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Service and Methods Demonstration Program

U. S. DEPARTMENT OF TRANSPORTATION
URBAN MASS TRANSPORTATION ADMINISTRATION
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16. Abstract

This report contains a description of the Service and Methods Demonstration Program. Transit demonstration projects undertaken in previons years are reviewed. Recently completed and current demonstration projects are described and project results from similar demonstrations are compared. The comparisons are made by grouping projects according to the program objectives addressed: (1) decrease transit travel time, (2) increase transit reliability, (3) increase transit coverage, (4) increase transit vehicle productivity, and (5) improve the mobility of transit dependents. Demonstrations are categorized as either experimental, i.e. those intended to develop and test concepts to the point where they merit widespread use, or exemplary, i.e. those conducted to achieve more widespread diffusion of proven concepts and techniques.

Independent activities carried out in support of the demonstrations are described, such as the development of evaluation guidelines and improved methodologies for demonstration evaluation, analytical studies in support of the development of experimental demonstrations, and case studies of independent local innovations. Information dissemination mechanisms and activities intended to facilitate more widespread knowledge of effective approaches to improving transit are discussed.

The Appendix contains a detailed description of each demonstration project including the objectives, history, status, results, evaluation and conclusions.

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PREFACE

The body of this report was prepared by the Office of Systems Research and Analysis of the Transportation Systems Center and the Summary and Overview and Background Chapters by the Service and Methods Demonstration Program Staff. It is one of the work items undertaken as part of the support to the Service and Methods Demonstration (SMD) Program sponsored by the Office of Transit Planning, Urban Mass Transportation Administration. It contains a description of all transit demonstration projects and support activities carried out under the SMD program. Results of the demonstrations are summarized and compared to permit an overall understanding of the applicability and effectiveness of techniques for improving the quality of public transportation.

The material reported here was compiled and prepared under the direction of the UMTA Program Manager, Ronald Fisher, and TSC Project Manager, Peter Benjamin. Structure, content, and editing were the responsibilities of Donald Kendall. The following TSC staff members participated in the preparation of this report: Robert Casey, Carla Heaton, Joseph Misner, Robert Waksman, Charles Cofield, Howard Simkowitz, Leonard Bronitsky, Sam Schiff, Willa Michener, Mary Stearns, Mary Jenkins, and Jan Lanza. Research and editorial assistance was provided by staff of the Raytheon Service Co., including Fred Hafer, Stanley Moss, Judith Ceremsak, Herbert Bogen and Robert Park.

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CHAPTER I

SUMMARY AND PROGRAM OVERVIEW

The Service and Methods Demonstration Program (SMD) is essentially the current expression of the techniques and methods category (as opposed to hardware development) of the Urban Mass Transportation Administration's demonstration activity. The authority to conduct demonstrations to improve "facilities, equipment, techniques and methods" was the first authority granted by Congress in initiating a Federal Government role in mass transportation in 1961. However, it was just recently (fiscal 1975) that the program began to take on a more activist posture in carrying out this authority. In prior years, it was relatively unstructured and responsive to random applications from local governments. These were not very useful in developing generalized concepts of national interest.

The basic premise of the Service and Methods Demonstration activity is that much better performance of existing urban transportation systems can be attained through the imaginative use of traffic management and marketing techniques, pricing, transit service variations and state-of-the-art technology. The program has very high pay-off potential with respect to improving the quality of transit service, which is a precondition for effective support of other prominent national objectives such as improved air quality and energy conservation.

A prime consideration in attempting to increase the effectiveness of our total demonstration effort has been to identify objectives which would be clearly attainable by virtue of actions taken as part of the demonstrations, independent of exogenous conditions.

The following objectives were chosen to categorize projects for program planning purposes on the basis of their being operational, technically credible, and supportive of meeting the transit problems cited above.

- Reduce travel time by transit.
  This is an important factor in increasing transit ridership and improving vehicle productivity.

- Increase the area coverage of transit service.
  This is important for increasing transit ridership, yet responding with cost effective approaches to public pressure for new transit service in our lower density suburban and non-urbanized areas.

- Improve the reliability of transit service.
  This is one of the most important factors in maintaining and increasing ridership.

- Increase the productivity of transit vehicles.
  This is most important in the continuing struggle to reduce operating deficits while maintaining or improving service.

- Improve the mobility of transit dependents.
  The development of promising techniques to achieve this is necessary to respond to increased pressure to provide mobility to people without automobiles.

Projects to accomplish the above objectives are categorized into two stages: experimental demonstrations which are intended to develop and test concepts to the point when they merit widespread use; and exemplary demonstrations which are intended to take these and other relatively proven concepts and apply them to projects in other cities that will continue the projects beyond the period of Federal funding thus gaining further exposure to the merit of these innovations.

CONTENT AND STRUCTURE OF THIS REPORT

The Summary and Program Overview reviews past efforts related to the current objectives of the program and specific plans for fiscal 1976. Chapter II is a background section describing the evolution of the program, past problems and the current structure.

The succeeding chapters contain a description of all demonstrations and activities being carried out under the SMD progrm. Results of the demonstrations are summarized and compared to permit an overall understanding of what has been learned about the applicability and effectiveness of various techniques for improving the quality of public transit. Discussions of exemplary and experimental demonstrations are organized according to the program objectives to which they are related. The techniques used to meet the objectives, such as bus priorities or demand responsive service, are described prior to discussion of their application within a particular demonstration.

Chapter III describes those demonstrations aimed at improving transit service by meeting three service oriented objectives: decreased travel time, increased coverage, and improved reliability. Chapter IV deals with the objective of increasing the productivity of transit vehicles and describes the various measures of productivity as well as demonstrations aimed at improving productivity. Demonstrations of methods for improving service for the transit dependent, with emphasis on the elderly and handicapped, are described in Chapter V.

Chapter VI discusses a variety of independent activities underway in support of the program. For example, there are analytical studies in support of the development of experimental demonstrations and case studies of independent local innovations. These improve the knowledge base of the program. Case studies which will be reported *in interim* and future annual reports will be a valuable supplement to the flow of information from the Service and Methods Demonstration Program to all urban areas.

The Appendix contains a detailed description of each of the current demonstrations, including those about to begin operation, those presently underway, and those that are already completed and evaluated. Each demonstration is described separately with the following information provided:

(1) Project Overview
(2) Objectives
(3) Project Description
(4) Project History and Status
(5) Results
(6) Evaluation and Conclusions
(7) References

DEMONSTRATION ACCOMPLISHMENTS THROUGH FY 1975

This review is confined basically to completed and currently active projects. However, some projects which began in fiscal year 1975 are discussed in the section on FY 1976 plans, in order to facilitate understanding of the evolution of the program.

Reduce Travel Time, Increase Coverage, Improve Reliability

Three of the program objectives, those relating to travel time reductions, increased coverage, and improved reliability, together reflect an attempt to enhance the overall level of transit service available to the public. Thus many of the demonstrations undertaken in the Service and Methods Demonstration Program are aimed at meeting these three objectives simultaneously.

Some of the earliest demonstrations sponsored by the Federal Government were express bus operations, which led to the firm establishment of such commuter services in St. Louis, Nashville, Baltimore, Chicago, Dallas, Louisville, Boston, and many other cities. Park-and-ride, as well as traffic management techniques, have been applied in conjunction with express bus service.

Stemming from these earlier express bus operations, more comprehensive demonstrations have evolved addressing the problem of peak hour congestion and people movement in heavily trafficked urban corridors. These demonstrations have involved the close cooperation of the FHWA and UMTA at the Federal level; transit operators, traffic engineers, highway engineers and planners at the local level. Two outstanding experimental successes are now operating completely under local sponsorship: the Shirley Highway Express Bus-on-Freeway Project, Northern Virginia, and the contraflow bus lane approaching the Lincoln Tunnel in Northern New Jersey. A third project, the "Blue Streak" express bus service was initiated in Seattle, Washington, after two referendum defeats of a proposed rail transit system. This demonstration provided a model for an area wide express bus system that was approved in a third referendum.

An exclusive bus lane was constructed in the median of the *Shirley Highway*, connecting employment centers in Washington, D.C. and Virginia with suburban areas in Virginia. Ninety new buses were purchased for the demonstration project, park-and-ride facilities for 800 cars were provided, and over 50 square miles were added to the service area. On-time performance was raised to 90 percent, a 20 percent reliability increase, and travel time savings averaging 17 minutes were achieved. Nearly 12,000 new transit riders were attracted to the service, removing 7,250 autos from the peak period traffic flow. Over 40 percent of the CBD-bound commuters in the corridor now use buses.

The *Lincoln Tunnel Approach*, a 2.5 mile reserved contra-flow bus lane leading to the Lincoln Tunnel along an expressway in New Jersey, handles up to 500 buses per hour. Riders are currently saving between 8 and 25 minutes on their trip, and 95 percent have reported increased reliability in travel times.

Experimental projects in Miami, Minneapolis-St. Paul, and Los Angeles are currently testing other techniques. In *Miami*, park-and-ride and express bus services have been augmented by a reserved lane operation and by giving buses priority at traffic signals along their route. This has resulted in bus speeds very nearly approaching the arterial speed limit. The improved service has doubled ridership. The results from this service will be compared to the implementation of a reserved bus and carpool lane on a parallel freeway in early 1976. The complex and multifaceted effort will permit a systematic evaluation of alternative bus priority strategies.

In *Minneapolis-St. Paul*, the technique used is ramp metering and central monitoring for a freeway to allow buses free access while auto access is metered, depending upon traffic flow conditions. This has permitted a significant expansion of transit service, resulting in a tripling of ridership on the express buses. A majority of the ridership increase comprises former auto users. Many riders who were diverted from local bus routes have saved travel time, and some local service has been eliminated due to overlap with new express services.

In *Los Angeles*, the median lanes of the Santa Monica Freeway will be reserved for buses and carpools, in both directions, 24 hours per day, over a distance of twelve miles in the spring of 1976. It will be the first time a freeway lane in the direction of traffic flow has been set aside for buses and carpools without a physical barrier. The feasibility of this operating concept, being attempted on the busiest freeway in the world, will be evaluated in terms of safety, public response, and cost. Results of this demonstration will be compared with a similar locally sponsored effort in *Marin County* where both with-flow and contra-flow bus-only lanes extend north along U.S. 101 from the Golden Gate Bridge.

Building on the success of these experimental traffic management projects, UMTA plans to work closely in the coming year with urban areas not currently active in the adoption of such proven transit service models. There are approximately eighty urbanized areas that are potential candidates for these innovations but only about a dozen of them are now actively involved in their adoption. In radial corridors where these techniques are used, it seems reasonable to expect to capture 50 percent of the person-trip commutation market. These service models made credible the requirement in guidelines for the new Section 5 capital and operating assistance program, that the efficiency of transit systems be improved by employing techniques to give transit priority in the traffic stream.

Another early project aimed at these service improvement objectives, and which produced favorable results, was a subscription bus service to a suburban work location in *Peoria, Illinois*. Although the bus service was competing with unlimited free parking provided by employers, and there was no traffic congestion, the premium fare subscription service attracted a large number of riders and met operating costs out of the fare box. After the demonstration ended, rising labor costs of the entire system drove the local operator out of business, but indications are that modest support could have resulted in the continuation of a highly popular service. The project showed that commuters can be attracted to high quality personalized transit service. This model has application in various forms in many urbanized areas.

More recent attempts to provide improved transit service in the suburbs have focused on the use of demand-responsive transit integrated with fixed route service. Perhaps the most comprehensive effort underway to develop this integrated service concept is the one being sponsored in *Rochester, N.Y.*, an urbanized area of approximately 600,000 population. Though responsive to all of the program's objectives, it is primarily aimed at developing a cost-effective strategy to increase area coverage and reduce trip time. A dial-a-ride operation is being implemented to provide demand-responsive circulation service in suburban areas, as well as feeding and coordinating with fixed route buses. Subscription buses provide service to employment centers and meet express commuter buses. The expanded coverage, coordinated transfer, and door-to-door services have resulted in steadily increasing ridership, now at 250 percent of the level obtained when the services were first introduced.

The dial-a-ride service will be substituted for lightly patronized fixed-route service in an attempt to increase the efficient utilization of resources. Introduction of computerized routing and scheduling of demand-responsive vehicles, together with direct digital communications from the computer to the buses are also expected to improve productivity. Another key effort will be to minimize transfer time between the fixed route and dial-a-ride services, to make this inconvenience as imperceptible as possible. In a sense, the service level of dual-mode technology will be approximated, using state-of-the-art technology and techniques. It is expected that the transit service model developed in Rochester will be applicable in about 15 similar cities.

On a much smaller scale, a similar project is operational in *Xenia, Ohio*, a city of only 27,000 population that lost a good portion of its transportation system in a tornado in 1974. A fixed route transit service has been established and will be continued with Section 5 assistance. Analyses have been made to determine where there may be opportunities at times of low demand to incorporate demand-responsive service (probably taxicabs) and thereby increase coverage and vehicle productivity. It is expected that the transit service model developed will be of interest to hundreds of small cities similar to Xenia.

In addition to demonstrations, studies related to the transit service objectives are currently underway to examine the potential for new improvements or adjuncts to transit service. The entire field of paratransit has been examined in detail and a popular monograph on the subject is being distributed. Other techniques being analyzed include congestion pricing mechanisms, auto restricted zones, and multi-user vehicle systems.

Increase Productivity

Because the subsidies required to provide high quality transit service have been growing rapidly, methods of reducing costs while still maintaining a high level of service are of significant interest to transit operators, users, and taxpayers. Thus, the achievement of economic efficiency in the operating and scheduling of transit vehicles, as well as raising the occupancy of all passenger carrying vehicles, is an important part of the program objective of increasing transit vehicle productivity.

An early demonstration in this area was the *Washington, D.C.* minibus, which provided low fare downtown circulation service in an attempt to attract high ridership for short trips. The service concept was eventually expanded to include feeder service from in-town employment centers to the downtown commercial district, and is now known as the Washington Downtowner Midibus. The buses operate in this higher density area during the base day at a cost of $12.54 per vehicle hour versus a system average of $18, and generate ridership averaging 9 passengers per vehicle mile, compared to a system average of 3 passengers per vehicle mile. Several cities around the country are adopting similar service to improve their downtown circulation.

Reserved and exclusive lane operations, such as the Shirley Highway and Marin County (Golden Gate) projects, not only increase ridership, and thus productivity, but also increase speed and schedule assurance. This permits the operators to utilize individual vehicles for more runs during a given period than would otherwise be feasible. In *Marin County* an additional 15 trips have been scheduled within the same period of time during the evening peak. It is estimated that an additional 23 buses would be required to operate the *Shirley Highway* service without the exclusive bus lane.

In *Rochester*, as mentioned earlier, dial-a-ride service was substituted for lightly patronized fixed route service in an attempt to increase the efficient utilization of resources. Introduction of computerized routing and scheduling of demand responsive vehicles, together with direct digital communications from the computer to the buses are also expected to improve productivity.

An increase in bus capacity can result in productivity improvements where demand is high. On the *El Monte Busway* in Los Angeles, a demonstration is being sponsored using double-deck buses which seat 84 passengers compared to the conventional 45–50 passenger bus. In *Manhattan*, 64-passenger double-deck buses are to be demonstrated on routes with high passenger demand.

During the sixties a series of experiments was performed in *Boston and Philadelphia* to test rider sensitivity to fare and service changes. It was shown that higher service levels were a stronger influence than fare changes in achieving increased ridership. The Service and Methods Demonstration Program has continued to study this area to further clarify the value of various service and fare changes. In *Amherst, Massachusetts*, a demonstration of free fare transit combined with auto restrictions achieved high ridership and vehicle productivity. Clearly, free fare and prepaid passes encourage ridership while also having the potential to reduce costs associated with fare collection.

Improve Mobility for the Transit Dependent

Providing mobility for those who are unable to afford or use an automobile is central to this objective. This constituency includes the young, old, poor, handicapped and unemployed, and project concepts ought to take into account all such user groups. However, constrained program resources and the intensity of political interest in particular groups combine to confine the focus of this program element at any point in time.

For example, during the period of the civil disorders and rioting in inner city neighborhoods in 1966–67, the limited demonstration resource concentrated on employment facilitation service models, especially service to outlying employment centers. In recent years, the emphasis has been on problems of the aged and handicapped, and legislative expression of such emphasis is common. The most recent is a statement in the Report of the House Appropriations Committee on the 1976 DOT Appropriations Bill. Even after reducing the request for the Service and Methods Program, the Committee directed "that $2,000,000 be earmarked specifically for demonstration projects to provide methods of accommodating the special transportation needs of the handicapped and elderly."

The current emphasis on the elderly and handicapped began in the early 1970's, responsive in particular to Section 16 of the Urban Mass Transportation Act (so-called, Biaggi Amendment, added by PL-91–453 in 1970), which states in part:

> "It is hereby declared to be the national policy that elderly and handicapped persons have the same right as other persons to utilize mass transportation facilities and services; that special efforts shall be made in the planning and design of mass transportation facilities and services so that the availability to elderly and handicapped persons of mass transportation which they can effectively utilize will be assured..."

With respect to the demonstration program, UMTA's efforts were criticized by the House Committee in 1973 with reference to the FY 1974 appropriation as being an assortment of localized projects, not showing promise of developing generalized concepts suitable for widespread adoption. Responsive to this criticism, new starts were curtailed and $1.4 million of the FY 1974 apportionment for this part of the program was used to finance a major research project. Now underway, and scheduled for completion in the latter half of FY 1976, it is a market research effort with respect to the transportation needs of the elderly and handicapped, which will address the issue of full accessibility of mass transportation systems versus specially designed services, and suggest services mixes and concepts (in fact, design typical demonstrations).

Following the organization of the research project, the caseload of existing projects was reviewed to try to identify concepts which showed promise of evolving as service models for cities of different sizes. The result was the identification of one very promising service model and a more focused program of experimentation, which dovetails with the research.

A range of demand-responsive services for the elderly and handicapped has been sponsored in recent years. The currently active caseload includes projects in Cranston, Rhode Island; St. Petersburg, Florida; Naugatuck Valley, Connecticut; Baton Rouge, Louisiana; and Cleveland, Ohio. These services are often coordinated with social service agencies and have frequently used specially modified equipment. All use small vehicles and require pre-registration to establish eligibility for use of the system.

Small City Model. In the *Naugatuck Valley, Conn.*, a transit service model has been developed that provides both subscription and dial-a-ride service and features a credit card system which permits monthly billing either to the riders or to the 20 social service agencies which use the system for client transportation. The equipment is activated by the credit card, records time, trip distance and other information permitting computerized billing, analyses of trip-making, vehicle usage, etc. The rider may be billed for a portion of the trip charge, with the supporting agency paying the remainder. The system covers a large service area (54 sq. mi., four towns, pop. 75,000) with a low density of eligible riders (119 per sq. mi.). It provides its approximately 3,200 registered users with almost 12,000 trips per month, achieving heavy use in a low density region by extensive reliance upon service to geographically concentrated destinations. Currently saturated, the system will soon receive additional vehicles to expand service. This service model, it is felt, has potential application in literally several hundred urban places.

Medium-Size City Model. The Naugatuck model, through close integration with the regular transit system and refinement of the fare collection system, has potential application in much larger places. To test such application, two projects were approved in FY 1975 in *Portland, Oregon*, and *Albuquerque, New Mexico*, cities with populations of approximately 400,000. These projects also require coordination with existing special transportation services offered by social agencies and with taxi service. If adaptation of the Naugatuck model is successful in these circumstances, there are approximately 40 cities in the 200,000–500,000 population range which seem to be potential sites for its use.

Large-City Model. To investigate the potential for the Naugatuck type service in the largest urban areas, such as *Chicago*, a planning phase was funded in FY 1975 to develop a detailed implementation plan for a pilot demonstration. The problem will be to reduce the multiple and fragmented transportation efforts provided by a large number and variety of agencies serving the elderly and handicapped, and to establish a centralized provision of transportation services for the various health and social service agencies. The planning phase will contain an inventory and analysis of data required to determine the travel needs of the mobility limited and the most effective approach to meeting those needs in one geographic sector of Chicago of about 500,000 to 750,000 population. The study will define the specific boundaries of the sector to be served in the demonstration phase, and will also develop plans, specifications, procedures and criteria for operating the special transportation service.

Support Activities

Numerous other activities designed to develop innovative techniques for improving urban mobility are being carried out within the Service and Methods Demonstration Program. The study related to travel requirements of various classifications of handicapped people and the aged was mentioned earlier. In another effort transit operations in a number of small communities are being studied in order to assemble a document and conduct a series of regional workshops which will point the way toward principles to be considered in implementing such systems in non-urbanized areas.

A study is underway to investigate the interaction between moving goods and moving people in urban areas and propose specific demonstrations which will lower the costs and increase the efficiency of urban goods movement. A state-of-the-art survey of park-and-ride systems has been made. This survey revealed a substantial amount of planning knowledge and guidelines that will be compiled for use by transportation planners.

Experts in attitudinal research and behavior prediction, both within and outside of the transportation specialty, were brought together for a conference on the application of these techniques to transportation planning, operations and evaluation. It was the consensus of this group that the investigation of alternative study approaches and the validation of attitudinal predictive and evaluative techniques had not been attempted in a structured fashion in the transportation field. Consequently, work is underway to define appropriate techniques to be applied in an experimental demonstration.

Additional techniques to assist in the planning and evaluation of demonstrations are being developed. These techniques include sketch planning methods, improved modal choice models based upon demonstration results, and improved survey and data collection techniques. Significant emphasis has been placed upon the development of a consistent framework for the evaluation of various demonstrations so as to permit cross comparison and enhance transferability of results. A set of evaluation design guidelines have been completed and will become the program standard for all demonstrations.

Finally, in support of the overall effort to disseminate information about program results through publication of reports documenting specific projects, program activities have been reported extensively in the professional literature, and a more formal mechanism to insure the accessibility and broad distribution of information is being created. Workshops were held in San Francisco and Miami in which the results of bus priority demonstrations were reviewed and the knowledge obtained was shared. Attendance included representatives of the transit and traffic operations fields, as well as various levels of government. A document developed as part of the workshops will provide technical guidelines for areas planning priority treatments for high occupancy vehicles. Continued use of this method of reaching users of Service and Methods Demonstration information is anticipated.

Many promising transit service concepts are being developed and demonstrated within the Service and Methods Program. Each demonstration is a specific, carefully structured application of a generalized concept or service model using techniques which support one or more of the program objectives. The emphasis on systematic evaluation and dissemination of the results of these projects should facilitate the transferability of the concepts to other urban areas. Hence, the long range impacts of the program will be to encourage widespread adoption of established techniques for improving the quality and quantity of public transportation.

