						
Modification cost	811,000	158.4	0	0	0	161.6	0	0	0	219.9	0	0	0	299.2	0	0	0	407.0	0	0	0	1,246.1
Operating cost	811,000	143.0	156.7	171.6	188.0	206.0	225.7	247.3	270.9	296.8	325.2	356.3	390.3	427.6	468.5	513.3	562.4	616.1	675.0	739.5	810.2	7,790.4

* Fractional modification of bus fleets does not benefit the handicapped (see discussion, Chapter 2). Complete modification would benefit 1,605,000 of the handicapped.

(1) Series F fertility assumptions and 8 percent inflation rate used.

(2) Annual replacement cost is relatively insignificant.

(3) Labor cost and annual maintenance cost not included.

(4) Assumes that presently planned subway construction will be spread over ten years and that no additional subways will be built after 1984.

TABLE XI

COST OF A NATIONAL PROGRAM TO IMPROVE THE MOBILITY OF THE CHRONICALLY HANDICAPPED
EMPHASIS ON PHASING-IN THE TRANSBUS

Type of Service Improvement	Number of Chronically Handicapped Persons Potentially Benefitted In First Year	Present Value of Discounted Cost for Three Time Periods (in millions)					
		Discounted at 8 percent			Discounted at 12 percent		
		5 years	10 years	20 years	5 years	10 years	20 years
Curb Modification - Modest Program	*	$ 303.8	$ 303.8	$ 303.8	$ 283.0	$ 283.0	$ 283.0
Provision of Power Wheelchairs	*	164.1	257.1	451.2	157.8	229.9	344.8
Phasing-in Transbus	0**	21.5	33.0	86.0	19.9	36.5	62.2
Modification of New Subway Stations (1)(2)	*N/A	51.0	102.0	102.0	47.4	87.0	87.0
Dial-A-Ride in Nonurban Areas	811,000	1,013.2	1,922.6	3,921.8	945.5	1,647.4	2,830.5
Provision of Modified Automobiles and Vans: (3)							
In urban areas where transit not available	41,000	47.8	74.5	130.0	46.3	67.0	99.9
In nonurban areas where dial-a-ride not available	49,000	56.7	88.0	153.4	54.7	79.0	117.8
Totals	901,000	$1,658.1	$2,781.0	$5,148.2	$1,554.6	$2,429.8	$3,825.2

* These numbers involve duplication and are omitted so that the initial impact of each program may be more easily compared.

** Fractional modification of bus fleets does not benefit the handicapped (see discussion, Chapter 2). Complete modification would benefit 1,605,000 of the handicapped.

(1) Labor cost and annual maintenance cost not included.

(2) Assumes that presently planned subway construction will be spread over ten years and that no additional subways will be built after 1984.

(3) Cost includes all modification costs plus the difference in the base cost between a van and an automobile.

TABLE XII

COST OF A NATIONAL PROGRAM TO IMPROVE THE MOBILITY OF THE CHRONICALLY HANDICAPPED
EMPHASIS ON RETROFITTING TRANSIT

Type of Service Improvement	Number of Chronically Handicapped Persons Potentially Benefitted In First Year	Present Value of Discounted Cost for Three Time Periods (in millions)					
		Discounted at 8 percent			Discounted at 12 percent		
		5 years	10 years	20 years	5 years	10 years	20 years
Curb Modification - Modest Program	*	$ 303.8	$ 303.8	$ 303.8	$ 283.0	$ 283.0	$ 283.0
Provision of Power Wheelchairs	*	164.1	257.1	451.2	157.8	229.9	344.8
Retrofitting Transit Buses	1,605,000	350.8	350.8	350.8	350.8	350.8	350.8
Phasing-in Transbus (beginning in 2nd year)	0	17.2	38.7	81.7	15.6	32.2	57.9
Retrofitting Surface Rail Cars	N/A	8.2	8.2	8.2	8.2	8.2	8.2
Modification of New Subway Stations (1)(2)	N/A	51.0	102.0	102.0	47.4	87.0	87.0
Dial-A-Ride in Nonurban Areas	811,000	1,013.2	1,922.6	3,921.8	945.5	1,647.4	2,830.5
Provision of Modified Automobiles and Vans:							
In urban areas where transit not available	41,000	47.8	74.5	130.0	46.3	67.0	99.9
In nonurban areas where dial-a-ride not available	49,000	56.7	88.0	153.4	54.7	79.0	117.8
Totals	2,506,000	$2,012.8	$3,145.7	$5,502.9	$1,909.3	$2,784.5	$4,179.9

*These numbers involve duplication and are omitted so that the initial impact of each program may be more easily compared.

(1) Labor cost and annual maintenance cost not included.