PLANS FOR FISCAL YEAR 1976

In the following pages, the FY 1976 plans are described with reference to each of the demonstration categories, exemplary and experimental, and by objectives under each category. The Congressional Submission sought $9.25 million for the program, but it appears that the appropriation level will be less. Within the $9.25 million level, $5.3 million was intended for 10 exemplary demonstrations; $4.95 million for 10 experimental projects. The discussion assumes $9.25 million, but a moderately lower level would not affect the substance of the program.

EXEMPLARY DEMONSTRATION CATEGORY

A number of promising innovations responsive to the program objectives have been evaluated under experimental demonstration projects. While there is a relatively limited budget in FY 76 with which to foster further adoption of these promising innovations, it is anticipated that we will join with a few places on a highly selective basis. Often the moral and technical support provided by the Service and Methods Demonstration Program is at least as important as the relatively modest financial resources available to assist the adoption of innovations.

Reduce Trip Time and Increase Area Coverage

A major effort is being made to gain greater participation in the improvement of public transportation from the *taxicab industry* which is still largely privately held. There is a substantial resource available in this industry to provide public transportation. However, it must increase its capacity to move people by innovating in the direction of shared-ride service as opposed to its traditional exclusive ride service; then it must be effectively engaged by the public sector. The problems appear to differ between the smaller urban areas (under 250,000 population) where there are often smaller taxi companies, and the larger urban areas where larger, more complex company operations may be involved along with publicly operated transit systems which cause more difficult system integration problems. However, the basic concept of integrating demand-responsive service with fixed-route service is very promising in both environments. The possible alternative methods for accomplishing the integration need to be better defined and given exposure.

Consequently, two projects in relatively small urban areas (under 250,000 population), and two projects in larger urban areas (over 1,000,000 population) are now being planned for support in fiscal year 76. Because the problems of integration are expected to be less complex in the small urban areas, conventional dispatching techniques will be used. In the larger areas, assistance will be obtained from our Office of Research and Development in the application of computerized dispatching to achieve the integrated demand-responsive and fixed-route service. This latter approach was used in developing the Rochester project in fiscal 75. The major differences in the projects planned for fiscal 76 are the use of taxicab companies and the type of trip patterns served. The fiscal 76 projects will involve more widely dispersed trip patterns.

Another significant project worthy of special note under this objective was funded in fiscal 75 and will become operational in fiscal 76 in *Houston, Texas.* It involves the application in four travel corridors of various proven traffic management techniques developed in earlier experimental demonstration projects. All UMTA program resources are being combined in this imaginative project to reverse the auto dominated trend in Houston. Local leaders in Houston recognize continued active expansion of the downtown business center will be greatly constrained by the capacity of the auto dominated approach. Consequently, they are working aggressively with us to develop effective low cost alternatives. Participation by the taxicab industry has been under active consideration as part of the project. It is expected that some form of integrated operation will be added later in the project although no funds are presently available for this in the fiscal 76 budget.

Increase Vehicle Productivity and Increase Area Coverage

Very closely allied with the travel time objective is the effort to raise vehicle productivities through *subscription arrangements.* In doing so, the service area or outreach of public transportation may be expanded at a minimal cost.

Public pressures are increasing for more transit service in return for local tax support. Cost effective approaches to providing the increased service coverage are needed to reduce or eliminate the associated increased cost and thus the tax burden these demands generate.

In areas where commuter trips cannot be served conveniently or economically by conventional fixed-route transit, subscription service may be utilized to increase vehicle occupancies and decrease the number of single occupant autos. Subscription service may be provided by taxi operators, bus operators, and vans driven by commuters either through ad-hoc or publicly organized efforts. Two projects in FY 76 will seek to demonstrate that all of these alternatives should be considered as part of an urban area's transportation system, and should be organized and administered by the area transportation provider. However, it is difficult to find organizations that are this flexible. One of these projects funded in the fiscal 75 budget will become operational in *Knoxville, Tennessee* in about eight months. It is estimated that several hundred urban areas are candidates for this type of innovative transit service model.

Improve Mobility for Transit Dependent

The Naugatuck Valley Demonstration Project discussed under Demonstration Accomplishments has provided a promising transit service model. Two projects were supported with the fiscal 75 resource and will transfer this innovation to Portland, Oregon, and Albuquerque, New Mexico. Because of the limited resource in fiscal 76 only one additional medium-sized (200,000 to 500,000 population) urban area will be financially encouraged to adopt this promising innovative method for serving the special needs of the elderly and handicapped.

With reference to the largest urban areas, it was reported under the Demonstration Accomplishments discussion that UMTA recently approved fiscal 75 funding for a study project leading to a demonstration design and possible funding for implementation in a sector of Chicago in fiscal 76. A similar type study is under review for possible funding in fiscal 76 in New York City.

EXPERIMENTAL DEMONSTRATION CATEGORY

Expansion of the knowledge base is essential for the advancement of any endeavor. These advancements may come in rather small increments in relatively low risk projects of the type just described whose major purpose is to gain widespread adoption of promising ideas. However, to make substantial gains in our knowledge of promising ideas requires bolder and consequently higher risk projects. These projects are generally more limited in scope with more tightly controlled evaluations.

Reduce Trip Time, Increase Coverage and Improve Reliability

Perhaps the most difficult operating environment for transit is in the *congested downtown* area. One demonstration project is planned in fiscal 76 to address this problem. Two research studies funded in fiscal 75 will develop site specific demonstration designs for two additional approaches — auto-restricted zones and congestion pricing.

The fiscal 76 demonstration project will be less complex than either of the concepts in the two research studies, although it will be a valuable step toward accomplishing the more complex projects. Under this demonstration, one or more streets will be designated for exclusive use by surface transit to expedite these operations in the downtown area. Also included with the transit only street(s) will be more routine aids such as specially timed traffic signals or total pre-emption of the signals by transit, bus turnouts, etc.

The more comprehensive approaches that will be under study in fiscal 76 will discourage vehicular traffic over a wider portion of the downtown area thus creating a more attractive overall environment for pedestrians. *The auto-restricted zone concept* is a regulatory approach where all thru-traffic to the downtown area except transit would be prohibited either permanently or at certain times of the day. Most cities in Europe that have applied the concept allow vehicular traffic to penetrate sectors of the downtown and it is expected that to achieve political acceptance in this country one would have to be at least this lenient. The *congestion pricing concept* is, as the term implies, a pricing as opposed to regulatory approach for limiting vehicular traffic in the congested area of downtown. Special licenses or windshield stickers would be required for all vehicles, except those providing public transportation, wishing to travel into or through this "priced" area of the downtown. Again, it may be applied either at peak times or on a permanent basis. One foreign city (Singapore) has just implemented the concept and London has seriously considered it. It has been under discussion for over 20 years in this country. However, the Service and Methods Demonstration Program effort is now the closest anyone has come to an actual implementation. Because of the comprehensive nature of both concepts, it is expected a full complement of UMTA resources would be needed to make implementation feasible.

Another demonstration project planned for fiscal 76 involves *applying traffic management techniques to a broader spectrum of public transportation modes.* In other words, it would complement efforts to develop para-transit services such as carpools, subscription vans and buses and shared-ride taxis, by employing traffic management techniques (reserved and contra-flow lanes, etc.) to expedite their flow in congested areas. The obvious problem this mixed use raises is the possible delay caused by differing vehicle performance, especially loading and unloading of passengers. Consequently, well documented information on the actual results of these interactions will be useful guidance in determining the appropriate application for these traffic management techniques in aiding all forms of surface public transportation.

A final project planned in fiscal 76 under these objectives would explore methods to develop currently under-utilized *water rights-of-way for transit.* It involves the use of relatively small (approximately 50 passengers) high-speed boats to provide trip times comparable to the automobile. Although it is not envisioned that waterborne transit service will become a major transit mode, preliminary studies indicate that there are a significant number of potential water rights-of-way in urban areas that might be developed to serve this market for transportation services. The demonstration would determine passenger acceptance of the high-speed boats, responsiveness of demand for the service at various levels, suitability of existing craft, potential markets for the service, and alternate services to attract off-peak use.

Improve Transit Vehicle Productivity

Closely related to this objective, which is generally thought of in terms of the number of passengers being moved a certain distance per unit of time, is also the basic cost of the particular vehicle operation. Efforts to reduce travel time may also work to increase passenger volumes and increase the number of trips that can be made by a driver and vehicle. These related efforts won't be repeated under this objective. Instead, efforts to shift demands to appropriate lower cost para-transit modes and to off-peak marginal cost operations are included under this objective.

In regard to the latter, one obvious strategy involves *the application of pricing.* Just as one is encouraged to use the telephone after business hours by reduced toll rates, people might be encouraged to use transit in the off-peak with lower rates. It has even been suggested by some that transit should be free in the off-peak, while others would completely eliminate the pricing mechanism and make transit free at all times. These issues have been under investigation in FY 75 using data from locally sponsored fare changes and will continue under study in fiscal 76 including development of a program of carefully designed experimental demonstrations to fill in data gaps. Of course, the price is just part of the input to the consumer decision, and the service being offered rounds out that decision. The relative weight given to each of these by various consumer groups is important to know in order to properly allocate limited resources being used to influence these decisions. Unfortunately, there is considerable debate and little hard facts regarding the price and service trade-offs. Several *price and service variation* demonstration designs will be developed in fiscal 76 for possible implementation in FY 77.

Ultimately, the price and service variation demonstration would consist of performing timely changes to transit fares and selective levels of service. It would measure the relative importance of each of these key elements as reflected by the actual transit rider reaction. The experiment would identify the price and service levels that caused significant increases in transit ridership, especially noting increases from previous automobile users. Also, upper service levels that did not cause any further increases in ridership or productivity would be identified. An overall evaluation would be made of the effect of these price and service changes in increasing mobility for the various sectors of the transportation market. Social-welfare implications would be defined.

To be more specific, price and service variations that would be considered involve the fare, wait and ride time, vehicle fleet, door-to-door accessibility, and comfort and convenience factors. Isolated and incremental reductions in fare would be used to obtain demand elasticities for different fare levels. Improvements in travel time and frequency of service would involve such things as increasing the number of vehicles and skip-stop or express service during the selective hours. Door-to-door accessibility might be improved by advance reservation and route deviation service, establishing a network of bus routes with timed transfer points at strategic locations in residential areas, and park-and-ride or demand-responsive feeder service to the line haul transit.

Comfort and convenience could be improved by introducing vehicles that are aesthetically attractive, clean, temperature controlled and more spacious with better seat design.

Related to the pricing strategy is the approach to *presenting the price to the consumer.* A study begun in fiscal 76 will analyze the various approaches used over the years for pre-paying for transit service. Consumer reaction to these various techniques, effect on system revenue, and administrative costs and problems are not presently very well documented. It is possible that it will be desirable to try new combinations of *pre-payment systems* and administrative techniques like the use of payroll deduction. Possibilities for site specific demonstrations will be analyzed and the funding of one operational project is planned in fiscal 76.

Finally, a small research study is planned to look into the feasibility of licensing private automobile operators to carry passengers on commuter trips only. The concept is termed "*Shared-Ride Autd*" and would provide service between well defined origins and destinations. Organized properly, it could reduce peak load burdens for the transit operator and provide users with more flexibility in their travel than is possible under more conventional carpooling. Consequently, the vehicle productivity of the auto system is raised and the cost burdens of peak operations for transit operators is reduced.

Improve Mobility for Transit Dependent

Examination of and preliminary experimentation with *user-side subsidies* will continue into fiscal 76. In fiscal 76, one demonstration project in Danville, Illinois, will become operational with funding having been provided in fiscal 75. Two additional projects are planned for funding in fiscal 76.

In this concept, selected groups of current or potential transit users (young, handicapped, elderly) are provided tokens or transportation vouchers at less than face value. The transportation provider (i.e., private taxi or bus operator) redeems them at full cash value, or even at a premium, from the agency administering the program. The objective is to improve trip opportunities for specific user groups by encouraging the development of services such as shared-ride taxi service at reduced rates. The project funded in fiscal 75 is in a relatively small community (approximately 40,000) and will involve shared taxi operations. One more similar experiment will be supported in fiscal 76, plus a more complex operating project involving both taxi and bus operations. With reasonable success, it may be possible with this concept to reduce the impetus toward the institutionalization of public providers to meet the mobility needs of the transit dependent. This concept also has special potential with respect to possible use by clients of HEW programs, using HEW funds to subsidize certain trips — e.g., travel to meal centers under the nutrition support program.

Another method that appears very promising in reducing the cost of providing special transportation for the elderly and handicapped, but at the same time increasing their mobility is the *community broker concept.* One project was approved in fiscal 75 to be demonstrated in a small sector of Santa Clara County, California, and one more project is planned in fiscal 76.

The community broker demonstration will identify individuals who will serve as transportation brokers for specific target groups desiring transportation services. The broker will be the middle man between these clients and the transportation providers. By grouping riders, the broker would attempt to work out arrangements with providers for reduced rates for groups travelling to shopping, health and recreational activities at times arranged in advance. He/She might also arrange group discounts (even no-fare service) for shopping, etc. The broker could work as an employee of a transportation provider, or an organization serving the target group; or could work independently and obtain a commission from clients (perhaps as a supplement to a retirement income). In the community brokerage system, the broker is not a supplier or subsidizer of services.

Finally, the *mobility problems of inner city residents* will be analyzed in a study now planned for funding in fiscal 76. Various promising approaches are expected to be identified in the research study and site specific demonstration designs will be developed. One demonstration is planned in fiscal 76. *Jitney-type service*, where sedans or vans operate random but frequent service between inner city points, exists in a few cities on an ad-hoc basis outside the local institutional or regulatory framework. This service has attractive and important mobility value to the residents of these areas not being met by the traditional fixed-route transit operation. It is anticipated the concept of jitney service with an organized licensing arrangement to protect users, but with relatively open entry, should add an important demand-responsive dimension for inner city public transportation at low cost.

RELATIONSHIP TO TRANSPORTATION SYSTEM MANAGEMENT (TSM)

A vital part of the Transportation Improvement Program regulations recently issued by UMTA and FHWA is the Transportation System Management (TSM) element. The regulations call for urbanized areas to formulate an overall policy strategy, assess candidate measures, and select, program and *implement actions* to improve the efficiency of the existing urban transportation network. The results of previous Service and Methods Demonstration (SMD) projects such as the Shirley Highway and I-35W Metered Freeway projects described herein are valuable sources of information on the types of innovative actions that can be taken. Future demonstration projects will expand the knowledge base of innovative measures that relate to TSM.

The materials currently being compiled by UMTA and FHWA to assist local areas to plan TSM actions include a large amount of information from SMD projects. As stated previously, the SMD program technically assisted in putting on two workshops in 1975, in San Francisco and Miami, in which a state-of-the-art document was critiqued and modified for immediate use in the TSM effort. In addition, to further assist local areas to identify and implement these actions, the SMD program is embarking on an effort to develop a set of documents based on information available from innovative projects. Each document in the set will be geared to a specific level of local interest ranging from the low level professional staff person charged with implementing the specific projects to the high level decision maker setting policy on the actions to adopt.

Future exemplary demonstration projects will encourage the adoption of the additional innovative actions that local decision makers continue to show hesitation to include in the TSM element. Also, experimental projects will explore new innovations such as congestion pricing and auto-free zones in further developing the assortment of vanguard practices that may ultimately be adopted through the TSM element.

CHAPTER II

BACKGROUND

PROGRAM DEFINITION AND PURPOSE

The Service and Methods Demonstration (SMD) Program is geared toward improving existing transit operations by sponsoring the implementation of new techniques and services on a nationwide basis. These innovations, by relying on existing transit technology, are intended to produce short range improvements in the quality and quantity of public transportation. The program places emphasis upon providing total coordinated transportation for an entire trip, not on a particular mode, rail or bus, or a particular portion of the trip; collection, line haul, or distribution. Instead, the focus is on getting persons from their origin to their desired destination as quickly, efficiently, and comfortably as possible. In most cases this requires a combination of modes, integrated and coordinated in order to supply a variety of transportation services for various users, trip purposes, and travel patterns.

The SMD Program includes all operating transit demonstration projects sponsored by the Urban Mass Transportation Administration (UMTA). It therefore subsumes ongoing activities previously classified as Service Development, Urban Corridor, and Intermodal Integration as well as new demonstrations initiated under the SMD label and those in the planning and proposal stages. Since the philosophy and structure of the SMD Program are an outgrowth of the experience gained from the demonstrations preceding it, a review of these earlier demonstration efforts is appropriate.

HISTORICAL PERSPECTIVE

The authority to conduct demonstrations to improve facilities, equipment, methods and techniques was the first authority granted by Congress in initiating a Federal Government role in mass transportation in 1961.

In the early years of the UMTA demonstration program, the emphasis was on implementing a wide variety of demonstration projects. The program gave relatively limited consideration to either a coordinated set of program goals or to a structured process of implementation, operation, evaluation, and dissemination.

One major problem during that period was the overemphasis placed on a system's breaking even: the success of a project was judged heavily on its ability to produce sufficient farebox revenue to meet operating costs. Public tax support of operating costs was not generally accepted at any level of government. The program operated in an environment of declining transit ridership, little local financial support for transit, and a demand responsive management posture on the part of the federal government. Yet in spite of meager local resources in support of transit, several demonstration services did continue to operate after Federal support was withdrawn.

Although most projects involved some degree of evaluation, the lack of consistent procedures for carrying out the various evaluation activities and of standardized performance measures hindered, and in some cases precluded any meaningful comparison of results across different projects, or any extrapolation of project results to other interested locales. These projects produced reports which were printed, distributed and placed in the National Technical Information

Service (NTIS). But the lack of widespread knowledge of the results of these projects indicates that the dissemination approaches used were too passive.

In recognition of commonly perceived deficiencies and problems, the Service and Methods Demonstration Program was established in Fiscal Year 1974 to provide a consistent and comprehensive framework within which to formulate, implement, evaluate, and disseminate results of demonstrations. In addition to the intent to broaden the number of demonstration projects and expand information dissemination, it remains important to continue to explore and develop new concepts with potential for upgrading transit service and urban mobility.

Despite the ad hoc nature of UMTA's earlier demonstration program it is important to note that past projects did provide useful experience and results that continue to have relevance in developing transit services. Some examples of these early demonstrations, and lessons learned from them, are given below:

1. In the mid sixties, a subscription, premium fare, commuter bus service was established by the City of Peoria, Illinois to serve employees of the Caterpillar Tractor Plant. In spite of the absence of traffic congestion and availability of free parking at the plant, the service attracted sufficient ridership to meet operating costs. After the demonstration ended, the operator was caught in the classic revenue/cost squeeze for the whole system: fares went up, ridership went down, and no subsidy was available. Eventually the operator went completely out of business. The subscription service concept, however, is valid and the demonstration is well documented. This type of service is being successfully offered in many areas today, usually in connection with dial-a-ride, with good results.

2. Other conventional fixed route transit services to suburban employment centers were demonstrated and were generally failures from a local viewpoint. Ridership levels were very low and revenues fell short of operating costs. This, coupled with the Peoria experience, reinforced the view held by many professionals in the field that there was a need for a more specialized service for such locations not in the central business district. Fixed route and scheduled feeder services to commuter rail operations in suburban areas were demonstrated in the sixties without much success in attracting patronage. These attempts further emphasized the need to develop different approaches to serving contemporary land use patterns. While these projects were failures in the context of local considerations, from a national perspective they added important insight into a rationale for developing more demand responsive transit services. Thus, in the late sixties, UMTA began to support the development of demand responsive transit technology.

3. Several suburb to downtown express bus demonstrations were successful both in attracting new riders and in meeting operating costs. This type of demonstration has been perhaps the most successful throughout the history of the program. Express commuter services were established on a permanent basis in St. Louis, Nashville, Baltimore, Washington, D.C. and Chicago. In more recent years, express service combined with bus priority has been implemented in many cities such as Seattle, Minneapolis, Miami, Washington, Dallas, Cincinnati, Louisville and New York. Based upon the results of UMTA demonstrations, many other cities have established express commuter service. Also, as will be seen later in this summary, these projects have led to new expanded local support for these services.

Figure 1. Shopping Trips Provided by a Dial-A-Bus Service

Figure 2. Free Fringe Parking Provided in Conjunction with Express Bus Service

4. Several successful park-and-ride demonstrations were conducted. These operations were maintained and park-and-ride has become an important part of the UMTA program and most transit systems around the county.

5. The first attempt at a special Central Business District (CBD) circulation system, the Washington Minibus was established in 1965. This type of service has been copied in several cities around the country even though part of the service concept is a low fare that cannot possibly cover operating costs. The Minibus was discontinued in 1971 due to a cost/revenue squeeze, deteriorating equipment which the private operator could not replace, and lack of local subsidy. It was replaced in December 1972 by a midibus, also sponsored by UMTA (see Appendix G). That service is still operating under local sponsorship.

6. A series of experiments were performed in Boston and Philadelphia during the sixties to test the effect of fare and service changes on ridership. In these extensive experiments, fare increases and decreases were combined with various changes in service levels. The tests indicated a much stronger passenger attraction to good service levels than to low fares, particularly during peak periods. Long term passes and monthly rates were found to be popular in two other projects. These projects occurred at a time when the industry was moving away from passes because it was felt that they led to a loss of net revenues. The results therefore did not appear to have much impact outside of the projects, at that time.

SERVICE AND METHODS PROGRAM ELEMENTS

In order to accomplish its overall goal of improving existing transit operations by the implementation of new techniques and services, the Service and Methods Program is organized into three separate but closely integrated functions: Exemplary Demonstrations, Experimental Demonstrations, and Information Dissemination.

Exemplary Demonstrations

The Exemplary Demonstrations are intended to encourage the adoption of proven innovative transit services and methods by conducting a series of demonstrations in selected regionally dispersed locations, thereby increasing exposure to these techniques. In these demonstrations the major thrust is to synthesize, combine, and apply methods which have already been developed and demonstrated to a reasonable degree on an experimental basis.

Initially, five objectives are being emphasized by the program. The first is a reduction in travel time for transit users. This can be accomplished by increasing service frequency, decreasing transfer time or number of transfers, increasing vehicle speeds, and similar measures.

Increasing transit coverage is the second objective. This is in keeping with a long term Departmental goal to improve mobility within urban areas and access to and from urban centers, for people and goods. Expanded transit coverage provides more choice of transportation modes, increasing the flexibility and efficiency of urban travel. Broader coverage also increases access to public transportation for those who do not have an alternative mode.

The third objective is an improvement in the reliability of transit service. Assurance of schedule adherence is an important component of high quality public transportation. Segregating

Figure 3. Downtown Contraflow Bus Lane

Figure 4. Exclusive Reversible Freeway Bus Ramp

transit vehicles from other traffic, monitoring vehicle location and status, improving routes and schedules, and upgrading the quality of maintenance are techniques which can increase the dependability of transit service.

The fourth objective is improved transit vehicle productivity. Increasing the efficiency of transit operations can provide more and better service to a greater number of people at lower cost. Increasing the speed and regulating the flow of transit vehicles through segregation of traffic, automated techniques for routing and scheduling vehicles and more efficient management of operations, are among the methods for increasing productivity.

Providing improved service for the transit dependent, especially the handicapped and elderly, is the fifth objective. The transit dependent are those members of the community who are dependent on public transit because they do not have the use of an automobile, are unable to drive and cannot afford private taxi service. They include the young, elderly, handicapped, poor, and members of one-car families. In recent years, a variety of approaches have been developed to improve the mobility and ease of movement for various special user groups. For the handicapped, vehicle modifications such as wheelchair lifts provide access where none existed. In addition, special demand responsive door-to-door subscription and reservation services, and coordination of transportation schedules and budgets with health and social service agencies are being applied to satisfy this objective.

Experimental Demonstrations

The Experimental Demonstrations will contribute to the expansion of the knowledge base and the development of new techniques leading to Exemplary Demonstrations. Therefore, the aim of the Experimental Demonstrations is to continue development of new services and methods, to increase understanding of the various factors which affect the public use and acceptance of transit, and determine the consequent impact of public transit upon the urban environment.

Experimental Demonstrations will usually be preceded by an analysis of feasibility and the development of a detailed implementation plan, including site selection criteria and site recommendations. These demonstrations may focus on specific issues related to a new concept, such as the institutional and legal considerations, or potential costs and benefits.

Examples of projects of an experimental nature would be demonstrations of innovative applications of paratransit services, auto restrictions in downtown centers, and novel approaches to delivering operating assistance funds.

Information Dissemination

The third major function of the program is Information Dissemination. An important feature of the restructured demonstration program that will become increasingly evident in FY 1976 is the effort to disseminate information coming available as output from the program.

In FY 1975 the program supported two workshops (discussed previously) dealing with priority for surface transit. In FY 1976 we plan to hold a series of six workshops, regionally dispersed, to assist small communities (urban areas under 50,000) in identifying promising alternatives for the use of the non-urbanized area funds becoming available in the UMTA program. Other workshops aimed at providing technical assistance to local areas on specific topics such as planning and designing park-ride facilities are also being planned for FY 1976.

Figure 5. Cars Waiting at Metered Expressway Ramp; Far Left Lane is a Bypass Lane for Buses

Figure 6. Midibus Transportation for the Elderly and Handicapped

Closely related to the effort to disseminate information through workshops is the effort to utilize conferences being held by our various constituencies, i.e., APTA, ITA, TRB, League of Cities. Our staff has interacted through these conferences to present material such as results of our efforts to integrate taxi operations into a coordinated urban transportation system and the research into cost effective methods to better serve the special needs of the elderly and handicapped. Added emphasis in FY 1976 will also be given to arranging for conference participants to visit the sites of actual operating demonstrations. Our research on how to effectively disseminate information indicates site visits may be one of the most effective methods.

A less effective method, according to those knowledgeable in disseminating information, is through reports. Nevertheless, it is being carefully attended to because of the traditional value held for this form of communication. The report contained herein is just one example of this and we plan to update the report on an annual basis hereafter. In addition, a very structured approach is underway for evaluating each operational demonstration not only to add to our internal knowledge base as an aid in establishing cogent policy, but also for reporting results externally. Our scope of attention is also broadening to include not only innovations directly sponsored, but relevant innovations which are usually not well documented. Numerous case studies are being sponsored in FY 1976 to expand our reporting base to the greatest benefit of local areas seeking out alternatives for improving their urban transportation system.

DEMONSTRATION CRITERIA AND FUNDING

The Exemplary Demonstrations are intended to be components of the transportation system in the urban areas in which they are implemented. Criteria for their selection include their potential for continued use at the demonstration site and an achieved level of effectiveness for the site commensurate with the long range operating costs. These demonstrations should have a potential for expansion under local initiative into a broad program of transit service improvements. In addition, each potential site must demonstrate a desire and capability, both financially and operationally, to continue and expand the service improvement beyond the termination of the demonstration period.

In order to foster these ends, the local area will be expected to contribute financially to an Exemplary Demonstration. Over the demonstration period, the federal contribution will decline and the local funding will increase, until the entire service is fully supported on a local basis. Thus, before a demonstration begins, a federal disengagement strategy and local funding mechanism will have been defined.

Federal funding sources other than the Service and Methods Program may also be sought for such investments as new vehicles or roadway modifications. Participation by the UMTA Capital Grants program and the Federal Highway Administration will be solicited for these funds. Therefore, the program involves a high degree of cooperation between various offices in UMTA, DOT modal administrations, as well as between the Federal Government, states, and urban areas.

The Experimental Demonstrations are more investigative in nature, with less expectation that any services or methods implemented will be continued beyond the completion of the demonstration. The Federal Government may provide full financing for any or all elements of the demonstration. The only local commitment required may be operational cooperation for the duration of the experiment. Should an experimental demonstration prove particularly useful, however, the locality may independently elect to continue the service or method.

CHAPTER III

DECREASING TRANSIT TRAVEL TIME, INCREASING TRANSIT COVERAGE, AND IMPROVING TRANSIT RELIABILITY

The Service and Methods Demonstration Program addresses three objectives which relate closely to the quality of urban transit service as perceived by the user: decreasing transit travel time, increasing transit coverage, and improving transit reliability. The demonstrations discussed in this chapter are aimed at meeting one or more of these objectives in an attempt to improve transit service. Most of the demonstrations achieve all three simultaneously. Among the demonstrations are a series of projects which encompass a broad range of innovative non-capital intensive techniques. Four novel concepts are being studied in preparation for Experimental Demonstrations. Once the analyses are completed, detailed demonstration designs will be prepared.

This chapter describes the various demonstration projects which have been implemented or planned to date and compares the approaches used and the results currently available. The last part of the chapter discusses the experimental studies currently underway.

TECHNIQUES

The demonstrations reported here utilize a variety of techniques for improving service. Many of these relate to improvements in the flow of buses and provision of faster bus service. Whether or not bus travel time is significantly reduced, is often not as important as the "perceived" speed, which is a function of the number of stops and the smoothness of flow. As bus services improve in speed and reliability, more riders, especially for commute trips, are likely to be satisfied with the quality of service.

The techniques which have been used to improve bus transit are listed across the top of Table 1. Many of these techniques are familiar; their "innovation" lies in their application to urban transit situations where they had previously been relatively untried. Other techniques are more novel. In Table 1, the techniques and major features of each demonstration are summarized. The techniques being applied include the following:

(1) EXCLUSIVE LANES are freeway lanes which are physically separated from the general traffic lanes, and whose use is generally restricted to high-occupancy or emergency vehicles. High-occupancy vehicles include buses and often carpools. The physical separation may exist at all times, or in peak hours only.

(2) CONTRAFLOW LANES are lanes which carry high-occupancy vehicles (usually buses only) in the opposite direction from the normal flow of traffic on that roadway. The purpose of this arrangement is to take advantage of the excess capacity of the minor flow direction (generally outbound from the central business district in the morning, or inbound in the evening) during peak periods.

(3) RESERVED FREEWAY LANES are restricted to use by high-occupancy vehicles, but no physical separation is provided. Signs and pavement markings are used to demarcate the reserved lane. This technique is attractive in situations where buses must enter and leave the reserved lane at many different points.

TABLE 1. DEMONSTRATIONS AIMED AT IMPROVED TRANSIT SERVICE

	BUS PRIORITY					Park-and-Ride	SERVICE IMPROVEMENTS						CONTROL SYSTEMS	
	Exclusive Lane	Contraflow	Reserved Lane	Arterial Preference	Ramp Metering		New Routes	More Frequent	Carpool Priority	Demand Responsive	Special Vehicles	New Marketing	Central Monitoring	Central Dispatch
Shirley Highway	11 miles; 2 lanes			downtown dis-tribution		yes	NVTC[1] service is new	yes	4 or more persons per carpool		improved amenities			
Miami			10 mile corridor	lane on parallel aterial		yes	more direct routing	yes	3 or more persons per carpool		improved amenities	yes	control of signal progression	
Minneapolis					17 mile freeway	yes	11 new express routes						monitor traffic conditions	
I-495 New Jersey (Lincoln Tunnel Approach)		2.5 miles				yes		yes				yes	plans for central traffic control	
Cincinnati						yes		yes				yes		
Rochester							subscription service			yes		yes		
Xenia	planned bus streets						entirely new service			planned	special H+E[2] vehicles		tracing of DRT[3] vehicles	yes
U.S. 101 Marin Couty		4 miles	4 miles								special H+E[2] vehicles			planned
Santa Monica			12 miles		both directions entire length	yes	new routes to park-ride lots	yes	3 or more persons per carpool			yes		

Notes: [1]Northern Virginia Transportation Commission
[2]Handicapped and elderly
[3]Demand responsive transportation

(4) ARTERIAL BUS PREFERENCES are arrangements which attempt to expedite the movement of buses along major urban streets other than freeways. Such streets are not limited-access roads, and are often regulated by traffic lights. Possible means of providing priority to buses are through traffic signal preemption (enabling the bus driver to exercise some control over the traffic lights), preferential turning movements, and reserved lanes, either with flow or contraflow.

(5) RAMP METERING is a technique for regulating the rate at which automobiles enter a freeway in order to provide free flow of traffic. As capacity of the roadway is approached, traffic lights at the entrance ramp are used to delay autos entering the main roadway. Ramp metering of auto entry onto the freeway is usually accompanied by provisions for buses (and possibly carpools) to obtain unrestricted access by passing the automobile queue and entering the freeway directly.

(6) PARK AND RIDE refers generally to the practice of driving to a place where a public transit vehicle can be boarded and leaving one's car at that point, using the transit service for the remainder of the trip. Many of the demonstrations considered here have made special provisions to encourage commuters to park and ride, such as special lots, reserved space in existing lots, express transit service from the parking site to the downtown, or low parking charges in fringe areas somtimes combined with high charges for downtown auto parking.

(7) DEMAND-RESPONSIVE SERVICE embraces a range of public transportation services whose schedules and/or routes can be influenced by the individual traveler. These services provide shared-occupancy, door-to-door personalized transportation on demand at modest fares. Specific forms of demand responsive service include shared taxi, Dial-a-Ride, and Dial-a-Bus, and are often collectively labeled "paratransit."

(8) SPECIAL VEHICLES include any which differ in capacity, comfort, or equipment from conventional urban buses. The variations may range from more comfortable seats or quieter engines, to elaborate platforms and hydraulic lifts to accommodate handicapped travelers.

(9) CENTRAL MONITORING AND DISPATCH refers to any use of computer technology to permit rapid adjustment or response of service to special conditions, such as weather, accidents, or unusual traffic volumes. A wide range of variation is possible within this general approach, and is illustrated in the demonstrations considered here, which exemplify methods ranging from monitoring of traffic conditions to generate commuter advisory information (using variable signs), to central control of traffic light signals, to central dispatching of vehicles in response to customers' demands.

It will be observed from Table 1 that in addition to these innovative methods, most of the demonstrations involve an increased level of resources devoted to transit in the corridors or service areas in which they operate. In particular, the introduction of new bus routes and the intensification of marketing efforts are common to many of the demonstrations. This is consistent with the philosophy of the exemplary category of projects in the SMD program, which is to demonstrate a battery of techniques as they would be used and combined in a typical transit operation, rather than to place primary emphasis on controlled experiments. However, in experimental projects such as Miami, Santa Monica, and the Shirley Highway, the implementation of the program in stages enables evaluators to distinguish the separate effects of various techniques.

As the table suggests, each demonstration site employs a different combination of techniques for achieving the SMD objectives. The sites are typical of many other urban areas in their demographic characteristics and transportation supply.

In the discussion which follows, the demonstrations in Table 1 are divided into three groups: those which have been underway for a long enough time period that meaningful data on results and impacts are available, and those which are currently underway but for which such data is not yet available.

ESTABLISHED DEMONSTRATIONS

The demonstrations in this category are among the largest, most visible, and most successful of Federally sponsored efforts to develop effective forms for urban commuter travel. All of them fall into the general category of "bus priority" arrangements as discussed above.

(A) *The Shirley Highway* (Washington, D.C. and Northern Virginia: see Appendix A for detailed project information). Begun in 1970, the Shirley Highway project was the first demonstration of the "busway" concept as an important alternative to rapid transit for line haul commuting. The success of this experimental demonstration has led to the adoption of the concept elsewhere. Today it is one of two major "busways" providing high speed transit commuting service through an urban corridor, with several other projects in final planning.

The project consists of two permanent, reversible exclusive lanes plus a short section of a single lane temporary roadway in the median of an eight lane highway serving the Virginia suburbs southwest of Washington. Bus service connects these high income, auto oriented suburbs to employment areas in downtown Washington and on the Virginia side of the Potomac River. Ninety new buses, purchased for use in the project and equipped with many features that enhance the riders' comfort, provide integrated local collection and distribution service in the outer suburbs and express line haul service using the exclusive lanes. Recently carpools of four or more persons were permitted to share the exclusive lanes with the buses. A new park-and-ride facility with more than 400 available parking spaces, and another 400 spaces from designated portions of two shopping center parking lots provide a major source of bus patronage.

The Shirley Highway project provides unmistakable evidence of the ability of high speed, high quality bus transit service to penetrate the commuter market even in a corridor whose population might not be viewed as a fertile market for mass transit. Ridership has grown steadily over the four years of the project's operation, despite being constrained at some points by limitations on the supply of buses. A total of 10,000 new bus users were attracted by the service. The bus system's ability to attract auto commuters was proven by removal from the peak period traffic stream of about 7,250 autos per day which would have been expected in the absence of the project. A majority of former auto commuters had driven alone prior to switching to the express bus. About 40 percent of the CBD-bound commuting trips are being captured by the bus service.

Although operating deficits were incurred during starting phases of the demonstration, total revenues over the entire project covered operating costs until late 1974.

The Shirley Highway project has achieved all three of the SMD program objectives which are being considered in this chapter. Those current users who were Shirley Highway transit patrons before the project began have reduced their travel times by an average of 17 minutes per one way trip. The bus system's geographic coverage has been expanded by over 50 square miles. Service reliability has also improved markedly. Over 90 percent of the buses, an increase of about sixty percent, now meet the operator's "on-time" criteria, i.e., the buses arrive not more than 6 minutes late at the first stop in Washington, D.C..

(B) *Miami I-95/N.W. 7th Avenue Bus/Carpool System* (described in Appendix C). This experimental demonstration, which has been underway for less than a year, is planned as a complex and multi-faceted effort which will permit a systematic comparison of the effects of different bus priority strategies on both a freeway and an arterial in the same corridor. The experimental techniques to be compared include signal preemption, signal progression, centrally controlled signal preemption and signal progression, a reversible reserved lane on the arterial, and a reserved with flow lane for buses and carpools on both sides of the freeway. Unlike the bus/carpool lanes on the Shirley Highway, Miami's lanes will not be physically separated from general traffic.

A four month experiment with new express bus routes operating in general traffic on the freeway was conducted during 1974 to provide a "base case", so that the specific effects of the various bus priority strategies could be separated from the effects of expanded service and new promotional efforts. At present the buses have moved from the freeway to the parallel arterial, and the three-month period involving only signal preemption on the arterial has been completed. The next phase, involving signal preemption and the use of the reversible lane, is currently underway, while the construction of the reserved freeway lanes is proceeding. A large number of new park-and-ride spaces (about 2200) are being provided to serve the express buses.

The increase in service attracted a sharp increase in ridership, from 600 daily trips on express bus to 1300. This patronage has been maintained and slowly increased as the buses moved to the arterial from the freeway. There is no evidence of a disproportionate diversion of former carpoolers to express buses.

It is too early to report travel time and reliability results for comparisons between the "base case" (pre-priority treatment) and the first stage of the bus priority experiment. To date, the most important achievement of the Miami demonstration has been the expansion of transit coverage to new employment centers not previously served by express bus, and the restructuring of residential collection routes in the north and northwest suburbs.

(C) *Minneapolis (I-35W) Bus-on-Metered-Freeway* (see Appendix B). The Minneapolis experimental demonstration project consists of the expansion of express bus service on an Interstate corridor freeway, and the use of ramp metering with central monitoring of traffic conditions. Buses are allowed immediate entry while autos are metered, thus stabilizing flow on the expressway.

The transformation of I-35W from a freeway for automobiles to a balanced transportation route was accompanied by a thorough marketing effort. Before the introduction of express bus service, the planning agency interviewed commuters who used the freeway to find out their perceptions of it as a commuting route. Their views helped to structure the development of transit service. The introduction of express bus service was accompanied by an extensive campaign to advertise the new service and influence the usage and acceptance of the system. This campaign included newspaper advertisements, mail-outs, and radio spots stressing the potential for time and cost savings available through the express bus service. Two sets of telephone surveys were conducted (in September 1973 and October 1974) to gauge public awareness and use of the express bus service, awareness of express bus advertising, attitudes towards the express bus

Figure 7. Shirley Highway Busway and Exclusive Bus and Carpool Lanes, Washington, D.C.

Figure 8. Minneapolis I-35W: Metered Ramp with Bypass Lane for Express Buses

service, characteristics of corridor users — bus and auto, and awareness and impact of metering on driving patterns.

As a result of the expansion of service from three to fourteen express bus routes using the I-35W freeway, ridership on express buses increased from 2600 to 6500 during the course of this phase of the project. Awareness of the increased coverage is reflected in survey results indicating that over half of the auto commuters and over 90 percent of express bus riders reported that express bus stops are located close to their home and downtown destinations. Some express bus passengers were diverted from other bus routes, and this diversion was sufficient to cause a decline in local bus patronage from 22,900 to 21,100 during the same period. The market share, or total bus riders as a percent of total person trips in the corridor, increased from 17 to 20 percent of the morning northbound peak period travellers before the metering phase began. Express bus travel time savings over the local bus service range between 15 and 46 percent.

Comparisons between the "before" situation and the partial implementation are obviously misleading, since the ramp metering is designed precisely to counteract the increased freeway congestion which has contributed to the slippage in travel speed during the evening peak period. If this third, already operational phase is judged successful, then the use of this innovative strategy will have enabled an improvement in the reliability and possibly the speed of express transit service in addition to the already observed gains in coverage and frequency.

(D) *I-495 New Jersey approach to the Lincoln Tunnel*: *Contraflow Bus Lane* (see Appendix D). The Lincoln Tunnel corridor, connecting northern New Jersey suburbs with midtown Manhattan, provides a different kind of environment for transit commuter service innovation, since the corridor is already heavily transit oriented. The observed gains in ridership with the experimental introduction in 1970 of 2.5 miles of contraflow exclusive bus lane approaching the western portal of the Lincoln Tunnel were substantial: 2,000 new riders per day, or an increase of 6 percent in an already large number of transit riders. A decline in auto occupancy observed at the same time suggests that some auto passengers in carpools switched to buses on the exclusive lane. Approximately 84 percent of the 30,000 peak hour commuters in the corridor now travel by bus.

The broad SMD objective of improving service for existing transit riders is especially well illustrated by the Lincoln Tunnel project. The contraflow project attracted some new riders to the bus service; however, many of the patrons had been regular transit users. Eighty one percent of the bus riders are using the same bus route that they had used prior to the beginning of the demonstration project. They experienced time savings ranging from 8 to 25 minutes per morning trip, and averaging about 10 minutes. Furthermore, 95 percent reported more reliable travel times as a result of the project when questioned in a survey.

In contrast to Minneapolis, the Lincoln Tunnel project represents no significant increase in transit coverage, but a marked improvement in speed and reliability of transit service.

Conclusions

All of the projects described above establish the fact (no longer controversial) that buses using existing roadways can successfully attract significant numbers of urban commuters who are accustomed to using their automobiles, if high speed, comfortable, reliable, and convenient service is offered. This conclusion applies not only to moderate income corridors such as northern Miami, but also in relatively high income areas such as Northern Virginia. In all cases, the key element is a mechanism for giving buses priority over other traffic: bus lanes on the Shirley Highway and on the

Figure 9. New Jersey I-495: Contraflow Operation Near the Lincoln Tunnel

Figure 10. Contraflow Bus Lane - U.S. 101, Marin County, California

approach to the Lincoln Tunnel, bus control over traffic signals in Miami, and provisions for buses to bypass freeway entrance queues in Minneapolis. In some cases, costs are imposed on auto traffic: limitations on the flow of vehicles onto I-35W in Minneapolis, and some increase in congestion elsewhere. Nonetheless, auto drivers as well as bus passengers often gain time through the implementation of these measures, most notably on the Lincoln Tunnel approach, where the buses use a roadway which would otherwise be allocated to minor direction traffic. The introduction of the technique may have permanently postponed a $100 million project to expand the capacity of the tunnel approach.

Increases in ridership for express buses tend to occur wherever there are parallel increases in the coverage of express routes. Thus, dramatic percentage gains have occurred everywhere but at the Lincoln Tunnel, where the market share for transit was already over 80 percent. And the Lincoln Tunnel demonstration showed that improved service could result in attraction of some additional ridership even in a market with extensive transit penetration. Provision for park-and-ride access appears to be an important component of accessibility in corridors where auto ownership is high and the customary commuting mode is auto.

The currently available operational data is not sufficient to determine whether ridership responds differently to the various techniques for providing bus priority. The Shirley Highway ridership did respond noticeably to the introduction of new park-and-ride capacity, but this may be interpreted as a method of expanding transit coverage. It is not yet clear to what extent new riders are attracted when priority treatments cause marginal reductions in line-haul travel time on existing routes.

One of the first priority projects, the "Blue Streak" project in Seattle, did cause a 30 percent increase in ridership with a small (approx. 5 min.) savings in travel time. Early indications are the marginal improvements from metering are having an even greater impact on ridership in Minneapolis.

It should be emphasized, however, that user perceptions of service improvements are at least as significant as actual increased improvements. On this basis, the demonstrations have been highly successful. Express bus users in the Minneapolis and Lincoln Tunnel demonstrations reported satisfaction related to significant perceived service improvements.

The Service and Methods Demonstration Program is primarily concerned with innovations that benefit transit users, and only secondarily with generating increases in ridership. When these four demonstrations are measured according to their success in achieving the specific SMD objectives of increased speed, coverage, and reliability, their record is one of general success. Table 2 provides indicators of the impact of the demonstrations on these objectives.