(2) Assumes that presently planned subway construction will be spread over ten years and that no additional subways will be built after 1984.

(3) Cost includes all modification costs plus the difference in the base cost between a van and an automobile.

TABLE XIII

COST OF A NATIONAL PROGRAM TO IMPROVE THE MOBILITY OF THE CHRONICALLY HANDICAPPED EMPHASIS ON DEMAND-RESPONSIVE SERVICE AND PHASING-IN THE TRANSBUS

Type of Service Improvement	Number of Chronically Handicapped Persons Potentially Benefitted In First Year	Present Value of Discounted Cost for Three Time Periods (in millions) Discounted at 8 percent			Discounted at 12 percent		
		5 years	10 years	20 years	5 years	10 years	20 years
Curb Modification - Major Program	*	$ 557.0	$ 557.0	$ 557.0	$ 518.6	$ 518.6	$ 518.6
Provision of Power Wheelchairs	*	164.1	257.1	451.2	157.8	229.9	344.8
Dial-A-Ride	3,485,000	4,349.4	8,253.4	16,836.1	4,059.5	7,080.3	12,163.3
Phasing-in Transbus	0**	21.5	33.0	86.0	19.9	36.5	62.2
Modification of New Subway Stations(1)(2)	*N/A	51.0	102.0	102.0	47.4	87.0	87.0
Provision of Modified Automobiles and Vans:(3)							
In nonurban areas where dial-a-ride not available	49,000	56.7	88.0	153.4	54.7	79.0	117.8
	3,534,000						
Total Costs		$5,199.7	$ 9,290.5	$18,185.7	$4,857.9	$8,031.3	$13,293.[illegible]
Partial Benefits(4)		$6,415.6	$13,026.2	$26,855.6	$5,970.8	$11,099.9	$19,291.[illegible]

* These numbers involve duplication and are omitted so that the initial impact of each program may be more easily compared.

** Fractional modification of bus fleets does not benefit the handicapped (see discussion, Chapter 2). Complete modification would benefit 1,605,000 of the handicapped.

(1) Labor cost and annual maintenance cost not included.

(2) Assumes that presently planned subway construction will be spread over ten years and that no additional subways will be built after 1984.

(3) Cost includes all modification costs plus the difference in the base cost between a van and an automobile.

(4) Increase in earnings; does not include other economic or social benefits (see next chapter for calculations)

TABLE XI.

COST OF A NATIONAL PROGRAM TO IMPROVE THE MOBILITY OF THE CHRONICALLY HANDICAPPED

EMPHASIS ON DEMAND-RESPONSIVE SERVICE, PHASING-IN THE TRANSBUS, AND LIMITED RETROFITTING

Type of Service Improvement	Number of Chronically Handicapped Persons Potentially Benefitted In First Year	Present Value of Discounted Cost for Three Time Periods (in millions): Discounted at 8 percent, 5 years	10 years	20 years	Discounted at 12 percent, 5 years	10 years	20 years
Curb Modification - Major Program	*	$ 557.0	$ 557.0	$ 557.0	$ 518.6	$ 518.6	$ 518.6
Provision of Power Wheelchairs	*	164.1	257.1	451.2	157.8	229.9	344.8
Retrofitting 50 Percent of Transit Buses	0**	175.4	175.4	175.4	175.4	175.4	175.4
Phasing-in Transbus	0**	21.5	33.0	86.0	19.9	36.5	62.2
Modification of New Subway Stations(1)(2)	*N/A	51.0	102.0	102.0	47.4	87.0	87.0
Dial-A-Ride	3,485,000	4,349.4	8,253.4	16,836.1	4,059.5	7,080.3	12,163.3
Provision of Modified Automobiles and Vans:(3)							
In nonurban areas where dial-a-ride not available	49,000	56.7	88.0	153.4	54.7	79.0	117.8
	3,534,000						
Total Costs		$5,375.1	$9,465.9	$18,361.1	$5,003.3	$8,206.7	$13,469.1
Partial Benefits(4)		$6,415.6	$13,026.2	$26,855.6	$5,970.8	$11,099.9	$19,291.0

* These numbers involve duplication and are omitted so that the initial impact of each program may be more easily compared.

** Fractional modification of bus fleets does not benefit the handicapped (see discussion, Chapter 2). Complete modification would benefit 1,605,000 of the handicapped.

(1) Labor cost and annual maintenance cost not included.

(2) Assumes that presently planned subway construction will be spread over ten years and that no additional subways will be built after 1984.

(3) Cost includes all modification costs plus the difference in the base cost between a van and an automobile.

(4) Increase in earnings; does not include other economic or social benefits (see next chapter for calculations).

The programs presented in Tables XI and XII place primary emphasis on modification of fixed-route transit systems, while the programs presented in Tables XIII and XIV place primary emphasis on demand-responsive service. It should be emphasized at this point that there are some qualitative differences between the benefits of these two alternatives. For instance, even though Table X indicates that demand-responsive service would benefit over twice as many people as would modified fixed-route transit service, the actual difference would be considerably greater since many of the 1,605,000 potential users of transit would still not be able to walk the one or two blocks to a bus stop, whereas they could use a door-to-door service. It therefore is impossible to determine how many persons would no longer have a transportation problem if fixed-route transit systems were modified. Consequently, economic benefits are not calculated for the programs presented in Tables XI and XII. This qualitative difference also means that the programs presented in Tables XI and XII cannot be directly compared with the programs presented in Tables XIII and XIV insofar as the number of persons potentially benefitted is concerned.

The program presented in Table XI places primary emphasis on the phasing-in of the transbus. The service gaps are filled by providing dial-a-ride in the areas where fixed-route transit service is not available but taxicab service is and by providing automobiles to the potential drivers who would have neither fixed-route transit service nor dial-a-ride service available. The initial impact of this program would be relatively small (901,000) persons benefitted) since fixed-route transit systems would not be fully accessible for 17.5 years. This program also would not benefit the urban handicapped who do not have fixed-route transit available and cannot drive, or the urban handicapped who need door-to-door service.

The program presented in Table XII is similar to the program in Table XI. The only differences are that all fixed-route transit systems are modified in the first year and the phasing-in of the transbus begins in the second year instead of the first year. These changes almost triple the number of persons initially benefitted, while increasing the cost less than 25 percent in the first five years.

The program presented in Table XIII includes no retrofitting, but the dial-a-ride service is expanded to include all urban areas. This program would serve the maximum possible number of the handicapped (3,534,000). For the first five years the present value of the cost of this program (using an 8 percent discount rate) would be $5.2 billion, compared with increased earnings of $6.4 billion.

The program presented in Table XIV would serve the same number of people as the program in Table XIII. The limited retrofitting is included to make fixed-route transit systems accessible in 8.75 years rather than 17.5 years. In this program and in the previous one, no additional people would be served by making fixed-route transit accessible. It merely would provide some of the persons who may not wish to use dial-a-ride with the option of using fixed-route transit. The addition of the limited retrofitting increases the present value of the cost for the first five years (using an 8 percent discount rate) to $5.4 billion. The increased earnings would remain $6.4 billion.

Table XV presents the costs of meeting the maximum demand for all alternatives. No additional persons are served but all modes of transportation are made accessible, thereby providing the handicapped --

TABLE XV

COST OF A NATIONAL PROGRAM TO IMPROVE THE MOBILITY OF THE CHRONICALLY HANDICAPPED

MAXIMUM PROVISION OF ALL ALTERNATIVES

Type of Service Improvement	Number of Chronically Handicapped Persons Potentially Benefitted In First Year	Present Value of Discounted Cost for Three Time Periods (in millions)					
		Discounted at 8 percent			Discounted at 12 percent		
		5 years	10 years	20 years	5 years	10 years	20 years
Curb Modification - Major Program	*	$ 557.0	$ 557.0	$ 557.0	$ 518.6	$ 518.6	$ 518.6
Provision of Power Wheelchairs	*	164.1	257.1	451.2	157.8	229.9	344.8
Provision of Modified Automobiles and Vans:							
Total demand (including vehicle base cost)	*(49,000)	1,828.0	2,846.8	4,978.0	1,759.4	2,549.7	3,812.2
Retrofitting Transit Buses	*	350.8	350.8	350.8	350.8	350.8	350.8
Phasing-in Transbus (beginning in 2nd year)	0	17.2	38.7	81.7	15.6	32.2	57.9
Retrofitting Surface Rail Cars	N/A	8.2	8.2	8.2	8.2	8.2	8.2
Retrofitting Subway Stations (1)	N/A	800.0	800.0	800.0	800.0	800.0	800.0
Modification of New Subway Stations (1)(2)	N/A	51.0	102.0	102.0	47.4	87.0	87.0
Dial-A-Ride	3,485,000	4,349.4	8,253.4	16,836.1	4,059.5	7,080.3	12,163.3
	3,534,000						
Total Costs		$8,125.7	$13,214.0	$24,165.0	$7,717.3	$11,656.7	$18,142.8
Partial Benefits (3)		$6,415.6	$13,026.2	$26,855.6	$5,970.8	$11,099.9	$19,291.0

* These numbers involve duplication and are omitted so that the initial impact of each program may be more easily compared. (49,000 is amount of nonduplication in modified vehicle alternative).

(1) Labor cost and annual maintenance cost not included.

(2) Assumes that presently planned subway construction will be spread over ten years and that no additional subways will be built after 1984.