The three projects, Shirley Highway, Miami, and Minneapolis, which attempted to achieve a sizable expansion of transit coverage have all been highly successful in achieving this SMD objective. As already noted, the expansion of coverage has been closely correlated with, and is confirmed by, the equally dramatic percentage gains in express bus ridership.

The data on the improvements in the reliability of transit service is less conclusive than the other data presented thus far. Minneapolis has made the most detailed study of the effects of its demonstration on bus schedule reliability, but the available data deal only with the service expansion phase and do not consider the effects of either the ramp metering or the bus bypass of

TABLE 2. ACHIEVEMENTS OF DEMONSTRATIONS AIMED AT IMPROVED TRANSIT SERVICE

	SERVICE AND METHODS DEMONSTRATION PROGRAM OBJECTIVES		
Demonstration	Reduced Travel Time	Increased Transit Coverage	Improved Transit Reliability
Shirley Highway	10 - 15 minute reduction over 11 miles	50 square miles of new coverage in 150 sq. mile corridor.	60% improvement in meeting on-time criteria
Miami	data not yet available	new employment centers served; new routes	data on normal operation not yet available
Minneapolis	data from ramp-metering phase not available; however 15 46% savings compared to local service	number of express bus routes increased from 3 to 14	data from ramp metering phase is not available; previous phase showed mixed results
I-495 New Jersey (Lincoln Tunnel Approach)	8 - 25 minute reduction over 2.5 miles	negligible, except for new park - ride facilities	95% of riders say service is more reliable

freeway entrance queues. These innovations will permit better schedule adherence due to the more uniform flow on the expressway.

ONGOING DEMONSTRATIONS

This category includes four demonstrations which were in operation at the time of this writing, but for which systematic data on results had not been compiled. They illustrate two other forms of bus line haul service to commuters, and also innovative forms of transit to increase speed, coverage, and reliability for potential users of transit other than commuters.

(A) *Cincinnati "Sun Run" Bus Service* (see Appendix F). This exemplary demonstration using proven techniques is an express bus service operating on arterial streets and linking a suburban area in the eastern corridor to the Cincinnati CBD. Six square miles were added to the transit service area through the modification of residential collection routes and a park-and-ride terminal at the outer end of the corridor. More frequent service was also provided. Increased enforcement against parking violators was implemented along the arterials, lights were synchronized, and turn controls were instituted. A large promotional program was undertaken to publicize the service.

These changes are clearly less extensive than in some of the other demonstrations. Nonetheless, ridership has increased substantially—almost 80 percent above pre-demonstration levels. Forty percent of the new riders were formerly auto commuters. Over 40 percent of the total number of bus passengers came from households with incomes in the $15,000 to $30,000 range, and 52 percent came from multi-car households.

No data are available on the effect of the project on bus travel times or schedule reliability. However, the demonstration serves as a reminder that even such "simple" measures as increased service frequency and aggressive promotion can have a powerful leverage in attracting new riders, even in a high-income market.

(B) *Rochester Integrated Fixed Route and Demand Responsive Demonstration* (see Appendix I). The Rochester Dial-A-Ride system is an exemplary demonstration of an integrated demand responsive and fixed route transit service connecting the suburbs and downtown Rochester.

The Rochester system will generally expand transit coverage in suburban areas of metropolitan Rochester, by providing door-to-door demand responsive and subscription services in three suburbs adjacent to the Rochester city limits. The pre-demonstration system began with a 10 square mile service area, which will expand to 25 square miles, and extend to two more service areas, 10 and 7 square miles respectively, by the end of the demonstration. The Greece and Irondequoit suburbs are each now served by reasonably good fixed route buses while Henrietta has only one bus line. The availability of Dial-a-Ride will greatly improve the mobility of those for whom fixed route service is not readily accessible or does not serve their travel patterns. Services will include demand responsive trips anywhere within the service area, subscription home-to-work and home-to-school trips, and feeder service to connect with fixed route buses into the CBD and between service areas.

On the pre-demonstration system, 54 percent of the dial-a-ride patrons previously made no trip or made the trip by car and 13 percent walked, indicating that dial-a-ride is serving riders who did not previously use transit. In the existing service area 5 percent of the households have no car and 62 percent have only one car, implying that household members are at least semi-dependent on transit and can benefit from increased transit coverage.

The existing routing and dispatching system uses manual digital communications between the control room and the vehicles. During the course of the demonstration a fully automated routing and dispatching system will be introduced. The improved efficiency in routing should minimize travel and wait times and improve reliability, by enabling accurate prediction of travel and wait time. As is indicated in Appendix I, wait time is now the larger portion of the total trip time (17–18 min. average vs. 13–14 min. average in vehicle time), and it has a relatively high variability (a standard deviation of 8.5 minutes was calculated from one survey). It is in this area that the most change can probably be expected from the computerization. Additionally, the demonstration plans to call for improved coordination between the demand responsive vehicles and the fixed route buses. This should minimize wait times at the transfer point, simultaneously improving transit reliability.

(C) *Xenia (Ohio) Model Transit Service Demonstration* (see Appendix H). The Xenia, Ohio, exemplary demonstration is unique in several respects: it is the only site discussed in this chapter which had no public transit service at all prior to the SMD demonstration, and the service was begun in the wake of a tornado disaster which (among its many devastating effects) destroyed 60 percent of the private automobiles owned by town residents. With a population of only 27,000, Xenia is also close to the lower end of the scale for an urban area considering some form of public transportation.

The Xenia Transit System consists of 10 vehicles and provides, under partial SMD sponsorship, all of the local public transit available to the residents. A prepayment system for fare collection is presently being implemented. The current fixed route system, which has been in operation since November 1974, now draws an average of 825 daily riders. In contrast to the other demonstrations, only 42 percent of system trips were classified as "work" or "business" trips. Demand responsive service utilizing the local taxi operator is scheduled for implementation in off peak and weekend periods later in 1975.

The success of the system in adapting transit coverage to the travel patterns is evident. At present, three quarters of the daily riders live within one and a half blocks of a fixed-route bus stop. Data regarding travel time and schedule adherence is not available.

The system appears to serve a less affluent set of riders than the other systems considered here. About three fifths of the riders have incomes of less than $9000 per year.

(D) *Golden Gate Transit District Bus Priority System; U.S. Highway 101, Marin County, California* (see Appendix E). This is one of the first examples of an independent local project being monitored and evaluated by the Service and Methods Demonstration Program. It will be reported within the program as a case study. The project illustrates another combination of exemplary techniques for giving buses priority on freeways when they are carrying peak hour suburban commuters. Since September 1972, buses leaving San Francisco via the Golden Gate Bridge have traveled for four miles from the northern end of the bridge along U.S. 101 in Marin County on a contraflow reserved bus lane, which was separated from opposing traffic by a buffer lane containing traffic cones during the evening peak period. In December 1974, while this arrangement was continued, four additional miles of concurrent flow reserved lanes were implemented on both sides of the highway for use in both the morning and evening peak. This extended the total length of the outbound evening bus lane to about eight miles.

At the peak load point along the contraflow lane in July 1973, express buses carried almost 9000 passengers, or 39 percent of the CBD oriented evening trips. This represents an 85 percent increase in ridersip over January 1972 volumes, but it is not possible to attribute all of this to the demonstration since other locally sponsored service improvements were underway simultaneously. No data on ridership since December 1974 is available by which to gauge the incremental effect of the new concurrent flow lanes. Travel time reductions of 8 to 18 minutes per trip are reported.

The U.S. 101 demonstration represents the first actual implementation of reserved concurrent flow lanes without any physical barriers on a freeway in peak hours. Carpools are not allowed on these lanes. Similar arrangements are planned in Miami and in Santa Monica (below), but with the addition of carpools, which add to the safety and enforcement concerns of the projects.

NEW DEMONSTRATIONS

New demonstrations of bus priority systems designed to improve the speed, coverage, and reliability of transit service are being planned in many cities. The Santa Monica project described below was recently selected for SMD funding.

(A) *Santa Monica Freeway Bus-and-Carpool Lane* (see Appendix K). This experimental demonstration project is also multi-faceted. Its experimental component is the testing of no barrier reserved concurrent-flow lanes for high occupancy vehicles (buses and carpools) along a 12 mile stretch of the Santa Monica freeway connecting Santa Monica with the Los Angeles CBD. The project also includes provision of seven new park-and-ride lots served by new bus routes, full ramp metering of both sides of the freeway, and a substantial increase in service frequency. Considerable time savings for bus commuters are projected. However, since there is no excess capacity on the Santa Monica Freeway even in many hours of the off peak period, the ramp metering may create additional congestion on adjacent arterials as cars are deterred from entering the freeway at their present rate of flow.

The Santa Monica demonstration will provide another test of the no barrier concurrent flow reserved lane concept. It is to be enforced by highway police, and the rate of illegal auto use of the reserved lane is expected to be held below 3 percent.

The park-and-ride facilities should enable a substantial expansion of transit coverage in the region. Effects on schedule reliability are difficult to project since (as in the Lincoln Tunnel Project) most bus routes will have the preponderance of their mileage on local downtown and residential or arterial streets, rather than on the reserved lanes.

Since the corridor is predominantly (though not exclusively) upper income in its demographic composition, the service will need to appeal to affluent multi-car households in order to succeed.

Summary

The demonstrations already under partial sponsorship by the Service and Methods Demonstration Program exhibit a rich variety of non-capital intensive techniques for providing additional mobility to urban residents and attractive alternatives to automobile commuting for work trips. While this summary has stressed their substantial accomplishments in improving the speed, coverage, and reliability of public transit service in the areas where they are located, their greatest significance should be evidence to other localities of the potential for economical and efficient improvements in urban transportation. From the standpoint of new localities, perhaps the most attractive common characteristic of these projects is their extraordinarily short lead times as compared to larger and more visible urban transit investments involving major construction of new facilities. Projects such as those in the Service and Methods Demonstration Program promise to be economical not only in dollars but in time, and to achieve measurable transportation benefits very shortly after their implementation.

FUTURE DEMONSTRATIONS

In addition to the established and ongoing demonstrations described above, the Service and Methods Demonstration Program is preparing plans for demonstrations that will be carried out in the immediate future. Demonstrations aimed at improving transit service will include further investigation of the use of taxicabs as an integrated part of an urban transit system, and the use of waterborne transit.

In developing new concepts for potential demonstration, a number of experimental studies are being conducted. Those aimed at improving transit service include three concepts which appear to have considerable potential for reducing transit travel time, increasing transit coverage, and improving transit reliability: automobile restricted zone, the multi-user vehicle system, and congestion pricing. In all cases the studies consist of two phases: first, an analysis of the operational, economic and institutional feasibility of the concept and an examination of any past experience in this country or abroad with the concept; and secondly, a preliminary design of experimental demonstrations in selected sites.

Taxicab Service Innovations

Taxicabs operating shared ride service appear to have important unexploited potential for meeting what some observers consider to be the nation's most significant transportation problem: the limited mobility of those without access to a private automobile. Full utilization of this potential may be hindered by regulatory policies which preclude publicly subsidized fares for groups such as the elderly, handicapped, or poor, or which restrict the provision of shared ride or subscription service.

In addition, taxis appear to be capable of substituting efficently for conventional transit in situations of low demand density and providing feeder support to high-capacity line haul facilities. Successful use of taxis for these purposes would achieve the SMD objectives of improved coverage, decreased travel time, and improved vehicle productivity.

Case studies conducted to date provide convincing evidence that under proper regulatory conditions taxicabs can provide efficient, high quality dial-a-ride services, and that local government can disburse subsidies to taxicab operators in a manner which increases mobility and ensures relatively efficient use of subsidy funds. Also, jitney services have been successful in some locations, and there are some indications that taxi feeders to conventional bus routes can appreciably improve total transportation service. However, some operational experiments have yet to be carried out, and even the most successful of the existing projects have had some serious problems in developing service provisions and fare structures.

Demonstration projects under the SMD program will enable planners to gain operational experience with some new forms of taxi service. The substitution of taxicabs for late evening and weekend bus services, and the use of jitneys under government subsidy in inner city neighborhoods and in heavily traveled corridors, are the most important near term projects.

Taxicabs appear to have a strong potential as the demand responsive component of an integrated fixed route and demand responsive service. In Rochester, transit buses provided the demand responsive as well as the fixed route service, but local conditions may dictate the use of taxis in the demand responsive role. The advantages of taxis are: more efficient utilization of an existing transportation resource; lower cost to the taxi operator because overhead can be spread over shared ride service and traditional premium taxi service; more efficient use of vehicles since they can be shifted from demand responsive mode to traditional taxi service; there is no need to establish a new organization to handle transit demands; a privately owned and tax paying business will be strengthened; and competition between taxi companies may lead to increased efficiency. In cases where it is not feasible or desirable to use taxis, service can be furnished directly by the local transit operator. The advantages of using a transit operator to provide the service are the increased ease of coordination of services.

A demonstration using taxi operators is planned for FY 1976. The demonstration will test various types of contracts with taxi companies, as well as various service concepts. Based on the results of these demonstrations, this concept will be further diffused through exemplary demonstrations in FY 1977.

Waterborne Transit

Ferry systems at one time provided a considerable degree of service in many cities but most were phased out due to competition from automobiles and bridge construction. In recent years, however, the amount of congestion on urban highways has suggested a second look at the potential of waterborne transit. With the use of modern, high speed boats, trip times on the water can compete with auto trip times, particularly during peak periods. In some cases it may be possible to serve areas that are not readily accessible by land transit. Moreover, the boats can be used to give access to recreational areas in offpeak periods and weekends.

A demonstration of waterborne transit will seek to use waterways to supplement urban transit, using existing boats such as hovercraft and hydrofoils. The initial demonstration will be conducted in a city with existing ferry operations in order to take advantage of its experience in conducting marine passenger services. The demonstration will determine consumer acceptance of the service, economics of operation, reliability of existing boats, user response to various fare levels, and changes in boat design needed to make the craft more acceptable for commuter operations. If the initial demonstration is a success, the service concept will be tried in an area that presently has no waterborne transit.

Automobile Restricted Zones

A one year study is underway to evaluate the feasibility of the automobile restricted zone (ARZ) concept and to develop initial demonstration designs in several selected cities. An automobile restricted zone is an area created in a congested portion of the city, such as the central business or shopping district, where automobile traffic is prohibited or restricted. Such a zone may range in size from a few blocks along several adjacent streets to large portions of major activity centers. There are many forms of automobile restriced zones: an ARZ might be created through the imposition of severe parking restrictions, barriers to through traffic, or a ban on all automobiles. An automobile restricted zone is expected to lead to a reduction of transit travel time and an improvement in transit reliability since transit vehicles will no longer be impeded by automobile congestion. In addition, an ARZ could lead to increased transit usage, decreased land requirements for parking, and decreased pollution, energy consumption, and accidents. All this would help to provide a more appealing environment for pedestrian oriented activities on or adjoining the street.

There are several large and highly successful auto restricted zones currently operating in Europe, but the few American ARZ's have typically been limited to closing off only one or two blocks on a shopping street. At this time it is not known whether the results from European cities are applicable to American ARZ's and further analysis (primarily socio-economic and political) is needed. Accordingly, the tasks in the study include an investigation of past and existing ARZ projects, an evaluation of the feasibility of the possible forms of the innovation for small, medium, and large sized urban areas, and the development of site selection criteria. This will be followed by a selection of possible demonstration sites and the development of a general demonstration design and implementation scheme for the selected sites. If the results from this study show ARZ to be a promising concept — politically, economically and socially — an experimental demonstration will be implemented.

Multi-User Vehicle System

Concurrent with the ARZ study will be a similar study of the multi-user vehicle system (MUVS) concept, in which initial demonstration designs for small, medium and large cities will be developed. A multi-user vehicle system is most succinctly described as a user operated taxi, where a fleet of vehicles is made available to qualified subscribers. There are different forms of multi-user vehicle systems depending on the number and location of access points and the types of trips permitted. There may be one or several well-defined terminals where users pick up and drop off vehicles, or vehicles may be picked up and left at curbside anywhere throughout the service area. Travel may be restricted to short trips within the service area or may include use of the vehicles for commuting from the suburbs, or to feed line haul transit. It is possible, but by no means necessary, that a MUVS could be an important part of the public transportation service within a large automobile restricted zone. This combination will be examined in the study.

By more efficient use of fewer and smaller vehicles, MUVS should decrease congestion and thereby lead to a decrease in travel times. In addition, there should be a decrease in parking requirements, pollution and energy consumption and an increase in mobility for those who do not own cars and for whom the use of public transit is not convenient.

Previous studies have emphasized the theoretical aspects of MUVS such as the design of specialized vehicles and the modeling of a vehicle redistribution scheme, but no overall system design emerged from the analyses, and the problems of designing an actual demonstration were never confronted. The tasks in the present study are the same as for ARZ. If the study shows MUVS to be a promising concept from an economic, political, and social viewpoint, experimental demonstrations will be implemented.

Congestion Pricing

The Service and Methods Demonstration Program is currently sponsoring activities to investigate the potential applicability of congestion pricing, identify possible demonstration sites, and conduct prototype design studies which will ultimately evolve into a demonstration design.

Congestion pricing can be defined as a mechanism whereby automobiles are charged a special additional price to travel in congested zones at congested times. Economists have advocated congestion pricing over the last two decades as a means of achieving more efficient utilization of street space in urban areas. It is possible that one reason why this idea has not been implemented is the lack of clear and persuasive evidence regarding administrative, legal, financial and political feasibility. Many studies have suggested that congestion pricing could be quite beneficial to the community as a whole, but only a demonstration of congestion pricing will answer the following questions:

- How feasible are the implementation, administrative and enforcing strategies?
- What shifts in travel pattern (level of trip-making, destination choice, modal shifts, time of day choice) will result?
- How much revenue will be raised by a congestion pricing scheme?
- Can the revenues be used to offset any adverse impacts on the poor?
- What will happen to retail business and the availability of labor in the area in which congestion pricing is implemented?

Congestion pricing is expected to serve the Service and Methods Demonstration Program objectives of reducing transit travel time and increasing transit reliability by means of directly effecting a reduction in area travel and easing of peaking problems in congested city centers. Such a scheme would additionally encourage efficient utilization of street and parking space, promote higher occupancies in private vehicles, increase the use of conventional transit and para-transit, and generate substantial revenues. It is hoped that congestion pricing would generate social benefits such as reductions in congestion, noise, air pollution, and energy consumption and contribute to the revival of downtown areas as desirable and attractive places to work, shop, and conduct personal business.

A popular monograph has been prepared which provides a descriptive summary of motivations, desirability, feasibility and costs of implementing congestion pricing. It also addresses questions of equity and efficiency. It is designed to provide local transport officials, policy makers and interested citizen groups with the most relevant evidence accrued to date on the likely impacts of congestion pricing.

In-depth analysis will be needed for the selection of demonstration sites, since few easily accessible objective criteria exist. A careful study has been conducted to compare potential measures. The next step will be to select about five sites for prototype design studies, which will form the basis for the eventual demonstration design. The studies will identify periods and areas of congestion, design appropriate pricing schemes, determine the instrument for administering the plan, determine the level of charges, and estimate the incidence of costs and benefits. In addition, they will consider possible ways of utilizing the revenues from congestion pricing to improve and expand conventional transit and para-transit services and to alleviate negative impacts on the poor.

CHAPTER IV

INCREASING TRANSIT VEHICLE PRODUCTIVITY

The objective of increasing transit vehicle productivity is increased economic efficiency in the operation and scheduling of transit vehicles. Efficiency is measured by utilization of transit drivers and vehicles, as reflected in the ratio of passengers served (passenger trips or passenger miles) per unit of transportation service provided (vehicle hours or vehicle miles). Higher vehicle productivity produces an associated decrease in the total cost of providing a passenger trip and hence a reduced ratio of operating costs to operating revenue.

Transit vehicle productivity may be increased in essentially two ways: either the number of passengers carried may be increased, while holding the units of transportation service constant; or, changes in the transportation service characteristics may be made which result in a higher passenger carrying capacity per unit of transportation service and per unit cost. The former is generally accomplished by providing an improved level of service; the latter can be accomplished by increasing the size and capacity of vehicles, or by changing the operating environment to enable buses and drivers to make more trips per operating hour. As transit is a labor intensive system, the most cost beneficial changes are generally those which enable a more intensive use of the driver's time.

An increase in transit vehicle productivity may be achieved through a variety of different techniques and will be reflected in system parameters — passengers carried, units of transportation service provided, and costs per passenger or per unit of transportation —in different ways, depending upon the type of service and the treatment applied.

The Service and Methods Demonstration Program is sponsoring Exemplary and Experimental Demonstrations which employ a range of techniques for increasing vehicle productivity. The experience gained from these demonstrations has already begun to yield valuable insights into the circumstances under which given treatments can be successful. Demonstrations planned for the future should continue to further the understanding of vehicle productivity changes. Demonstrations which have increasing transit vehicle productivities as a major objective, to date, have focused largely on the efficiency of the vehicle operating environment to increase productivity. However, it should be pointed out that all of the demonstrations discussed previously under the objectives of the increased coverage and reliability and decreasing travel times, if successful, should experience increases in ridership. Unless proportionate increases in vehicle hours or miles are required to accommodate the increased ridership, an increase in transit vehicle productivity will also result.

ESTABLISHED AND ONGOING DEMONSTRATIONS

The demonstrations of increased productivity are discussed and compared in the remainder of this chapter. Table 3 contains the characteristics, features, and status of these demonstrations. Table 4 shows results, in terms of various productivity measures, for the operating demonstration projects.