(3) Increase in earnings; does not include other economic or social benefits (see next chapter for calculations).

to the extent that it is possible -- with the same transportation options as the nonhandicapped have. Initially, the cost of this program would exceed the increase in earnings -- but not the total benefits (see next chapter) -- but at some point shortly aften ten years the earnings would begin to exceed the cost. It should be noted that in all of the programs presented the cost is front-end loaded, whereas the benefit stream is relatively constant. Consequently, the ratio of benefits to costs increases over time in all cases.

Table XV, in particular, makes it clear that a national mobility-improvement program is not only economically desirable, but that the benefits to be derived are of such magnitude that they exceed the cost of even the most ambitious program.

CHAPTER IV

BENEFIT ESTIMATES*

The major economic benefit of providing transportation for the handicapped would be the increased earnings of the handicapped who are able to become, or remain, employed as a result of improved mobility. According to an Abt study, 13 percent of the handicapped age 17 to 64 would return to work if transportation were no longer a problem.[44] Since the maximum number of persons benefitted by the alternatives discussed in this study is 3,534,000, 43.8 percent of whom are age 17 to 64, it is estimated that 201,000 persons would become employed if a program such as presented in Table XIII were implemented. If these persons earned an average of $6,300[45] per year, the annual benefit would be $1,267.8 million. Discounted at 8 percent per year, the present value of this benefit would be: $6,415.6 million for a five year period, $13,026.2 million for a ten year period, and $26,855.6 million for a twenty year period.**

Other economic benefits include increased ability to perform homemaker services such as shopping, reduced absenteeism, etc. Improved transportation would also permit some institutionalized persons to live

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*A social perspective, rather than a taxpayer or consumer model, is used in this paper to define benefits.

**Series F fertility assumption and 8 percent inflation rate used.

at home and receive treatment as outpatients instead of inpatients. In addition, as the TSC report points out, improvement of transportation services would create new jobs for operating personnel for the new services and for manufacturing and construction personnel in the building of new facilities and equipment.

In addition to the benefits to be realized by the chronically handicapped, the benefits to the acutely and voluntarily handicapped should also be considered. Although increased mobility is not likely to change the life style of the acutely handicapped, it may have a significant economic impact by allowing them to return to work earlier. The individual benefit to the voluntarily handicapped obviously is not as significant as it is to the chronically and acutely handicapped, but it is nonetheless real.

Although the economic benefits are quite significant, the other social benefits may be even greater. Transportation improvements, which permit millions of handicapped persons to become more independent and socially productive and which in general improve their lives and their self-concepts, may be justifiable purely on the basis of equity without regard to the economic benefits.

CHAPTER V

POLICY ISSUES AND CONCLUSIONS

The magnitude of the economic benefits of the alternatives discussed suggests that a national program of improving mobility for the handicapped is justifiable on purely economic grounds. However, the economic benefits resulting from increased employment should not be the only, nor even the main, criterion for a mobility-improvement program. The noneconomic social benefits accruing to over 3 million unemployable handicapped persons provide compelling reasons for the implementation of a national program.

If improved mobility were adopted as a national goal, one of the major issues to be decided would be whether to provide mobility (the ability to travel between point "a" and point "b") or accessibility (the ability to use all modes of transportation operating between point "a" and point "b"). The program outlined in Table XIII would provide mobility for the maximum possible number of the handicapped. It also includes accessibility of new subways and eventual accessibility of fixed-route transit systems, provisions which could be eliminated if mobility were the sole objective. The programs presented in Tables XIV and XV provide for increased accessibility in addition to basic mobility. As these tables indicate, increasing accessibility does not increase the economic benefits nor does it increase the number of persons who are able to travel between any two points. The major justification for a more comprehensive program are the principles that the handicapped should be as fully integrated into society as possible, and that all citizens have the right to access to all publicly operated facilities. The rejection of "separate but equal" policies that has emerged from the civil rights movement can be viewed as applying to the handicapped as well, even though the "separateness" has its origin not in arbitrary discrimination, but in technology and social costs. If a program consisted only of providing an exclusive or near exclusive service, such as dial-a-ride, for the chronically handicapped, they would continue to be segregated from the rest of society and would suffer the stigma which accompanies such segregation. A more comprehensive program not only reduces the stigma of disability but also benefits many of the nonhandicapped who would not benefit if improvements were limited to an exclusive service for the handicapped (e.g., elimination of steps in buses would benefit many of the nonhandicapped).

Another major consideration is the feasibility of the alternatives suggested. Curb cuts, power wheelchairs, and modified automobiles and vans have been in use for some time and there does not appear to be any question about their feasibility or desirability. In the case of curb cuts the primary need is for dissemination of program guidelines to local communities. The present state of the art of wheelchair technology and, to some extent, of modified automobile and van technology suggests that funding for additional research should be considered. Outside funding for research and development of relatively low unit-cost products usually is not necessary to promote research by firms in a competitive industry. However, since the wheelchair industry is dominated by one company, there may be strong justification for the funding of wheelchair research by disinterested parties.

The feasibility of the transbus should easily be determined from the demonstration results, which should soon be available. Dial-a-ride systems also have been demonstrated in various communities. However, evaluations of these demonstrations have not focused on the impact that such systems have on the mobility of the handicapped, and none of the demonstrations has been a taxi-based dial-a-ride system. Therefore, several demonstrations of this alternative may be requried to determine its appropriateness.

Another issue is whether it would be desirable to provide funds directly to consumers instead of to the providers of transportation services. For those services which cannot be marketed, such as modified curbs or modified fixed-route transit systems, it would be necessary for the federal government to offer direct grants to the providers of the services in order for the modifications to be made on a national scale. Legislation requiring the provision of the services may also be necessary. For the purchase of wheelchairs and modified vehicles, direct payment to the consumer has the advantages of providing the opportunity for the consumer to choose the wheelchair or vehicle most appropriate to his or her needs and of encouraging competitive markets. A direct subsidy to the consumer for door-to-door service also gives the consumer the opportunity to choose the most appropriate provider and might be simpler to administer than subsidies to providers. However, most providers probably would not have the economic incentive to modify their vehicles unless the fare subsidy were significantly greater than the operating subsidy proposed in Table X. It therefore may be more efficient to offer capital grants for vehicle modification to the providers of the service in addition to providing fare subsidies to consumers.

Policy decisions also must be made regarding the latent demand for mobility. The programs presented in Tables XI through XV are designed with existing demand in mind and, consequently, do not include a provision for mobility counseling. The purpose of mobility counseling is to acquaint potentially mobile persons with the benefits of mobility and to overcome the psychological barriers which make them immobile, thus inducing additional demand for accessible transportation systems. If the purpose of a national program is to meet existing demand for accessible systems, counseling may not be needed. However, if the objective is to make improved mobility a reality for as many of the handicapped as possible, mobility counseling would be an essential element in any national program.

Although this paper has concentrated more on costing out alternatives than on documenting the need for them, I believe the discussion makes it obvious that a major curb-modification program should immediately be initiated and that power wheelchairs, modified automobiles and vans, and mobility counseling should be provided to all handicapped persons needing them. In addition, the transbus, having an automatic ramp - not a power lift - as <u>required</u> equipment, should be phased-in as soon as possible, and demonstrations of taxi-based dial-a-ride systems should be immediately funded. It cannot be emphasized too strongly that door-to-door service is needed and should be provided.

The remaining alternatives discussed in this paper are not cost-effective solutions to mobility problems. Retrofitting fixed-route transit vehicles would benefit only those persons in wheelchairs, a very small percentage of the handicapped population. It would also impose social costs on all other users of fixed-route transit since the operation of the power lift would slow down schedules. It is even more obvious that retrofitting subway systems is not a cost-effective alternative, and almost equally clear that the money now being spent on modifying new subway systems would be more effective if spent on other alternatives.

NOTES

[1]John C. Folcocchio and Edmund J. Cantilli, Transportation and the Disadvantaged, D.C. Heath & Company, Lexington, Mass., 1974, p. 150.

[2]Abt Associates, Inc., A Study of the Rehabilitation Services Administration Program Services and Support Systems, prepared for the Rehabilitation Services Administration, Cambridge, Mass., c. 1973, Vol. IV, pp. 20, 28.

[3]Transportation Systems Center, The Handicapped and Elderly Market for Urban Mass Transit, prepared for the Urban Mass Transit Administration, Cambridge, Mass., October 1973, p. 11.

[4]Op. Cit., Falcocchio, p. 35.

[5]Abt Associates, Inc., Travel Barriers; Transportation Needs of the Handicapped, prepared for the U.S. Department of Transportation, Cambridge, Mass., August 1969, p. 6.

[6]D.P. Garner, Chief Project Planner, Planning Division, Ministry of Transportation and Communications, Ontario, Canada, "Developing Policies for the Transportation of the Physically Handicapped in Ontario" (paper presented at the Fifth Annual International Conference on Demand-Responsive Transportation Systems of the Transportation Research Board, Oakland, California, November 12, 1974), Exhibit 8.

[7]Abt Associates, Inc., Accessibility of the Metropolitan Washington, D.C. Public Transportation System to the Handicapped and Elderly, prepared for the Office of Environmental Affairs, U.S. Dept. of Transportation, Cambridge, Mass., August 1972, Tables 9 and 19.