Two quite similar demonstrations which have effectively increased the carrying capacity of buses by increasing the number of bus trips per bus hour are the Shirley Highway and the U.S. 101 Marin County express-bus-on-freeway demonstrations. In each case, a form of exclusive bus lane

TABLE 3. DEMONSTRATIONS AIMED AT IMPROVED TRANSIT VEHICLE PRODUCTIVITY

PROJECT TITLE	PROJECT LOCATION AND DEMONSTRATION DATES	PROJECT CHARACTERISTICS	TECHNIQUES EMPLOYED TO INCREASE VEHICLE PRODUCTIVITIES	PROJECT STATUS
U.S. 101 Exclusive and Reserved Bus Lanes	Marin County, California September 1972	Commuter bus service on contraflow and with flow exclusive and reserved bus lanes on U.S. 101; lanes are utilized by 12 bus routes	Decreased travel times & increased reliability enable buses to make more trips per hour	P.M. peak contraflow lanes began operation in Sept. 1972; A.M. peak lanes began operation Dec. 1974; to be extended March 1975
Shirley Highway Express Bus-on-freeway	Shirley Highway Connecting Northern Virginia Suburbs to Wash., D.C. April 1969 - December 1974	Express commuter bus service, using 11 miles of exclusive freeway lanes (2 reversible lanes); 90 buses use the lanes to serve 11 rts.	Decreased travel times & increased reliability enable buses to make more trips per hour	Construction to be completed in October 1975
Double Deck Bus	New York City (Manhattan) Los Angeles (San Bernardino Express Busway) January 1975 - December 1977	8 double deck buses operating on 2 local Manhattan route, characterized by short passenger trips, overcrowding and automobile congestion; 2 double deck buses on express commuter routes, characterized by long passenger trips & high speeds.	Increase bus size to increase capacity for less than a proportionate increase in in capital cost, and no additional vehicles or drivers required.	Los Angeles buses began service in April 1975. New York City buses to begin service in January 1976.
Integrated Transit Demonstration	Greece, Irondequoit, & Henrietta, suburbs of Rochester, N.Y. March 1973-September 1977	Demand responsive and subscription service, using small buses in medium density, medium income suburbs of a large metropolitan area	Computerized vehicle dispatching to maximize efficiency of vehicle operations; substitution of DRT for fixed route service where DRT can operate more efficiently.	DRT service has been in operation in Greece since 1972. Service will begin in Irondequoit in Nov. 1975, and in Henrietta in Sept. 1976.
Downtowner	Washington, D.C. December 1972-June 1974	Off peak circulation service in the downtown area, connecting areas of dense employment concentration with the retail shopping core.	Utilized non-productive driver time from other parts of the system; increased ridership through use of a unique zonal fare system.	Service maintained by Washington Metropolitan Area Transit Authority (WMATA)
Free Fare Transit Demonstration	University of Massachusetts Amherst, Mass. Febuary 1972-December 1973	Free fare bus service on 88 miles of on & off campus bus routes connecting the campus with the Town of Amherst's shopping and residential areas. The population of Amherst is 27,000 including 16,500 resident students. Campus parking reduced 46% and peripheral parking begun.	Free Fare transit, in conjunction with increased coverage and reduced number of campus parking spaces increases transit ridership and vehicle productivities	Service is being continued by the University of Mass.

TABLE 4. ACHIEVEMENTS OF DEMONSTRATIONS AIMED AT IMPROVED TRANSIT VEHICLE PRODUCTIVITY

DEMONSTRATIONS	PRODUCTIVITY MEASURES										
	Passenger/ Vehicle Hour	Passenger/ Vehicle Mile	Pass. Mile/ Seat Mile	Oper. Costs/ Vehicle Mile	Oper. Costs/ Vehicle Hour	Oper. Costs/ Passenger Trip	Oper. Costs to Revenue	Bus Capacity Increase	Bus Trips/ Day Increase	Passenger Trips/Day Increase	Bus Capital + Oper. Cost /Month Saved
U.S. 101, Marin County, Exclusive and Reserved Bus Lanes									15	675	
Shirley Highway Express Bus on Freeway (Late 1972)	22.9	1.21		$0.84			.99				$26,000 (17 additional buses)
Double Deck Bus, New York City and Los Angeles								45-50 seats /bus to 70-85 seats/bus			
Integrated Transit Demonstration (Pre-Demonstration Statistics Nov. 1974)	5.3	2.18		$1.29	$14.37		3.49				
Downtowner Washington, D.C. 1973	36.9	7.4		$2.42	$11.98		2.4				
1974	51.5	9.6		$2.33	$12.54		1.6				
Free Fare, Amherst Univ. of Massachusetts Spring 1973	43.3										
Dec. 1973	86.6		0.6	$0.41		$0.14					

for express buses was provided on a freeway (Shirley Highway in Washington DC and U.S. Highway 101 in Marin County, California) serving corridors which are heavily traveled by commuters and heavily congested during peak hours, In both cases the lanes effected significant decreases in travel time and improved reliability of schedule maintenance in a manner which allowed more efficient scheduling of bus trips.

In the case of U.S. 101 in Marin County, results to date are available only for the PM peak, as the AM peak express lanes have only recently been opened. Since the evaluation has not yet been completed, available system operating statistics are currently limited. The operator has stated, however, that scheduled trip times have been reduced by an average of 10 minutes on 12 different routes which operate over the lanes, enabling nonproductive vehicle time to be eliminated. Buses which previously sat idle downtown, waiting to make the last peak hour trip, now can be utilized more effectively during the peak. The net effect is stated to be an increase of 15 trips within the evening peak period, producing an associated increase in passenger trips of 675, and a decrease in the ratio of cost to revenue.

The Shirley Highway experience is equally successful, but has been measured in a somewhat different manner. Because routes and coverage have been changed in conjunction with the opening of the exclusive lane, direct comparisons with pre-demonstration bus productivity would be misleading. However, the project evaluation team has estimated that to provide the same number of bus trips per day without the exclusive lanes would now require 20 additional buses or an operating cost increase of $30,000 per month. Thus, it appears that the provision of exclusive bus lanes in corridors where travel is characterized by congested commuter traffic can produce significant benefits in service level improvements to travelers and in productivity increases to transit operators.

A somewhat different approach to increasing transit vehicle productivity is being taken along a commuter corridor (El Monte Freeway) in Los Angeles. Two German Neoplan double deck buses with a capacity of 84 seated passengers plus standees will be substituted for conventional (45-50 seat) buses for some of the runs. The total number of route miles and vehicle hours will remain constant, but vehicle capacity and thus presumably vehicle productivity will be increased. As no new drivers will be required, operating and capital cost increases are expected to be less than proportional to that required to provide a similar capacity increase with conventional buses.

In New York city, eight British Leyland buses, four of which are funded by the Service and Methods Demonstration Program, will also be operated, but under very different travel conditions. The buses, with a capacity of 64 seated passengers plus 19 standees, will operate over two local Manhattan routes characterized by short trips, crowded vehicles, and heavy traffic congestion. As in Los Angeles, the use of double deck buses should increase vehicle productivity (measured in passengers per vehicle mile or passengers per vehicle hour) for a less than proportionate increase in capital and operating costs, and without further contributing to problems of congestion and pollution.

In Washington, D.C., the "Downtowner" demonstration (see Appendix G) represents another approach to the problem of eliminating nonproductive driver time. The off peak, fixed route service on "midi" buses (25 seats plus 15 standees) provides downtown circulation between two areas of dense employment concentration through the retail shopping core at 6-minute headways. Because the new service was designed to serve off peak trips, it was able to utilize drivers from other parts of the transit system who would otherwise be idle because of low off peak demand. Thus, the marginal cost to the system as a whole of providing the new service was low,

Figure 11. Double Deck Buses will run on El Monte Busway between El Monte and Los Angeles

Figure 12. Midibus in Washington, D.C. - Offpeak, Low Fare Downtown Circulation Service

because it required only a few additional drivers. The average operating cost per vehicle hour of "Downtowner" service ($12.54 in 1974) can be compared to the system average ($18) to show that the service contributed to a net system reduction in cost per vehicle hour of service. Additionally, the "Downtowner" offered a unique zonal fare system, which is considered to have increased ridership and thus vehicle productivity. Riders boarding in either of two end zones paid a fare of 25 cents, while riders boarding in the core shopping zone paid only 10 cents: a round trip from the employment areas cost a total of 35 cents.

The data in Table 4 shows that in the course of a year vehicle productivity for the "Downtowner service increased by 39 percent, from 36.9 to 51.5 passengers per vehicle hour; or alternatively, by 29 percent, from 7.4 to 9.6 passengers per vehicle mile. This reduced the cost to revenue ratio from 2.4 to 1.6.

Another method of increasing vehicle productivity is being demonstrated with the Rochester, New York, integrated fixed route, demand responsive system. The demonstration service area is a medium density suburb with some fixed route transit service. The type of service offered is demand responsive and subscription, serving local travel, short commuter trips, and feeder trips to longer fixed route travel.

The characteristics of the Rochester service are quite different from the demonstrations described previously. Consequently, the treatments being applied to increase vehicle productivities differ substantially from those previously described, as they are tailored to the characteristics of the service and the service area. Two different methods of analysis are involved — one dealing solely with the efficiency of the routing of demand responsive vehicles and one dealing with the efficiency of the fixed-route plus demand responsive Rochester Transit System.

The installation of a computerized system of vehicle routing and dispatching for Dial-a-Ride vehicles is expected to produce a greater efficiency in both control room operations and vehicle routing. The result may be an increase in vehicle productivity by several measures. From a system point of view, more efficient use of vehicles would produce a higher ratio of passengers per vehicle hour and would increase the effective system capacity. From the point of view of individual trips, routing circuity may be lowered, producing a more favorable ratio of passenger miles (by the most direct route) per vehicle mile. That is, the number of miles which a passenger travels out of his way to accommodate other passengers would be minimized. Finally, if the computerization achieves higher levels of service (as measured by wait times and ride times), ridership should increase, producing a further increase in vehicle productivities. It should be noted that ridership levels, and thus productivities, for this system are relatively low. Very small off peak load factors imply individualized service. Increased ridership will allow the computerization to effect more efficient routings and vehicle utilization than at present. Also, improved routing and control may allow a reduction in the number of vehicles with no deterioration in service. The statistics presented in Table 4 show vehicle productivities on the Dial-a-Ride system only, before introduction of computerization or system integration. As can be seen, increased vehicle productivities would provide an important reduction in operating subsidies required.

Vehicle productivity on the total transit system can be increased by the substitution of Dial-a-Ride service for fixed route services in areas and times of the day where Dial-a-Ride can operate more efficiently. Such a situation is characterized by a fixed route service with very low patronage in an area in which Dial-a-Ride is operating with excess capacity. In one such case, a recent substitution of Dial-a-Ride for fixed route service enabled the fixed route service to eliminate nonproductive vehicle hours and miles, raising fixed route system productivity. It also may enable

Dial-a-Ride service to utilize more intensively vehicles which are already in service, increasing the number of passengers carried for a less than proportional increase in vehicle hours of service. Results from this substitution of service are not yet available.

In Amherst, Massachusetts, the University of Massachusetts operated a demonstration (see Appendix J) which increased vehicle productivities through ridership increase. The new ridership was attributable to increased transit coverage and a free fare policy, plus increased parking fees and parking restrictions. The University campus is located within the town of Amherst. Its 6,000 employees and 24,000 students dominate the town of 32,000. Sixteen thousand five hundred students live in the town on and off campus, and the rest commute from outside. Because the campus in the town is a major traffic generator, traffic patterns were highly concentrated, producing severe congestion. A coordinated package of service improvements was designed to address the problem of automobile congestion on the campus and inadequate transportation for people who did not own automobiles. The service improvements were implemented in stages.

During the first semester of the demonstration, service was expanded from a 4 bus system with 14 on campus route miles to 13 buses providing 120 vehicle hours of service on 88 route miles connecting high density housing areas to the campus and the town center. In the second semester three more buses were added, vehicle idle time at bus stops was reduced, and vehicle hours of service increased to 170 hours per day. Service to outlying points was cut back, but frequency was increased on all other routes. At the same time the number of core parking spaces was cut by 46 percent and core parking fees were increased $5 to $41 and $55. Shuttle bus service was provided to previously unused peripheral parking lots. Because of the number of changes which were introduced at one time and the additional complicating effects of the energy crisis it is extremely difficult to attribute ridership and vehicle productivity changes to any single policy. However, vehicle productivity did increase from 55 to 90 passengers per vehicle hour in the second part of the demonstration. Daily ridership doubled from 6,500 to 13,000 during the same time period. The result was a low operating cost per passenger trip of eleven cents. Passenger volumes have continued to increase since the end of the demonstration period. The important conclusion from this demonstration is that in "university towns" a bus service and parking policy having the the components described here can be very successful in obtaining high vehicle productivities and relieving problems of auto congestion and limited student mobility.

FUTURE DEMONSTRATIONS

A number of demonstrations of techniques for improving transit productivity will be conducted in FY 1976 and 1977. The concepts to be demonstrated include subscription van service, subscription bus service, and shared ride autos. In addition, studies will be undertaken leading to demonstrations of the potential of pre-paid passes, light rail, and reduced fares.

Subscription Van Service

It is often difficult to provide efficient, economical transit service to low density urban areas. The long pickup and distribution route makes it difficult to fill a conventional transit bus, and some residential areas are so far from work locations that a bus can make only one trip during a peak period. A new driver and bus would have to be provided to carry each increment of approximately forty commuters.

Figure 13. Rochester, New York - PERT Dial-a-Bus Provides Door-to-Door Service

Figure 14. University of Massachusetts at Amherst - Free-Fare Midibus Service to and from Campus

One strategy for providing transit to commuters from low density remote areas is the use of subscription vans, or van pools. One of the commuters drives the vehicle, a 10–12 passenger van, picks up other commuters, and transports them to work and back. This service concept has been used effectively by several major corporations. It is popular with the riders and covers total costs through user charges. Although the concept has been successfully tested by individual employers, the service is not planned as part of the total urban transportation system by the public body responsible for providing transportation services.

Some of the problems that a demonstration of this type may encounter are in the area of insurance and competition. Vanpool drivers and their employers may be open to liabilities arising from accidents or loss of personal property by riders. Additional insurance protection may be required which will vary from one locality to another. Transit companies (if they are not involved in operating the subscription service) and taxi companies may object to the competition from subscription vanpools. The point should be made that service of this type may increase the use of transit or taxis during the day by vanpool passengers as they do not have a car for use on local trips or errands.

The purpose of this demonstration is to show that subscription van service can effectively supplement fixed route transit systems without adversely affecting existing transit service, and that the service can be organized by the transit provider. Initial demonstrations will be conducted in FY 1976.

Subscription Bus Service

Subscription bus service (also referred to as "bus pooling") has been introduced in several localities such as Reston, Virginia and Rochester, New York in the past few years. Such services are generally aimed at commuters whose urban travel needs are not adequately served by conventional mass transit services because they live in lower density areas or localities far from the CBD, or work in non-CBD employment centers. The efficient operation of a subscription bus service requires a large number of riders (35 or more) traveling from a relatively concentrated area or a few park-and-ride sites to a major employment center. Past uses of subscription bus service have necessitated a long trip distance to utilize the driver and vehicle economically while charging a reasonable fare.

Demonstration projects dealing with subscription bus service would attempt to show that such service could effectively supplement fixed route service without adversely affecting the existing service. This subscription service could be provided at little or no cost to the taxpayer. It offers a higher level of service than conventional bus transit in the types of residential areas mentioned above.

Subscription service has not been particularly successful for short commuter trips (less than 10 miles). The cost of providing one short trip in a peak hour does not differ much from the cost of a long trip, and passengers resist paying comparable fares for less perceived benefit. But a coordinated program of staggered work hours in a major employment area, a subscription bus service could cover two to three routes per peak period, thus greatly improving productivity and reducing the cost to the passenger.

Demonstrations of subscription bus service will be promoted in FY 1976, to be followed by further demonstrations which will build on the experience gained.

Shared Ride Auto

One method of using the excessive capacity in low occupancy auto on highways is to provide the means and incentives for some auto drivers to carry other commuters as passengers, thus increasing vehicle productivity in terms of persons carried. However, the difficulty of organizing carpools and the lack of incentive for commuters to form them limits the wide spread use of conventional carpools. This demonstration proposes a way of organizing shared rides by providing assembly areas or fixed routes where passengers can wait for rides in any number of vehicles going to their destinations. The demonstration would also work out arrangements by which drivers could charge fares.

There are currently several barriers to implementing this type of operation. Legal and institutional questions must be addressed, as well as problems of insurance, maintenance standards, passenger and driver security, and service reliability.

Although the final design of the service will depend on site conditions, the following description should give an idea of how the shared auto will operate. A license will be issued to a private auto owner to carry commuters to and from work along specified routes or from specific sections of the urban area. The service can be operated on a subscription basis, in which case it would resemble a carpool, or passengers may be picked up at designated loading points or along designated routes, in which case it would resemble a jitney service. A shared auto may be allowed to pick up passengers on certain streets or sections of streets in a suburban area and then operate non-stop to an employment area. Park-and-ride lots can be established where commuters will have access to a shared auto. In all likelihood, the same persons will ride the same vehicle or groups of vehicles every day. However, this scheme will allow a backup for those days when an individual's schedule varies.

Some of the advantages of shared autos are that they can serve destinations such as large non-CBD employers that cannot be conveniently served by fixed route bus, and they can be used to reduce severe overcrowding on certain transit routes in peak periods.

During FY 1976 a site specific study will be performed with the intention of developing a demonstration of the concept if it proves feasible and the stated problems can be overcome.

Prepaid Passes

A study of fare policy and fare collection mechanisms is being conducted to assess the potential of pre-paid passes for increasing transit vehicle productivities.

The basic concept of pre-paid passes is that a change in the riders' perception of the cost of a transit trip will increase trip frequency. By allowing the transit user to pay for a transit pass in advance, through periodic billings, or through payroll deductions, the fare visibility is lowered, and, in the case of unlimited trip passes, the fare itself may frequently be lowered. If this results in increased trip frequency, vehicle productivities will be increased with no change in level of service, or vehicle operating policy. Additional benefits may accrue through time and cost of fare collection.

This study of pre-paid passes, examining the experiences of past and present pre-paid pass programs, is currently underway. The product of the study is a report on the most promising mechanisms and policies for implementing pre-paid pass programs and the plans for demonstrations which will incorporate these techniques.

Light Rail

Another way of achieving better productivity is through the use of vehicles sized to fit the passenger demand on that route. The demonstration using double deck buses, described earlier, is based on this principle; another possibility is the use of light rail vehicles. Because of its suitability to articulated vehicles operated by a single driver, light rail may offer advantages in productivity. The Service and Methods Demonstration Program is making preliminary investigations into the potential for a light rail demonstration.

Reduced Fares

A number of cities have introduced reduced fares at off peak periods as a way of inducing some riders to shift from the congested peak period to the uncongested off peak. Most commuters have little choice over the times at which they travel to work. But shoppers and others on personal trips, who make up as much as 20 percent of the riders in rush hours, can be diverted to off peak trips by fare reductions. This diversion of riders has the double effect of reducing crowding at rush hour and increasing ridership at off peak times when excess capacity exists in transit vehicles, and additional riders can be carried at very little additional cost. Reduced fares may also attract new riders to the system. If a system increases its passenger miles without adding vehicle miles, its productivity has increased. Fare reductions at off peak periods may thus offer an alternative way of improving vehicle productivity. The Service and Methods Demonstration Program is investigating a study of this approach to improving productivity.

CHAPTER V

IMPROVED TRANSIT SERVICE FOR THE TRANSIT DEPENDENT

Many people are transit dependent because age, income, or physical disability restricts their ability to own or use an automobile. Their mobility is severely limited by the restricted availability of transit, the high cost of taxi service, and their inability to make arrangements to be chauffered by auto. The problem is particularly acute for the elderly and handicapped. According to a study of transportation for the elderly and handicapped by the National Urban League, limitations of conventional fixed route transit have made it inaccessible to 37 percent of the urban handicapped and elderly population, because their age or infirmity prevents their being able to board the vehicle (8 percent) or to reach the nearest transit stop (29 percent). Consequently, 14 percent of their personal travel is by taxi as compared to 2 percent for the general public.

The objective of increasing public transit for the transit dependent is aimed at meeting the travel needs of a population, who, by reason of personal handicap, age or economic status, cannot make effective use of existing public transit. The Service and Methods Demonstration Program is sponsoring demonstrations of specially tailored door-to-door service, which include the use of improved or modified equipment. Additional study of the requirements and needs of these user groups is also being conducted.

Vehicle design changes to accommodate physical infirmities focus on ease of ingress, egress, and safe comfortable riding conditions. This usually involves vehicles with lower steps, improved handrails and stanchions, adequate seating, and wheelchair lift devices. Operations and service improvements are achieved by coordinating transit supply, schedules, and routing with the travel needs. The major trip purposes are oriented toward personal, medical, shopping, and social/recreational travel. The needs of the elderly, handicapped, and other transit dependent groups can often be best met by some type of door-to-door, demand responsive service. Because much of this travel is planned in advance, reservation and contract operations are being widely used to avoid the large costs involved in serving a dispersed, low density market on a rapid response basis. Coordination of transit service with the schedules of health and social service centers further increases the efficiency and capacity of the system. Also, since the demand occurs primarily during off peak periods, in some cases the service may be made available to the general public during peak periods to increase system productivity.

Other elements of this kind of service include a vigorous marketing program combined with registration of eligible users. Low fares and prepaid passes or billing systems are valuable to accommodate the limited financial resources of many of these users.

The following sections contain a description of the demonstrations of these concepts and a discussion of the results achieved.

ESTABLISHED DEMONSTRATIONS

There are seven demonstrations currently in operation that have been specifically designed to achieve the objective of improving transit service for the elderly and handicapped. These projects are located in Cranston, Rhode Island; Lower Naugatuck Valley, Connecticut; St. Petersburg, Florida; Lincoln, Nebraska; Cleveland, Ohio; Syracuse, N.Y.; and Baton Rouge, Louisiana.

Additionally, a demonstration project in Rochester, New York, now in the planning stages, will be providing specially tailored transit services for the elderly and handicapped as a part of its integrated demand responsive and fixed route public transit system.

Table 5 contains a summary of the characteristics and features of five of these demonstrations. They are distinct from each other in terms of transit service area, residential density of potentially eligible ridership, and vehicle fleet size. The Cranston TRANSVAN system, which began in March 1973,[1] is representative of a medium sized transit service area, a medium level of residential density of potentially eligible ridership, and a small vehicle fleet size (two 19 passenger Flxettes and a GM coach retrofitted to accommodate wheelchairs). The Naugatuck Valley Transit District, serving Shelton, Ansonia, Seymour, and Derby, Conn., was initiated in March 1973. It is an example of a large transit service area, a low residential density of potentially eligible ridership, and a medium sized vehicle fleet (six specially equipped 21 passenger buses, one of which can accommodate wheelchairs, plus three 13 passenger vans). St. Petersburg's TOTE (Transportation Of The Elderly) system, which was initiated in September 1973, is representative of a small transit service area, a high residential density of potentially eligible ridership, and a relatively large fleet size (eleven 13 passenger vans plus two vans equipped with wheelchair lifts that accommodate ten passengers in addition to one wheelchair).

Rochester's PERT (Personal Transit) Dial-a-Ride system operates within a medium sized transit service area. The residential density of the general public served by this demonstration is approximately 4,000 per sq. mile, whereas the residential density of the handicapped and elderly population is 330 persons per sq. mile, similar to Cranston. The initial fleet size for the Rochester demonstration is 15 vehicles, with one specially equipped vehicle to accommodate wheelchairs. Rochester plans to experiment with dedicating some portion of its fleet to service the handicapped and elderly population during the off peak periods.