[8]Op. Cit., Travel Barriers; Transportation Needs of the Handicapped, p. 31.

[9]Op. Cit., The Handicapped and Elderly Market for Urban Mass Transit, Appendix A.

[10]Bill Hopkins, Minnesota Society for Crippled Children and Adults, Minneapolis, Minnesota, personal communication, April 1975.

[11]Vern Anderson, Architectural Barriers, report of the Minnesota Society for Crippled Children and Adults, Golden Valley, Minnesota, April 24, 1969, p. 6.

[12]David Anderson, MB Associates, San Ramon, California. In Transcript of Federal Architectural Barrier Compliance Board hearings, June 20-21, 1974, San Francisco, California.

[13]Don M. Cunningham, Professor, Department of Mechanical Engineering, University of California at Berkeley, personal communication, October 1974.

[14]Robin Aids, Inc., Vallejo, California, and Motorette, Inc., Los Angeles, California, personal communication, September 1974. Robin Aids and Motorette specialize in automobile and van conversions for handicapped persons. (Costs inflated to 1975 dollars.)

[15]Ibid.

[16]Ibid.

[17]Robin Aids, Inc., Vallejo, California. Far West Coach, Inc., Fountain Valley, California. Motorette, Inc., Los Angeles, California. Karl Guenther, Ann Arbor Transportation Authority, Ann Arbor, Michigan, personal communication, November 1974.

[18]William Bean, "Transportation Overview," Rehabilitation Record, XIII (July-August 1972), 2.

[19]Urban Mass Transportation Administration, "Benefits of Transbus," Washington, D.C., c. 1973-1974.

[20]Booz-Allen Applied Research, Prime Contractor, Transbus Project, Bethesda, Maryland, personal communication, November 1974.

[21]Op. Cit., The Handicapped and Elderly Market for Urban Mass Transit, p. 67. (Costs inflated to 1975 dollars and labor cost added.) David Anderson, MB Associates, San Ramon, California. Alameda-Contra Costa Transit, Oakland, California.

[22]Op. Cit., Travel Barriers; Transportation Needs of the Handicapped.

[23]Op. Cit., The Handicapped and Elderly Market for Urban Mass Transit, p. 67. (Costs inflated to 1975 dollars.)

[24]J. Leonard Lovdahl, President, Handicabs of Milwaukee, Inc., "Private Services -- Specialized Transportation for the Elderly and Handicapped" (paper presented at the Fifth Annual International Conference on Demand-Responsive Transportation Systems of the Transportation Research Board, Oakland, California, November 12, 1974), p. 7. (Inflated to 1975 dollars.)

[25]Ronald F. Kirby, Senior Research Associate, Urban Institute, Washington, D.C., "The Potential of Taxicabs for Providing Innovative Para-Transit Services" (paper presented at the Fifth Annual International Conference on Demand-Responsive Transportation Systems of the Transportation Research Board, Oakland, California, November 12, 1974), p. 2. (Inflated to 1975 dollars.)

[26]Katherine O'Leary, Office of the Secretary, U.S. Department of Transportation, "Review of Demand-Responsive Service Implementations in North America" (paper presented at the Fifth Annual International Conference on Demand-Responsive Transportation Systems of the Transportation Research Board, Oakland, California, November 12, 1974), p. 4.

[27]Daniel Ross, Massachusetts Institute of Technology, Cambridge, Massachusetts. (Cost inflated to 1975 dollars.)

[28]Gerald A. Geile, Chief, Transit Grants Division, Urban and Public Transportation, Department of State Highways and Transportation, State of Michigan, Lansing, Michigan, personal communication, November 1974.

[29]Op. Cit., O'Leary. Jim F. Young, Urban Mass Transportation Administration, U.S. Department of Transportation.

[30]David Watter, Urban Mass Transportation Administration, U.S. Department of Transportation.

[31]Op. Cit., Geile. Dave Systems, Inc., San Francisco, California.

[32]Op. Cit., O'Leary, Figure 2.

[33]Op. Cit., Geile.

[34]Charles A. Boynton, President, American Taxicab Association, in Taxicab Management, November 1974, Vol. 11, p. 6.

[35]Mark Battle & Associates, Inc., Transportation for the Elderly and Handicapped, prepared for the Urban Mass Transportation Administration, July 1973, pp. 149, 168.

[36]Hale Zukas, Center for Independent Living, Berkeley, California, unpublished paper, 1974.

[37]U.S. Department of Labor, Bureau of Labor Statistics, The Occupation Outlook Handbook, 1974. (Wage inflated to 1975 dollars.)

[38]The Urban Institute, Survey of Severely Disabled Closed 18, 28, 30 From Vocational Rehabilitation Programs, Washington, D.C. (mimeograph), 1974.