While these demonstrations have many unique features, there are general similarities and characteristics common to all of them. They all provide door-to-door service including some form of demand responsive, or dial-a-ride service, as well as advanced reservation and/or subscription service.

A variety of vehicles from 10–13 passenger vans to small 19–25 passenger buses are being used in these demonstrations. The smaller equipment provides the maneuverability required for door-to-door service in residential areas. At least one vehicle in each demonstration is specially equipped to carry passengers confined to wheelchairs.

In all cases, eligible persons are required to register with the transit agency before becoming a rider. However, each project is different with regard to the eligibilty requirements for registration (see Table 5) and the frequency of registration (Cranston's registration is on a quarterly basis, whereas registration for the Naugatuck and St. Petersburg systems are valid indefinitely).

[1]Between 1971 and 1973, a limited transportation service for senior citizens living in elderly housing was provided under local auspices.

TABLE 5. DEMONSTRATIONS AIMED AT IMPROVED SERVICE FOR THE TRANSIT DEPENDENT

DEMONSTRATIONS	CATEGORY									
	Transit Service Area (sq. miles)	Target Population Density (person/sq. mile)	Vehicle Fleet Size	Eligibility Requirements	Number of Registered Users	Percent of Elderly	Percent of Handicapped	Percent of Mentally Retarded	Percent of General Public	Number of Trips per Month
Transvan Cranston, Rhode Island	28	430	3	over 62 yrs. or handicapped (unable to use public transit)	500[1]	62[2]	3[2]	35[2]	·	2,800
Naugatuck Valley Transit District, Connecticut	57	120	9	65 yrs. and over or handicapped	3,177[3]	25[4]	4[4]	17[4]	54[4]	11,800
TOTE (Transportation of the Elderly St. Petersburg, Florida	13	2,800	13	60 yrs. and over or handicapped	16,000[5]	NA	NA	NA	-	10,000
PERT (Personal Transit) Rochester, New York	16	330	15	NA	NA	·	NA	-	·	NA
NET (Neighborhood Elderly Trans.) Cleveland, Ohio	7.6	2,237	14	60 yrs. and over	NA		NA	·	-	11,800[6]

Notes: [1]For quarter ending March 1974

[2]For period from March 1973 to April 1974

[3]As of February 1974, when registration was discontinued due to saturation

[4]As of March 1974

[5]As of December 1974

[6]As of August 1975

Cranston's TRANSVAN system serves a variety of trip purposes both within and outside Cranston, on an advanced reservation basis with the required period of advance notice varying according to trip purpose. The service can be characterized as many-to-many, many-to-few, and many-to-one (depending on trip purpose and user group). Reservation is on a first call-first served basis and scheduling routing is manual.

The Naugatuck Valley Transit system offers group service on an advanced reservation and subscription basis and individual ridership on both subscription and demand responsive basis. The group ridership (rent-a-bus) is the predominant type of service. Social service and health agencies in the Lower Naugatuck Valley subscribe to rent-a-bus service and obtain regular weekday service. Other groups can charter buses on a demand responsive basis (first call-first served) for use during evening hours and on the weekend. The rent-a-bus is essentially a many-to-one service. The subscription service is a many-to-many service. The demand responsive service is constrained to a few-to-many service due to the competing demand for vehicles arising from the rent-a-bus service. The scheduling and dispatching functions are manually operated and arranged by telephone and two-way radios.

St. Petersburg's TOTE system provides reservation, subscription, and demand responsive service.[1] Additionally, buses can be chartered by groups for trips outside as well as within the service area. The TOTE system provides both many-to-many and many-to-one services. Demand responsive service and advanced reservation service are, as in the case of Valley Transit District (VTD) and TRANSVAN, telephonically arranged and manually controlled by a scheduler/dispatcher.

Cranston's TRANSVAN advanced reservation service is, by comparison with VTD and TOTE, more constrained. Selected destinations are available only on specified days. This limitation is largely due to the small fleet size of the TRANSVAN system.

The demand responsive service provided by TOTE is the most widely available of the three programs. By contrast, VTD offers demand responsive service only on a once-a-week basis to each of five subareas, and TRANSVAN offers demand responsive service on an emergency basis only.

The three systems have markedly different fare policies. Cranston uses a prepaid pass system ($1.25 per month or $3 per calendar quarter for unlimited rides). VTD issues a credit card to each registrant, and users are billed on a monthly basis. The specific user charge is based on 10.5 cents per vehicle minute, but is adjusted to account for vehicle occupancy, time of day, and the status of the user, (handicapped and elderly or general public) as well as other factors. The credit card fare collection system is named FAIRTRAN. A special feature of this system allows an agency or other third party to pay all or a percentage of a customers specific ride. Limitations on fare sharing can be designated based on day, time, location, or maximum expenditure per month. St. Petersburg's TOTE service has a two level fare structure. The fare for advanced reservation service is 35 cents per one way trip. The fare for demand responsive service is 60 cents per one way trip. For round trips with an uncertain return time, the return portion is treated as a demand responsive trip.

Figure 15. Wheelchair Lift on Vehicle - Naugatuck Valley, Connecticut

Figure 16. Low, Wide Steps Provide Ease of Boarding - Naugatuck Valley, Connecticut

The success of the ongoing demonstrations can be measured in a number of ways. In terms of eliciting registrants (who may or may not actually use the system), the projects have met with varying success (see Table 5). Cranston (the only system with periodic, as opposed to one time, registration) experienced a fairly steady increase in registration, from 280 to 545, between December 1972 and December 1973. In the next quarter, registration dropped to 500, presumably due to the saturation of TRANSVAN's limited vehicle fleet capacity. Approximately 850 different Cranston residents have registered for the service at one time or another. Comparing the latest registration figures of 500 with the eligible (elderly and handicapped) population, the market penetration is around 5 percent. The gradual increase in registration to saturation levels of system capacity is attributable to the intensive publicity program initiated in 1972, consisting of radio spots, press releases, posters, and newsletters. Although Cranston has no plans at present for expanding the service, it appears that any such expansion would elicit additional registrants.

The Naugatuck Valley Transit service similarly experienced an increase in registration levels until February 1974, when registration was discontinued due to system saturation. The 3200 registrants as of that date comprised 2000 handicapped and elderly persons and 1200 of the general public, representing about 28 percent of the elderly and handicapped market and 40 percent of the existing transit using general public. In contrast to Cranston, an intensive registration campaign was not required. A transit strike occurring at the same time that registration was inaugurated explains why there was a strong initial response from the general public. Communication of the program to the elderly and handicapped was effectively handled by social service agencies.

Registration for the St. Petersburg TOTE service began in May 1973, prior to initiation of service. At the same time a major publicity campaign which consisted of brochures, posters, news spots, and a newsletter, was launched to penetrate the target market group. Almost 7,000 persons were registered during the pre-service period. By April, 1974, one-half year after service began, almost 12,600 persons had registered. By the end of 1974 registration reached 16,000, or approximately 42% of the potentially eligible ridership.

TOTE service has not yet been saturated. St. Petersburg plans to continue registration among the elderly and is also considering implementing service in other areas of the city as well as opening registration to the general public. The present under utilization of the vehicle fleet can be partially explained by a large amount of fixed route service on the Municipal Transit System, which provides service along 36 routes, many of which lie within the TOTE service area.

An examination of actual user demands for those three ongoing projects provides an even better comparative measure of success than registration levels, since the registration figures for Naugatuck and St. Petersburg (which include persons who no longer use the service) probably tend to overstate market penetration relative to Cranston. Moreover, registration statistics alone can be a misleading indicator of service usage patterns.

Cranston's vehicle fleet is able to serve about 2,800 person trips per month (or 930 trips per vehicle per month). Since the service has reached a saturation point, this volume of trips probably understates the monthly demand for TRANSVAN service.

Figure 17. Small Bus Used for Transporting the Elderly and Handicapped, TRANSVAN Service, Cranston, Rhode Island

Figure 18. Small Bus Used for Transporting the Elderly and Handicapped, TOTE Service, St. Petersburg, Florida

the potential monthly demand in the region probably exceeds 11,800 trips. Hence, ridership is expected to increase when Naugatuck receives the nine additional vehicles it has ordered.

St. Petersburg's relatively large fleet of vehicles currently serves about 9,800 person trips per month (1,100 trips per vehicle per month, with only 9 out of 13 vehicles in operation). This is an unsaturated system and St. Petersburg is considering opening service to the general public in order to obtain greater vehicle utilization. As noted before, the existence of good alternative public transit (which has recently initiated a $2 per week unlimited pass) has had an effect on the market penetration of TOTE.

The recently initiated Rochester dial-a-ride demonstration features two weekly subscription services for the handicapped and elderly. One service runs between an elderly housing project and a supermarket which is paid for by the supermarket at no charge to the elderly. The other service provides rides to a shopping center at a 25 cent fare. Fares have also been reduced on the off peak for the elderly and handicapped using the dial-a-ride feeder to fixed route service. A thorough survey of the handicapped and elderly population will be conducted to assess the travel needs of this market. Rochester has begun to work with local social service agencies in order to understand better the mobility problems of the handicapped and elderly.

Overall, it can be concluded that the ongoing demonstrations have been successful in providing door-to-door, inexpensive transit service to groups of persons who would otherwise face severe barriers to mobility. The projects discussed above employ a wide variety of operational policies and procedures in a variety of service area applications. The most effective approach to serving elderly and handicapped needs varies with the SMD site characteristics. The program has demonstrated a variety of techniques for serving this market and is thereby encouraging other localities to apply those techniques appropriate to their area. However, the preceding comparison of registration and travel statistics does illustrate a strong potential for imbalances to arise between service demand and supply. This in turn suggests the need for careful planning (and possibly staged implementation) of elderly and handicapped transportation systems to ensure that the type of service and system capacity are compatible with user needs.

FUTURE DEMONSTRATIONS

In addition to the knowledge already gained from the current set of demonstrations, understanding of methods for serving the needs of the handicapped and elderly will be improved by demonstrations planned for the near future.

A transportation broker is one concept which will be tried in Santa Clara, California. The demonstration will employ an individual or individuals to serve as a "transportation broker" for particular target groups desiring some form of transportation. The broker will act as middle man between clientele and the transportation providers. The primary functions will be: 1) to group individuals desiring travel to some common destinations in order to reduce individual travel costs, and 2) to develop and maintain contact with various groups, agencies, etc, serving the elderly and handicapped, to increase a market for transportation among these groups.

By grouping riders for one trip the broker would reduce the cost to his clientele while bringing more business to the provider. In Santa Clara County, the broker will work independently and obtain a Commission from clients. However, the broker could work as an employee of a transportation provider, or an organization serving the target groups.

A transit service model that has proven itself on an experimental basis in Naugatuck Valley, Connecticut, as an effective means to improve service for the elderly and handicapped is being transferred to two medium size cities, Portland, Oregon, and Albuquerque, New Mexico. It will test the upper limit of city size for this type of service which incorporates a range of demand responsive services to meet the special travel needs of the elderly and handicapped. Under this concept the many separate interests of social welfare agencies in transporting their clients are coordinated and the appropriate agency billed for all or part of the particular client's transportation. A credit card device developed for this function was used in the demonstration in Naugatuck Valley. It is estimated that there are forty medium size cities similar to Portland and Albuquerque (i.e. up to 500,000 population) where this concept would have application.

Specific elements included in the Portland and Albuquerque projects are:

1. Flexible routing with three types of service modes offered; fixed route, subscription service, and demand responsive.

2. An automated credit card fare collection system that eliminates cash payments by the use of credit cards and monthly billings. This allows variable fare schedules with formulas based on distance, time, number of other riders, and rider status.

3. Coordinated agency transportation allowing social service agencies to discontinue separate transportation services. The "fare share" element of the fare collection also permits agency client costs to be shared by agencies and their clients.

4. Specially modified vehicles with safety and comfort features that meet the needs of the elderly and handicapped.

The development of a transit service model for meeting the mobility needs of the elderly and handicapped in a large city is even more difficult. Consequently, a study leading to a demonstration design has been funded in Chicago. A demonstration in a large urban area will have the objective of reducing the multiple, fragmented efforts by various agencies serving elderly and handicapped and other transportation disadvantaged by establishing a centralized provider of transportation. The provider may involve a local transit operator, taxi operator, or a combination of both.

A demonstration is currently in progress in Danville, Illnois, involving the concept of user-side subsidies. User-side subsidies are those paid directly to users so that they can afford more transportation services. Tickets can be purchased by selected users at reduced cost and used to purchase transportation services at full market rates. The major hypothesis being investigated is that a user-side subsidy is an effective way to sponsor improved mobility for selected groups, particularly elderly and handicapped persons. The viability of the user side subsidy as a means for improvements and development of local public transportation services is also a question of considerable interest.

If user-side subsidies prove to be an effective way to encourage the development and provision of efficient public transportation for specific target user groups, the technique will be considered for more widespread use. It appears to have an advantage over many existing subsidy mechanisms in that it allows the user group to make transportation choices. Further, subsidies need not be limited to publicly owned transportation systems; private operators can compete for them, with the most efficient operators benefiting most from the subsidies.

Criteria have been developed for selection of additional demonstration sites. Information is being gathered on places where user-side or similar subsidies have been or are being utilized. Some of these will be published as case studies.

Future demonstrations such as those described here are in various stages of planning. Those based on expansion of tested and successful concepts are in the later planning stages while the more experimental demonstrations require further time for concept refinement and site exploration. All of the demonstration efforts for elderly and handicapped are intended to provide transit operators with information and an array of methods for meeting the proposed UMTA Elderly and Handicapped regulations.

CHAPTER VI

SUPPORT ACTIVITIES

In addition to conducting demonstrations and studies leading to demonstrations, the Service and Methods Demonstration Program has undertaken a number of activities intended to broaden the overall information base, improve transit planning and operations, and develop analytical and evaluation techniques, in areas such as park and ride planning and transit fare policies. Such studies are intended to assess the state of the art and identify gaps in understanding. A study into the nature of the problems of the handicapped, for instance, is being conducted to obtain a better understanding of their travel requirements.

Development of improved methodologies used in planning and evaluating demonstrations is another area of support. For example, attitudinal survey techniques are being upgraded and used in Service and Methods Demonstrations where their applicability and reliability can be tested. More efficient, standardized procedures for measuring and analyzing demonstration results are being developed in order to improve the quality of the project evaluations.

Still another important support activity is the dissemination of demonstration results to a wide variety of potential users of this information. The diffusion of information about demonstrations is essential to achieving the goal of more widespread application of proven transit innovations. These and other support activities are discussed in the following sections of this chapter.

THE IMPACT OF TRANSIT SERVICE AND FARE INNOVATIONS

Better understanding is needed of the impacts of different forms of transit fare and service changes. In the first instance, the changes in transit ridership and the diversion of traffic from other modes, particularly from the private automobile, should be investigated. As a longer term objective, a wider range of second-order impacts should also be studied, including income redistribution questions: who pays and who benefits from specific types of transit innovations.

An increased understanding of matters like these, coupled with some study of the incremental costs of different types of innovation, will permit more reliable assessment of the relative costs and effectiveness of various policy options available to transit agencies and, hence, their relative appropriateness for achieving the objectives of the local decision makers.

Work to date has focused on using readily available transit operating statistics for transit systems which have made significant innovations, in an attempt to identify the costs and ridership response attributable to innovations of different types.

After the readily available data sets have been thoroughly analyzed in order to derive the strongest possible, analytically sound conclusions from them, additional data will be collected to provide important information about variables which are not included in the typical transit agency's operating statistics. In particular, questions about diversions from other modes and the income redistributional aspects of transit innovations will require additional data.

In addition, attention is being paid to the need for interpretation and dissemination of research in this topic area in a non-technical fashion, in order to communicate it to a potentially wide audience of the general public. To this end, a popular monograph surveying the current state of knowledge has been prepared and will be published shortly.

TRANSIT FOR THE HANDICAPPED

The Urban Mass Transportation Administration is engaged in the long term effort of developing means for more effective utilization of mass transit facilities and services by elderly and handicapped persons. Despite the advances that have been made, a review of the current literature on the subject reveals a dearth of detailed, factual information either about the nature of the problems of the handicapped or the design of facilities, vehicles and equipment which affect their ease of daily living and travel. This is not meant to imply that much of this information does not exist, but rather that there is no single source which defines the precise nature of the problem.

This research project, therefore, is intended, (1) to develop detailed information as to what persons with various degrees of disability can and cannot do and how this affects their travel requirements, and (2) to develop viable transportation service alternatives utilizing all modes which can satisfy such requirements effectively at minimum cost.

The project will involve the description of transportation handicaps; a proposed scheme for determining numbers and types of transportation handicapped; a description of a methodology for planning and designing to meet special needs of the transportation handicapped; and hypothetical solutions to the mobility problems of the handicapped.

Based upon the information developed, operating demonstrations will be designed to test the most promising approaches in representative environments. The central issue to be addressed is the cost/benefit trade off between developing the needed transportation service by modifying existing and new transportation systems to make them accessible to the handicapped, and instituting transportation services specially designed for the handicapped market. At the conclusion of the study, the most promising approaches will be applied under the appropriate conditions at selected demonstration sites.

PRELIMINARY STUDY OF PARK AND RIDE PLANNING TECHNIQUES

A study of existing literature in the area of park and ride facilities, services, and planning techniques was undertaken in order to assess and summarize the state of the art in planning and implementing these systems. The study incorporated both published information and the comments of planners and operators in several cities. It covered the issues of demand forecasting, costing, pricing, administrative and institutional problems, and the prediction of external impacts. Existing methodologies and items of substantive knowledge were reviewed and summarized, and specific gaps in present knowledge and techniques were identified.

Some of the main conclusions of the study were:

(1) Despite extensive experience with park and ride operations in many cities, the effect of many variables on park and ride demand is not well understood. Especially problematical is the importance of service variables other than time and cost, such as constraints on parking either in the CBD or in the fringe lot, and the probability of finding a seat on the transit vehicle.

(2) There is already a substantial body of informal knowledge about park and ride demand patterns, based on generalizations from operating experience. Guidelines can be drawn from this

knowledge to cover such issues as desirable and undesirable sites for locating park-and-ride lots, allowable fares and headways on transit vehicles serving such lots, and maximum feasible user charges for fringe parking. These guidelines are already well summarized in existing reports.

(3) The primary concerns of local communities in which park and ride lots might be located are the nuisance effect of such lots, including increased noise, congestion, and illegal parking. Prediction of these impacts, design techniques which minimize their effect, and political strategies for securing community approval are topics on which existing published knowledge is notably inadequate.

(4) There is no convenient summary of feasible approaches to the administrative and institutional problems which commonly arise in the implementation stage of park-and-ride projects. These problems include interpretation of applicable UMTA and FHWA regulations, arrangement of contracts for lot maintenance and insurance, methods of purchasing or holding options on possible land sites, and other such matters.

A state-of-the-art overview of park and ride is being prepared to serve as a manual for planning such facilities.

TRANSIT OPERATIONS IN SMALL URBAN AREAS

The purpose of this project is to obtain and disseminate information relevant to the issues facing transit operators and planners in smaller cities (populations less than 50,000), especially in planning an entirely new transit service. Various traditional transit and innovative paratransit services, such as Dial-A-Ride using small buses or taxis, are being investigated to determine their suitability to conditions in small urban areas.

A series of case studies of transit systems appropriate for small cities is being conducted. Case study communities include: Amherst, Massachusetts; Chapel Hill, North Carolina; El Cajon, California; Eugene, Oregon; Evansville, Indiana; Merced, California; Merrill, Wisconsin; Westport, Connecticut; and Xenia, Ohio. Following the case study preparation, regional workshops will be held in which some of the case studies will be presented. Discussion topics such as the types of transit services suitable for small cities and the most appropriate service area characteristics for each, the factors to be considered in the planning and implementation of transit service, the economics and financing of small transit systems of different vehicle sizes, and typical service frequencies, fares, and ridership levels will be a most important component of such workshops.

A state-of-the-art document will be produced, including the case studies as well as additional information obtained through the workshops and other interactions with transit planners and operators.

URBAN GOODS MOVEMENT STUDY

In recognition of the overlap between the problems of transporting people and goods within the urban environment, the Service and Methods Demonstration Program is sponsoring a study to investigate the urban goods movement problem and propose solutions that could be implemented in a demonstration. The study has three objectives:

- To measure the contribution of urban goods movement to such problems as traffic congestion, air and noise pollution, inefficient land use development, and energy use and to determine the extent to which costs involved in moving urban goods could be reduced.

- To formulate and evaluate new and previously proposed ways of reducing the various costs of urban goods movement and of coordinating the land use requirements of urban goods movement with overall land use planning.

- Depending upon the results obtained, to design a demonstration to implement and test the proposed solutions.

Throughout the study, emphasis is being placed on viewing urban goods movement in the context of the overall urban transportation environment. In proposing and evaluating solutions priority will be given to those changes that improve the institutional, operational, and physical integration of goods movement with mass transit, paratransit, and automobile transportation.

THE TRANSIT OPERATIONS AND PLANNING STATUS RETRIEVAL SYSTEM

The Transit Operations and Planning Status (TOPS) data file is an indexed and cross referenced information retrieval system being developed to provide quick access to information on transit improvements and innovations in urban areas. A typical entry in TOPS includes information on the project location, a brief description citing major results (as available), the operating and funding agences, project status, cost,and information source. Each entry in the file is a concise summary of a particular project in a specific urban area. The file will be maintained and updated on a regular basis, using as sources transit industry publications, Departmental news releases, capital grant and technical study grant awards, and contacts with UMTA regional representatives.

The TOPS file should prove to be a useful tool for demonstration site selection and the dissemination of information among sponsors of similar projects, and for anyone interested in the status of innovative projects and plans.

The user will access TOPS at a computer terminal through the use of key words and simple conversational commands. For example, a user can obtain a survey of all existing projects of a certain type, such as low or no fare buses in downtown areas, or a list of new projects in a selected urban area. This allows the user to peruse the data files by project type or location, depending upon the nature of the inquiry.

INFORMATION DISSEMINATION

In order for demonstrations to result in significant innovation in many transit properties and urban areas, the technique demonstrated and the results obtained must be well documented and widely distributed. Thus it is important not only that the demonstrations be structured so as to make them transferrable, but that the information be disseminated in such a way that the officials in those urban areas which might benefit from these techniques are made aware of their potential. Therefore, an integrated plan for dissemination of information to a wide variety of target groups, including transit planners, operators, and city officials is being prepared. Both existing and potential new channels of communication will be examined and judged for their appropriateness in terms of the information to be conveyed and the persons or groups to be reached. Existing practice will be observed critically and will be improved or supplemented where desirable.

Various methods of diffusing information from the Service and Methods Demonstration Program are currently being employed. Among these are site visits, workshops, conferences, publication of research papers and project results, and active dissemination of state of the art documents. Films and videotape presentations will be used as a supplement to or substitute for on-site visits to demonstrations; a videotape on the Rochester demonstration is in planning.

An overview of the Service and Methods Program has been presented to the 1975 Annual Meeting of the Transportation Research Board (Ref. 1, see end of chapter). The program has been described in the Urban Concepts Newsletter and various transit industry publications. The International Taxicab Association described the program in detail in its magazine to make its members aware of potential innovative uses of taxis in public transportation (Ref. 2). Descriptions of various innovative techniques, study results, and of projects which have been demonstrated are being published in the form of popular monographs. One such document on paratransit techniques has been distributed recently (Ref. 3). A survey document covering transit service innovations of all types has been prepared and is currently in draft form.

The results of demonstrations of bus priority techniques were reported and described at a workshop on the subject held in San Francisco in February 1975. The workshop was sponsored jointly by UMTA and FHWA and conducted through the Technology Sharing Program of the Department. A second similar workshop was held in Miami for the eastern United States in April. These workshops cover the range of current experience with bus priority techniques: where they have been used, what the costs and benefits have been , and the characteristics of a successful system. The papers presented will be incorporated into a state of the art document on bus priority techniques, which will be distributed widely.

IMPROVED ANALYTICAL TECHNIQUES

The Service and Methods Demonstration Program has fostered the development of improved analytical techniques as necessary to provide for more efficient use of resources in planning, data collection, and evaluation of demonstrations.

Analytical techniques currently being developed (or improved) in conjunction with the program include:

- Attitudinal survey techniques to provide more accurate predictions of behavioral responses to various service
- A multi-modal fully competitive mode choice model to predict the user response to transit service innovations.
- A more standardized evaluation methodology emphasizing efficiency and accuracy to improve the quality and comparability of demonstration project results.
- The SCOT model (Simulation of Corridor Traffic), which simulates trafic flow within an urban freeway corridor to allow testing of traffic control strategies and planning policies.

These activities are described in the following paragraphs.

Attitudinal Survey Considerations

Although attitudinal surveys have been used widely for transportation planning and evaluation, there is uncertainty about the accuracy of their predictions; that is, the correspondence between their results and respondents' subsequent behavior. To increase understanding of their appropriate uses and to determine their predictive validity, attitudinal survey applications and methodology need to be examined in more detail. This will upgrade the quality of the analytical support tools of this type available to transportation planners.

In order to define the state of the art of attitudinal surveys as used in transportation planning and evaluation, a one day interdisciplinary workshop was held on January 30, 1975 at the Transportation Systems Center. Twenty-one experts representing the fields of transportation and urban planning, transit operations, market research, and sociology participated in the workshop. The workshop participants were in agreement about the status and directions for attitudinal survey research. They concluded:

- Attitudinal survey results can provide supporting information for making specific decisions to supplement more traditional transportation planning techniques.
- Attitudinal surveys are more accurate in predicting responses to short term changes than long term trends.
- Attitudinal surveys can predict behavioral responses to relatively small system improvements more easily than to major innovations. To predict responses to innovations, it would be useful to conduct a series of short run attitudinal surveys to track the response of transit users as their perception of the innovation improves.
- Attitudinal surveys must comprehensively examine the many facets of attitudes in order to reliably predict behavior.
- Attitudinal survey methodologies as used in transportation have not kept abreast of new developments in the field of market research. Many of these may be appropriate and applicable to improving transit. Accepted techniques utilized in many other fields have not been validated in transportation analysis and planning.

A summary of the workshop discussion and conclusions will be published.

As a result of the consensus reached by the conferees, additional study is being undertaken to examine potentially useful techniques and to conduct validation tests. Service and Methods demonstrations will be used as test sites for evaluating the applicability of different techniques to various types of innovations. Expected outputs include a determination of the predictive validity and evaluative utility of attitudinal survey techniques and a specification of their most useful applications.

Shirley Highway Mode Choice Model

The Shirley Highway mode choice study produced a calibrated mode choice model, based on the Shirley Highway data set, that can be used to predict the impact of similar innovations in other urban areas (Ref. 4). The resulting mode choice model (actually a family of models) is multimodal, that is, it can deal with more than two modes at one time and is fully competitive. Models that are not fully competitive are limited by the assumption that the ratio of the probability of choosing one mode over a second is independent of the other modes in competition, and, if a new mode is introduced, the probabilities for the already existing modes are reduced by the identical proportion. This is in conflict with the principle that a mode should compete most strongly with the mode that it most resembles. A fully competitive model will be useful for planning demonstrations and prédicting ridership when more than a binary mode choice is involved. Two such cases are (1) contra-flow express bus competing with both local bus and auto and (2) dial-a-ride, park-and-ride, and taxi feeder service to a line haul route.

The data requirements for the Shirley Highway model are identical to those for the conventional model from which it was derived: those used in the case study included auto ownership total auto/bus travel time, and auto/bus commute cost divided by an income factor. Using the same data set, the results of the Shirley Highway model were compared with those from two widely used models, and the Shirley Highway model proved to be a better predictor of mode choice for three out of four decision criteria. The model has also been calibrated using data from Denver, Minneapolis, and Washington, D.C. for a three way modal split (auto driver, auto passenger, and bus). The results were an improvement over those generated by the commonly used model from which it was derived.

The Shirley Highway model will be used to estimate the sensitivity of bus and auto usage to changes in policy and transportation variables. With this knowledge, a decision maker can predict the total effect on mode choice of a change in a policy variable, such as a one dollar auto commuter tax, for example, or from a change in a transportation variable as an increase in transit vehicle speed. The model is currently being validated using data from the fall 1974 surveys for both the Shirley Highway and Minneapolis demonstrations.

Evaluation Tools

Every Service and Methods Demonstration project involves some form of an evaluation program, whereby specific data collection and analysis activities are undertaken to ascertain the extent to which SMD and local project objectives are satisfied. Since the evaluation process serves as a bridge between the operation of a demonstration project and the understanding of its actual performance at the demonstration site as well as its potential effectiveness in other locales, considerable emphasis is placed on improving the state-of-the-art of evaluation techniques and increasing the consistency of approaches used in different projects.

With regard to improving the state-of-the-art, the major areas which have been stressed are efficiency (cost and time saving approaches) and accuracy. Overall efficiency of the evaluation process has been enhanced by the development, for many SMD projects, of detailed evaluation plans prior to project implementation. Timely preparation of these plans has increased efficiency by eliminating duplication of effort among various participating agencies and assuring an orderly flow of evaluation tasks.

More specific examples of cost and/or time saving approaches which have been devised in conjunction with Service and Methods project are to be seen in the Shirley Highway and Miami projects. Both evaluations involve surveys of the potential market for transit in addition to the market actually captured, and are innovative in their sampling approaches. Rather than incurring a high rate of nonresponses and inapplicable cases by random sampling of a telephone directory or other general sources, the sampling source is automobiles crossing selected screen lines within the corridor during relevant time periods. A sample of license plate numbers is recorded to obtain names and addresses of potential mail survey respondents.

Increasing the accuracy of evaluation activities comprises two areas: measurement accuracy and statistical accuracy. Passenger counting is a form of data collection which has received recent attention from the standpoint of measurement accuracy: several projects rely on more than one source of ridership data in order to obtain more reliable estimates of this significant performance measure. Increasing emphasis has been placed on statistical accuracy. An example is the determination of the minimum sample sizes for data collection needed to achieve prescribed significance levels.

In addition to the effort of evaluation teams to devise innovative data collection and analysis methods, there are extensive activities underway to increase the consistency of evaluation procedures among projects. Achieving consistent quality and quantity of data across demonstrations will make possible extensive comparisons of user characteristics, site characteristics, system performance and financial measures. These types of comparisons will be especially significant in the cases of multiple applications of a particular service in several locations or for demonstrations involving alternative services directed toward a particular program objective. The initial output of efforts in this area is a document containing guidelines for evaluating demonstration projects. The guidelines are intended to foster consistency of evaluation techniques and results by providing a common framework for developing and then executing the evaluation of each new SMD project.

The guidelines cover such diverse areas as recommended formats for evaluation plans and presentation of results, recommended data collection and analysis procedures for specific performances measures, standardized data sets to be included in surveys and minimum statistical accuracy requirements.

These guidelines will be modified and updated on a periodic basis to reflect refinements in techniques. The guidelines are representative of the program philosophy of creating a structured, comprehensive, consistent and immediately useful approach to developing and demonstrating innovative means for achieving improvements in public transportation.

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APPENDIXES

APPENDIX A

SHIRLEY HIGHWAY EXPRESS BUS-ON-FREEWAY PROJECT: WASHINGTON, D.C. - NORTHERN VIRGINIA

Project Overview

The Shirley Highway Express Bus-on-Freeway Project was the first large scale demonstration of the bus priority concept. Three major elements comprise the project: (1) The partially completed eleven mile, two lane reversible roadway in the median of the Shirley Highway (I-95) which was initially used only by buses and later also by carpools with four or more members; (2) the bus transit operation, involving new buses with special features operating on new routes with new schedules; and (3) residential fringe parking facilities for bus riders located in shopping centers and in newly constructed lots. Complementing the transit services was a comprehensive marketing and promotion campaign intended to inform the public of the demonstration.

The demonstration project influences urban travel within the corridor area indicated in Figure A-1. Approximately 550,000 people live within this 150 square-mile area. At the northeast end of the corridor are major employment centers, including the Pentagon, the rapidly growing Crystal City Complex in Virginia, and downtown Washington, D.C. The Shirley Highway (I-95) is one of two limited access radial commuter facilities connecting the Virginia suburbs with Washington. During peak periods this highway, as well as the six other major radial arterials, operates under conditions of severe traffic congestion.

The major demonstration project elements evolved into a coordinated system over a six year period (1969 to 1974). Federal funding of the operational elements of the project ended in December 1974. The Shirley Highway Express Bus Service is now being offered under local sponsorship.

The Project was jointly sponsored by the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA). The Steering Committee which guided the development of the project comprised the Northern Virginia Transportation Commission, the Metropolitan Washington Area Council of Governments, the Washington Metropolitan Area Transit Authority, the District of Columbia and the Virginia Highway Departments, as well as UMTA and FHWA. The Northern Virginia Transportation Commission contracted with the AB+W Transit Company (subsequently acquired by the Washington Metropolitan Area Transit Authority as part of the regional bus system) for operation of the project bus service.

Precise costs of the demonstration project capital expenditures are difficult to establish because construction cost information is only available for the entire roadway., It has been estimated that a maximum construction cost of $43 million could be allocated to the reversible lanes. Expenditures attributable to the bus transit element of the project were $3.8 million for 90 new-feature buses, $16,000 for six bus shelters, and $6.7 million for bus operating costs. The cost of manually opening and closing the reversible lanes for each peak period averaged about $10,000 per year.

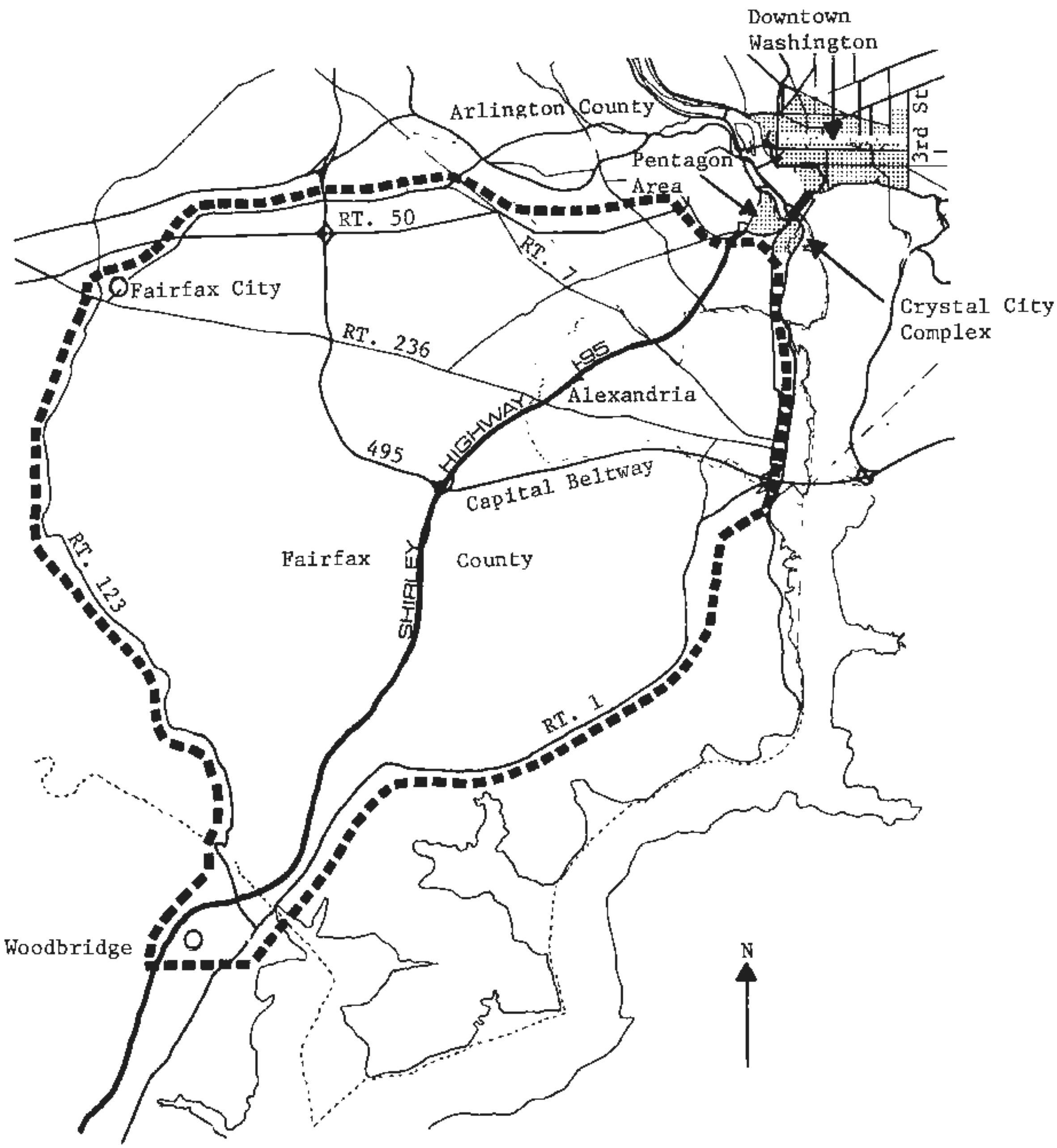

Figure A-1. Shirley Highway and Corridor Area

Objectives

The Shirley Highway Project encompasses four of the Service and Methods Demonstration Program objectives. These are:

- Reduction of travel time for transit users.
- Increase in the coverage of transit service.
- Improvement of the reliability of transit service.
- Increased transit vehicle productivity.

By providing a high speed, congestion free line haul route for buses, the reversible lanes provide transit users with a much faster, more reliable service than they previously experienced. These improvements in travel times and reliability enable the transit operator to increase productivity by allowing the same number of buses and drivers to make more trips than would be possible without the reversible lanes. The project bus service is covering areas not previously served by transit to the extent of about 50 additional square miles.

Other project goals were to demonstrate the effectiveness of the express bus-on-freeway operation as a means of:

- Increasing the peak period people moving efficiency of the entire corridor;
- Reducing adverse environmental effects and fuel consumption of the transportation system;
- Improving the level of service (i.e., travel time and parking availability) of the automobile system;
- Improving the mobility of the transportation disadvantaged; and
- Improving the general financial situation of the bus operator.

Project Description

Three major elements comprised the project: 1) the reversible priority lanes for buses and carpools on the Shirley Highway and the bus priority lanes in/Washington, D.C.; 2) a bus transit operation involving additional buses (with special features) on new routes and with new schedules; and 3) residential fringe parking facilities for bus riders.

The first project element provides exclusive or priority lanes for buses from the time they enter the Shirley Highway until they reach their terminal points in downtown Washington or the Pentagon. Figure A-2 depicts the Shirley Highway, showing the completed 9 mile permanent eight lane section (two three-lane directional roadways separated by a two-lane reversible Express

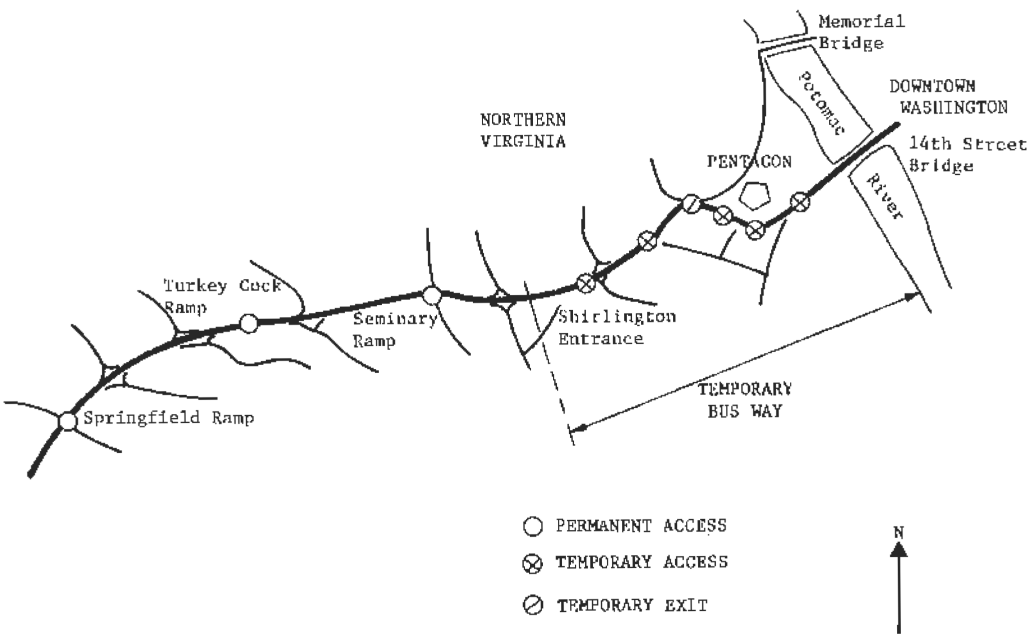

Figure A-2. Shirley Highway Busway Entrances roadway – Figure A-3) and the 2 mile portion still under construction with the single-lane temporary busway.[1] When completed in Fall 1975, the reversible priority lanes will be approximately 11 miles long and will end at the southern end of the 14th Street Bridge over the Potomac River.

After travelling through the Corridor on the busway, inbound buses crossed the Potomac on the 14th Street Bridge. (The reversible lanes were only used during the peak periods—inbound from 6:30 to 9:00 a.m. and outbound from 4:00 to 6:30 p.m.) The buses than merged with regular District of Columbia traffic. Within the District, peak period bus lanes and special turn advantages give the buses some priority over autos. Figure A-4 shows the locations of priority bus lanes and special turn advntages as of December 1972. This plan was modified during the project as construction of the local subway (Metro) progressed.

In December 1973, the 9 mile completed section of the reversible priority lanes that had been previously used exclusively for buses was opened to carpools with 4 or more occupants. The carpools entered the reversible lanes at the two Southern points and exited at Washington Boulevard (just before the temporary buslane began).

Project bus operations (the second project element) consisted of peak period Shirley Highway bus service operated by the AB+W bus company prior to the project,[2] the new demonstration service which was administered by the Northern Virginia Transportation Commission (NVTC) and new service initiated by the Washington Metropolitan Area Transit Authority (WMATA) to accommodate expanded patronage.[3] WMATA (formerly AB+W) served the pre-project bus route; however, the project service was provided by 90 new special feature buses purchased by NVTC using the UMTA demonstration grant funding,[4] UMTA funding was also used to install bus passenger shelters along these routes.

Figure A-5 depicts the A.M. peak period service as of June 1972. The new project routes had more direct routing in suburban and downtown collection and distribution to complement the express lanes, and thus provided fast and reliable peak period bus service. In addition, project buses were also used to provide new midday and reverse commuter routes.

The 90 NVTC buses provided approximately 80 hours of revenue service during each peak period. This represented 95 vehicle trips on 14 routes. During the height of the peak period, headways on most of the project routes were generally on the order of 7 to 15 minutes.

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[1] The permanent reversible lanes are 24 feet wide with 10 foot shoulders. The temporary busway is 18 feet wide, but may narrow in some locations to 11 feet; of course, I-95 is built to interstate standards.

[2] WMATA acquired the AB+W Transit Company, a private firm, on February 4, 1973, as part of the regional bus system. It now operates the former AB+W buses as well as the NVTC service.

[3] Although not part of the project, private companies such as Colonial Transit, Greyhound, and Trailways also operated commuter buses on the reversible lanes.

[4] At the completion of the demonstration project WMATA acquired the NVTC buses and continues to operate the project service.