[39]Tony Solamon, Motorette, Inc., Los Angeles, California, personal communication, April 1975.

[40]Total vehicle figures are from the Transit Fact Book: 1973, American Transit Association, Washington, D.C.

[41]Op. Cit., The Handicapped and Elderly Market for Urban Mass Transit, p. 67.

[42]Op. Cit., Charles A. Boynton.

[43]Stanley Hirsch, Long Island Taxi and Transportation Operators' Association, "Taxicab Operations in the United States" (paper presented at the Fifth Annual International Conference on Demand-Responsive Systems of the Transportation Research Board, Oakland, California, November 12, 1974).

[44]Op. Cit., Travel Barriers; Transportation Needs of the Handicapped, p. 23.

[45]Ibid., p. 24. ($4360 inflated by 44.5 percent cost of living increase, 1969 to 1975.) If the average earnings at closure of those handicapped persons who have received rehabilitation services were used, the individual benefit would be $5700 per year (in 1975 dollars) instead of $6300. (U.S. Dept. of HEW, Rehabilitation Services Administration, Characteristics of Clients Rehabilitated in Fiscal Years 1968-1972, Table II.) However, the $5700 figure includes many low paying jobs, such as those performed at home or in sheltered workshops, where transportation is not a factor. It is safe to assume that when transportation is needed to get to a job, the job will pay more than can usually be earned at home or in a sheltered workshop. It also should be noted that the $5700 figure includes jobs in rural areas, whereas the vast majority of the persons who would be benefitted by the alternatives discussed in this paper live in urban areas, where wages are higher. Consequently, Abt's estimate of $6300 appears to be reasonable, particularly when it is contrasted with the average of $8900 (in 1975 dollars) earned by nonagricultural production or nonsupervisory workers in the private sector. (Council of Economic Advisors, Economic Indicators, January 1975, p. 15.)

SELECTED BIBLIOGRAPHY

Abt Associates, Inc. A Study of the Rehabilitation Services Administration Program Services and Support System. Prepared for the Rehabilitation Services Administration, U.S. Dept. of Health, Education and Welfare. Cambridge, Mass., c. 1973.

———. Accessibility of the Metropolitan Washington, D.C. Public Transportation System to the Handicapped and Elderly. Prepared for the Office of Environmental Affairs, U.S. Dept. of Transportation. Cambridge, Mass., 1974.

———. Travel Barriers; Transportation Needs of the Handicapped. Prepared for the Office of Economics and Systems Analysis, U.S. Dept. of Transportation. Cambridge, Mass., August 1969.

American Institute of Architects, Potomac Valley Chapter. Barrier Free Rapid Transit. Prepared for the President's Committee on Employment of the Handicapped. Washington, D.C., September 1969.

Arthur D. Little, Inc. Employment, Transportation and the Handicapped. Prepared for the Office of Research, Demonstrations, and Training, Social and Rehabilitation Service, U.S. Dept. of Health, Education and and Welfare. Cambridge, Mass., July 1968.

Bray, Peter and Don M. Cunningham. "Vehicles for the Severely Disabled," Rehabilitation Literature, V. 28, No. 4 (April 1967), pp. 98-109.

California Division of Mass Transportation. Student Wheelchair Transportation--Loading and Securement. Sacramento, California, 1974.

Crain & Associates. Para-Transit Survey. Component of MTC Special Transit Service Needs Study. Menlo Park, Ca., 1974.

Cunningman, Don M. Special Vehicles for the Severely Disabled. University of California, Berkeley, Ca., March 1972.

Dallmeyer, Kenneth E. and Vasant H. Surti. Transportation Mobility Analysis of the Handicapped. Center for Urban Transportation Studies, University of Colorado, Denver, Colorado, 1974.

Davis, Frank W., Kenneth W. Heathington, Roger W. Alford, David P. Middendorf, Richard T. Symons. A Preliminary Analysis of Two Shared-Ride Taxi Systems. Prepared for the Urban Mass Transportation Administration, U.S. Dept. of Transportation. Transportation Center, University of Tennessee, Knoxville, Tennessee, August 1973.

———. An Organizational and Environmental Review of Two Privately Owned, Shared Ride Taxi Systems. Prepared for the Urban Mass Transportation Administration, U.S. Dept. of Transportation. Transportation Center, University of Tennessee, Knoxville, Tennessee, October 1974.

"Designing for the Disabled," Railway Gazette International, v. 127, no. 11 (November 1971), 440-2.

Dwoskin, Stephen. "Disabled's Encounter with the Environment." Design and Environment, v. 1, no. 2 (Summer 1970), 60-3.

Edinburgh University, Department of Urban Design and Regional Planning. Planning for Disabled People in the Urban Environment. London, 1969.

Falcocchio, John C. and Edmund J. Cantilli. Transportation and the Disadvantaged: the Poor, the Young, the Elderly, the Handicapped. Lexington, Mass., Lexington Books, 1974.

Ferguson, D. "Problems of Handicapped Persons in Using Transport." In Proceedings of Human Factors in Transportation Conference. 1973, 10.1-10.12.

Grumman Health Systems. Transportation Vehicles and Systems for the Handicapped. Melville, N.Y., 1971.

Kirby, Ronald F. Para-Transit: A Summary Assessment of Experience and Potential. Prepared for the Urban Mass Transportation Administration, U.S. Dept. of Transportation, June 1974.

———, Kiran U. Bhatt, Michael A. Kemp, Robert G. McGillivray, and Martin Wohl. Para-Transit: Neglected Options for Urban Mobility. Prepared for the Urban Mass Transportation Administration, U.S. Dept. of Transportation, June 1974.

Kubat, Al. "Unique Experiment in Independent Travel." Journal of Rehabilitation (March-April 1973), 36-39, 42.

League of Oregon Cities, Urban Services Program. "Curb Ramps at Crosswalks: An Example of Construction Standards," Eugene, Oregon, University of Oregon, Bureau of Governmental Research and Service, 1974.

Levine, Robert. "BART and the Handicapped," San Francisco Bay Area Metropolitan Transportation Commission, Working Paper 17-1-75, Bart Impact, 1974.

Long, Charles, II. "The Handicapped Driver - A National Symposium." Journal of Rehabilitation (March-April 1974), 34-38.

Mandella, Joseph L. and Harry A. Schweikert, Jr. "Mobility for Physically Impaired Persons," Defense Transportation Journal, v. 28, no. 4 (July/August 1972), 63-7.

Mark Battle & Associates, Inc. Transportation for the Elderly and Handicapped. Prepared for the Urban Mass Transportation Administration, U.S. Dept. of Transportation, July 1973.

Mouchaboir, George E. "Management of a Transportation System for the Disadvantaged," Traffic Quarterly, v. 28, no. 2 (April 1974), 291-306.

"New Direction in Planning and Action in Transit Programs for the Transportation Disadvantaged." In Proceedings of Third Annual Florida Transportation Conference, St. Petersburg, Florida, November 1973.

Noakes, Edward H. "Architectural Barriers and the Problems of the Handicapped." In Proceedings of ASCE Mass Transportation Interface Conference, 1972, 51-65.

Paralyzed Veterans of America. Mobility Needs for Physically Impaired Persons. Washington, D.C., 1969.

Perle, Eugene D. "Urban Mobility Needs of the Handicapped, an Exploration," Studies in Geography, no. 16 (Northwestern University Department of Geography), 1969, 20-41.

Proceedings of Conference on Transportation and Human Needs. American University, Washington, D.C., July 19-21, 1972.

Rehabilitation Record, v. 13 (July-August 1972), 1-24.

Sahaj, Lynn. "UMTA Program Focuses upon the Transportation Needs of Persons with Special Problems," Transportation Topics for Consumers, v. 1, no. 4 (November 1973), 1, 4-5, 7.

Schnell, John B. "Public Transportation and Transportation Needs of the Elderly and Handicapped," Transportation Research Record, no. 516 (Transportation Research Board), 1974, 1-10.

The Urban Institute. Comprehensive Needs Study of the Severely Handicapped. Prepared for the Rehabilitation Services Administration, U.S. Dept. of Health, Education and Welfare. Washington, D.C., 1975.

"Transportation for the Handicapped - An Equal Opportunity to Travel," Metropolitan, v. 71, no. 3 (May/June 1975), 14-17.

Transportation Research Board. Proceedings of Fifth Annual International Conference on Demand-Responsive Transportation Systems, Oakland, California, 1974.

"Transportation Service for the Handicapped," Taxicab Management, v. 22, no. 11 (November 1974), 14.

Transportation Systems Center. The Handicapped and Elderly Market for Urban Mass Transit. Prepared for the Urban Mass Transportation Administration, U.S. Dept. of Transportation. Cambridge, Mass., October 1973.

U.S. President's Committee on Mental Retardation. Transportation and the Mentally Retarded. Washington, D.C., GPO, June 1972.

Urban Mass Transportation Administration. The Additional Cost of Providing Mobility for the Elderly and Handicapped on the Washington Metropolitan Rail Rapid Transit System. Prepared for the U.S. Dept. of Transportation. Washington, D.C., May 1973.

Van Abel, David P. "Transportation Needs of the Aged and Handicapped," A Background/Resources Paper for the Upper Great Lakes University Consortium for Transportation Research, Springfield, Virginia, NTIS, 1973.

White House Conference on Aging. Transportation. Washington, D.C., March 1971.