Figure A-3. Exclusive Reversible Lanes, Shirley Highway, Showing Buses and Carpools

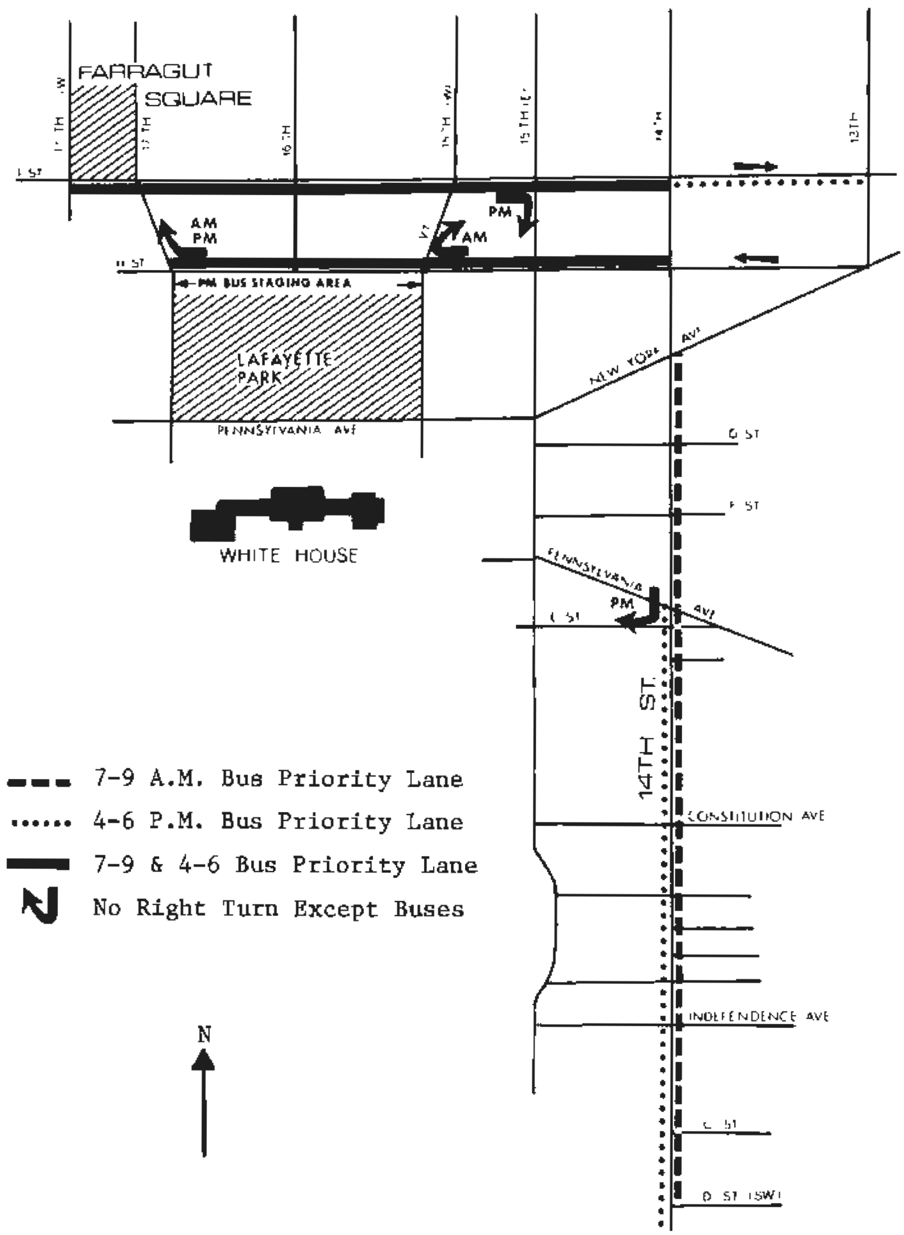

Figure A-4. Peak Period Priority Lanes in Downtown Washington, D.C., June 1972

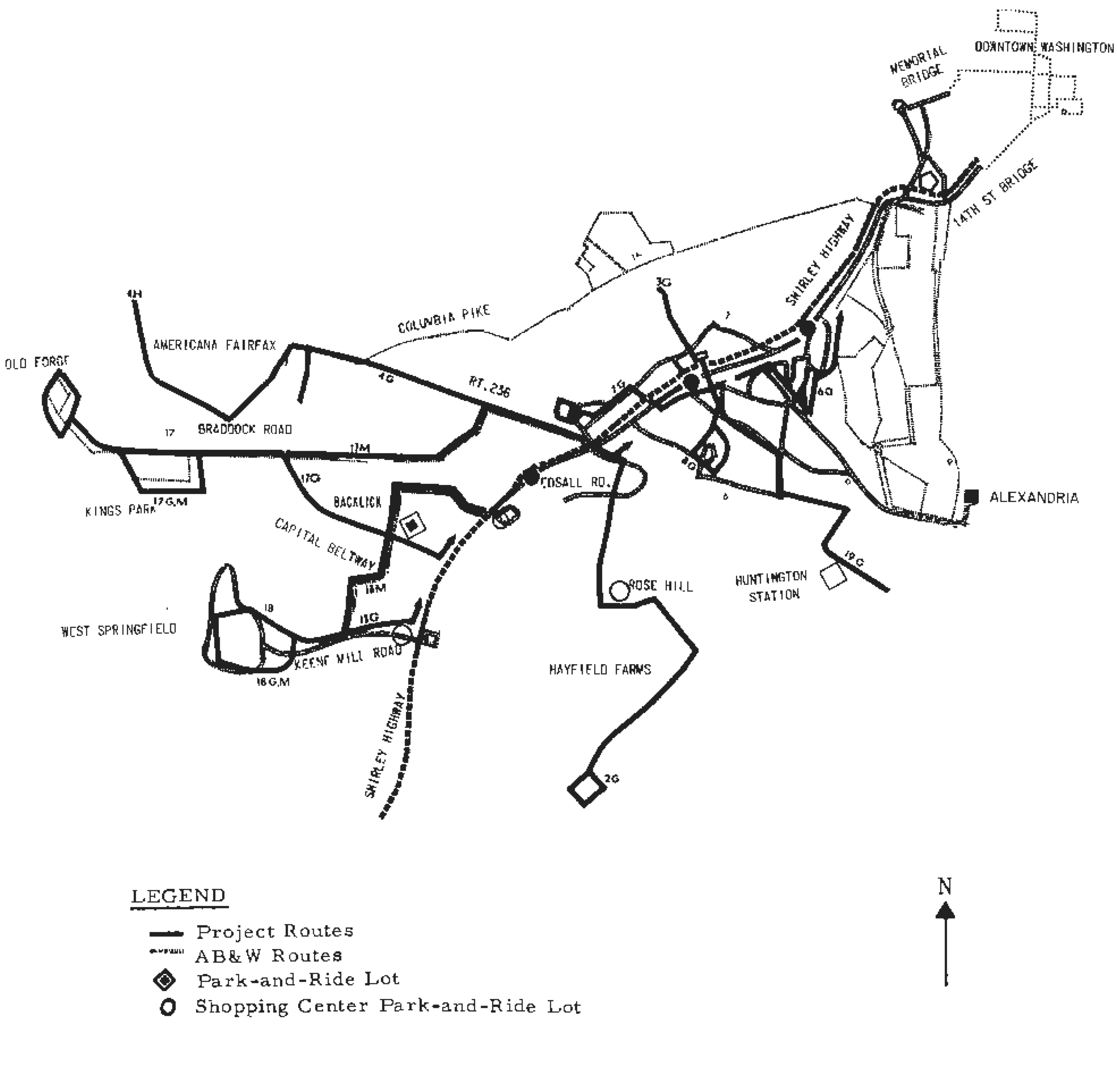

Figure A-5. AB&W Peak Period Bus Routes and Project Service, Shirley Highway Corridor, June 1972

There were 8 routes during the off peak hours. One hundred and twenty vehicle trips were made on these 8 routes. During off peak hours the reversible lanes were not open and consequently buses mixed with other traffic on the general traffic lanes. However, there was usually no congestion during these hours. Fares on the project buses ranged from 40 cents (for local trips) to 80 cents, depending on the distance traveled. Fares for project peak period Shirley express trips generally averaged about 70 cents.

The 90 new buses had special features designed to increase passenger comfort. These included: air conditioning, wider, more luxurious seats, smooth line interiors (no advertising racks) with colorful plastic wall coverings, carpeting or a new vinyl mat-type floor covering that was color coordinated with the walls and seats, and improved lighting.

Residential fringe parking facilities (third project element) were coordinated with the new bus service to serve park-and-ride patrons. The lot at Backlick Road near the Capital Beltway (I-495) is a permanent park-and-ride facility on the site of a future Metro station which NVTC leased during the project. The five acre, lighted lot has 400 parking spaces, a kiss-and-ride staging zone, a bike rack and passenger shelters. The NVTC also obtained permission from two shopping centers (Springfield Plaza and Shirley Plaza) to designate portions of their lots for all day free parking for bus users. Other shopping centers were also used for parking by daily riders, but were not officially part of the project.

Complementing the transit services of the demonstration was a comprehensive marketing and promotion campign. The key elements of the publicity were special displays located at shopping centers, flyers containing promotional facts mailed to Virginia residents, and limited newspaper and radio advertisements. Other components included public service announcements, and a considerable amount of favorable news coverage.

The 1970 Census data provided a demographic description of the corridor before the entire busway opened in 1971. The 1970 Census tracts within the corridor boundary were used for the tabulation of selected demographic characteristics. Table A-1 compares corridor demographic characteristics with those of Washington D.C. and the entire SMSA.

Project History and Status

The reversible priority lanes were opened in stages as the reconstruction of the Shirley Highway progressed northward to Washington. Beginning in 1964, the Shirley Highway has been improved from a four-lane controlled access highway to an eight-lane interstate facility with two three-lane directional roadways and a two-lane reversible express roadway. In September 1969, the 4.8 mile completed portion of I-95 reversible roadway between Edsall Road and Shirlington was opened to buses exclusively during the morning peak period.

In September 1970 the first portion (1.6 miles) of a single lane temporary busway was opened through the area under construction from Shirlington to north of Glebe Road. The final section of the temporary busway, extending to the new Potomac River Bridge, was opened on April 5, 1971. At the same time, the new 14th street Bridge was opened to buses and a system of peak period priority bus lanes on downtown Washington streets was implemented.

As the reconstruction progressed, the temporary single buslane was replaced by the two lane reversible roadway. By May 1973, the nine mile section of the reversible roadway from Springfield to the Pentagon was completed. The Shirley Highway, including the reversible lanes, is

TABLE A-1. SELECTED DEMOGRAPHIC CHARACTERISTICS: SHIRLEY HIGHWAY CORRIDOR, WASHINGTON, D.C. AND WASHINGTON, D.C. - SMSA

1970 DEMOGRAPHIC CHARACTERISTICS	CORRIDOR		SMSA		WASHINGTON, D.C.	
	TOTAL	PERCENT	TOTAL	PERCENT	TOTAL	PERCENT
POPULATION:						
Total	496,470	93	2,861,123	75	756,510	29
Negro	32,379	7	763,445	25	537,712	71
Number of Families	167,564		898,496		162,656	
AREA:						
Square Miles	152.6		2,399		61	
Population per sq. mile	3,253		1,193		12,390	
YEAR MOVED INTO HOUSING:						
1968 - 1970 (March)	73,871	47	367,995	41	96,118	37
1965 - 1967	35,147	22	206,136	23	59,743	23
1960 - 1964	24,117	15	139,366	15	40,229	15
1950 - 1959	17,922	11	128,366	14	41,226	15
1949 or earlier	5,764	4	62,059	7	25,222	10
1970 FAMILY INCOME:						
Medain	$15,000		$12,993		$9,583	
CLASS OF WORKER:						
Private	110,666	52	665,596	57	179,830	54
Government	95,080	45	460,779	39	141,163	42
Self-employed	6,768	3	50,419	4	13,510	4
Total	212,514		1,176,794		334,503	
AUTOS AVAILABLE:						
1	74,497	44	405,179	45	113,671	70
2	60,004	36	277,330	31	28,380	17
3 or more	9,680	5	49,713	5	4,379	2
Total (Autos)	233,545		1,108,978		183,568	
Average (Autos/family)	1.34		1.23		1.13	
None	25,179	15	166,274	19	16,226	10
MEANS TRANSPORTATION TO WORK:						
Driver	147,958	69	748,801	60	125,415	37
Passenger	30,186	14	163,922	13	39,246	12
Total	178,144	83	912,723	73	164,661	49
Bus	21,906	10	190,187	15	119,021	36
Walked to Work	7,965	4	78,504	6	33,745	10
Worked at Home	3,352	2	24,019	2	6,880	2
Other	4,107	2	33,022	3	11,039	3
WORK PLACE:						
D.C. Central Business District	20,095	9	128,453	12	48,467	18
D.C. Remainder	38,259	18	363,813	33	171,925	63
Arlington	40,114	19	103,655	10	11,590	4
Virginia	88,847	41	183,811	17	7,181	3
Other	28,241	13	308,948	28	34,298	12

still under construction from there to the Potomac River, with a temporary busway through this section.

Bus service was developed as the busway was opened in sections, and the 90 demonstration project buses were purchased in increments. Although the opening of the initital busway sections in 1969 and 1970 stimulated increased ridership, the private bus company was unable to expand the peak period bus service significantly until the demonstration project began in 1971. After the opening of the entire busway into Washington and the beginning of the demonstration project, 30 new feature project buses and eight new peak period routes were introduced in June 1971. Twenty more buses were added in February 1972, 10 more in June, and 16 were placed into service in September. The final 14 began operating in February 1973. Mid-day bus service began in 1972. This service consisted of two radial routes between the southern part of the Corridor and Washington, D.C. and two which circulated in opposite directions within the Corridor.

The fringe parking lots also were not introduced simultaneously. Parking at designated portions of the two shopping centers began in June 1971, while the permanent facility at Backlick Road was opened in October 1972. Bus passenger shelters were installed during 1973 and 1974.

Carpools were permitted to use the completed sections of the reconstructed reversible lanes beginning in December 1973. Carpools and buses will share the entire length of the facility when the I-95 reconstruction project is completed in 1975 (current policy of the busway operator, the Virginia Department of Highways and Transportation).

UMTA funding of the operational elements of the demonstration service ended as of December 31, 1974. However, UMTA funded the evaluation of the demonstration project separately and it was completed in June 1975 by the National Bureau of Standards.

Results

The provision of lanes for exclusive use by buses (and, more recently, by carpools also) on the Shirley Highway has considerably reduced bus commuting time. In November 1972 an estimate of bus travel time indicated travel time savings averaging 17 minutes (ranging between 12 and 19 minutes) for project buses using the exclusive lanes.

Another effect of the provision of exclusive lanes is the greater reliability in bus travel time since buses have been essentially removed from external traffic influences on this portion of the trip. As a result, bus on time performance (i.e., the percentage of buses arriving not more than six minutes late at the first stop in Washington, D.C.) has been increased to 92 percent from 33 percent at the beginning of the project.

As express bus service operating on the exclusive lanes was expanded, ridership increased at a comparable rate. The fact that the express buses always operated at, or above, seated capacity even though the bus service was continually expanded indicates that the number of buses in service at a particular time acted as a constraint on patronage. Figure A-6 highlights the passenger trends to November 1974. (Patronage on buses operated by the private carriers is included.) The figure reveals that all of the bus patronage growth since April 1971 is attributable to the routes which enter south of Shirlington in contrast with the relatively static conditions of the routes entering at Shirlington. The total A.M. peak period (6:30–9:00 A.M.) exclusive lane bus patronage reached 16,000 persons during November 1974. In addition, 4,600 auto persons in four or more person carpools used the exclusive lanes during the peak period in November 1974. Approxi-

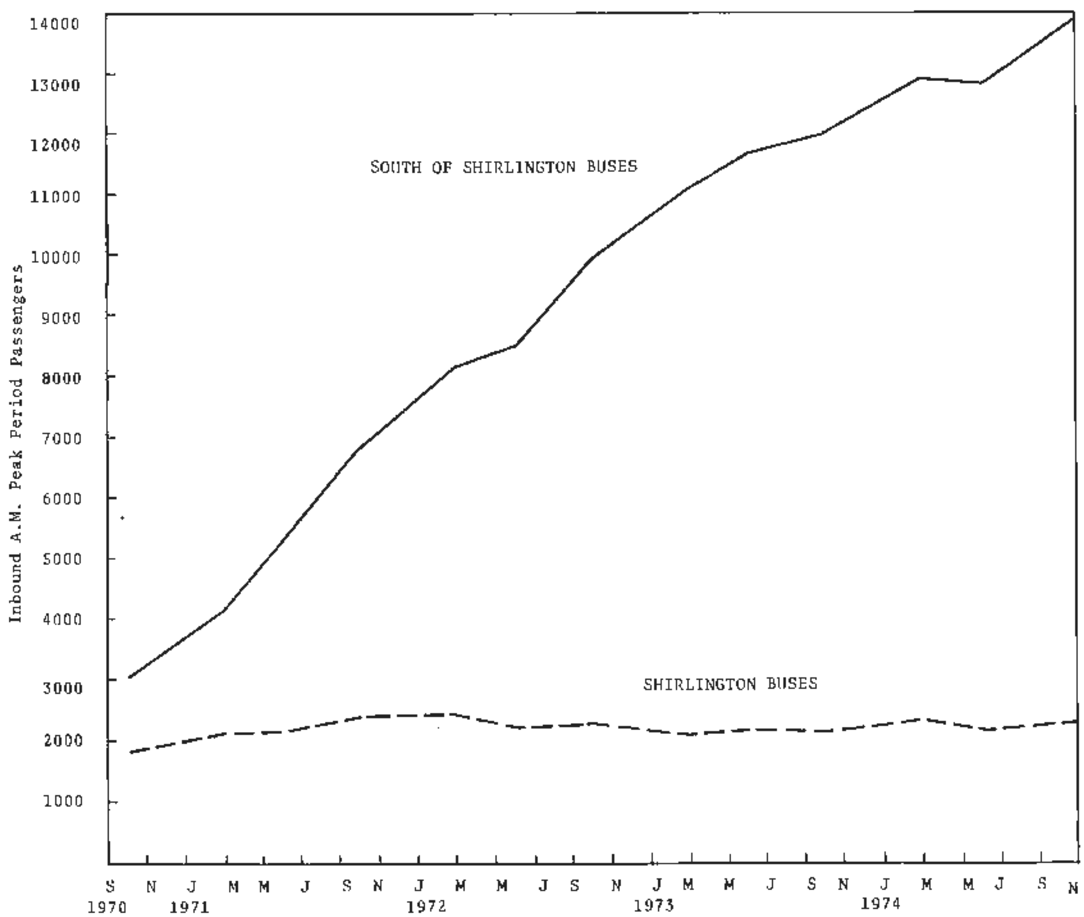

Figure A-6. Trends in Busway Patronage, Shirley Highway Corridor mately 16,000 auto persons used the three auto lanes during this same period. This A.M. peak person trip total (36,600) is 19,600 persons more than in April 1970 when the Shirley Highway had only two auto lanes and only a small segment of exclusive roadway. During the November 1974 peak hour (the hour with the maximum observed person trip volume), 7,600 bus passengers and 3,400 carpool persons were observed on the two exclusive bus and carpool lanes and 6,900 auto person trips were observed on the three auto lanes of the Shirley Highway.

Data for the other evaluation elements are shown in Table A-2. Operating characteristics are available only for the service provided by the 90 buses purchased by the NVTC and operated by WMATA under contract. As a measure of the amount of service provided by other buses, bus ridership during the A.M. peak periods using the exclusive lanes at the Shirlington counting station was 16,000 in November 1974, while NVTC service carried 7,100 or a little less than 45 percent of the total.

Former auto users riding the demonstration project buses have indicated that service features have been the primary determinants of their decisions to change from automobile to bus. Service features include the comfort of the trip and the reliability of the bus service, especially in its ability to avoid much of the peak period traffic congestion.

Analysis of the response to an on board bus survey revealed that only one person of the 551 interviewed reported that shopping center advertisements first notified him of the bus service; 7 percent of all respondents indicated that the (NVTC) "flyer" was their source of information; 10 percent gave credit to newspaper and radio promotions; while 15 percent believed that seeing buses on the busway was responsible. In vivid contrast to these advertising modes, "word of mouth", which garnered 41 percent of the replies, was demonstrated the most effective news mechanism. This suggests that one promotional method that might prove to be effective would be to encourage regular satisfied patrons to inform others of the service.

The following comments describe the impact of this project on the transit operator:

(1) The exclusive lanes stimulated substantial patronage growth (nearly 12,000 persons for the A.M. peak period, since September 1969) for those routes experiencing the greatest time savings. The number of persons per bus for these routes meets or exceeds seated capacity despite substantial increases in the number of buses being utilized.

(2) The percentage of the daily ridership served during the peak period is extremely high for both NVTC and WMATA routes (80 percent for WMATA routes and 91 percent for NVTC routes). This peaking translates into labor costs for the operator which are difficult to offset.

(3) Preliminary estimates by the WMATA staff and the project evaluation team indicate a more efficient utilization of resources during the peak periods. To maintain present headways without the exclusive lanes would require approximately 20 additional buses and drivers during the peak periods. This is equivalent to a monthly cost saving of approximately $30,000.

(4) From July 1971 through 1974 peak period project service operated in the black. Peak period net income was low in the first half of 1972, corresponding to additional expenses accompanying the expansion of service but without compensating increases in revenue. By the latter half of 1972 patronage grew to absorb the increased capacity and peak period revenue reached a record high. Off peak service continues to lose money, but from the first half of 1971

TABLE A-2. SELECTED RESULTS: SHIRLEY HIGHWAY EXPRESS BUS-ON-FREEWAY PROJECT, WASHINGTON, D.C. - NORTHERN VIRGINIA

	July-Dec 1971	Jan-Jun 1972	July-Dec 1972	1973	1974
OPERATING CHARACTERISTICS OF NVTC* PROJECT TRANSIT SERVICE:					
No. of Project Buses in Service	30	56	76	90	90
Ridership:					
AM&PM Peaks	3,708	5,648	8,803		13,235
Off-Peak	270	545	786		
Daily	3,978	6,193	9,589	13,328	
Transit Travel Time			50 min.		
Transit Trip Length			16.7 mi.		
Transit Vehicle Peak Speeds:					
Local Streets			16.1 mph		14.4 mph
Shirley Highway			30.0 mph		38.5 mph
CBD Streets			12.0 mph		10.2 mph
Total Passenger Revenues	$345,195	$538,816	$812,453	$2,001,647	
Total Operating Cost	$362,149	$613,742	$807,013	$1,877,837	
Revenue/Passenger	$0.70	$0.67	$0.69		
Operating Ratio (Cost/Revenue)	1.05	1.14	0.99	0.94	
Productivity:					
Pass/Veh/Mi	1.00	1.16	1.21	1.16	
Pass/Veh/Hr				16.45	
Operating Cost/ Passenger	$0.72	$0.77	$0.69		
Operating Cost/ Vehicle-Mile	$0.86	$0.90	$0.84		
PEOPLE MOVEMENT ON SHIRLEY HIGHWAY (AM PEAK PERIOD):					
Bus Person Trips on Shirley	9,093	10,521	12,105	13,769	15,550
Auto Person Trips on Shirley	5,660	5,700	5,900	11,400	12,500
Auto Occupancy on Shirley	1.33	1.39	1.37	1.42	1.56
Average Auto Speeds on Shirley		19.1 mph		37.2 mph	26.7 mph
TRANSIT USER CHARACTERISTICS:					
Age:					
Under 21	4%				3%
21-39	59				59
40-65	36				37
Over 65	1				0
Sex:					
Male	60%				62%
Female	40				38
Family Income:					
Under $5K	1%				0%
$5-15K	37				21
$15-30K	56				61
$30K and over	6				18

* Northern Virginia Transportation Commission

TABLE A-2. SELECTED RESULTS: SHIRLEY HIGHWAY EXPRESS BUS-ON-FREEWAY PROJECT, WASHINGTON, D.C. - NORTHERN VIRGINIA (CONT'D)

	July-Dec 1971	Jan-Jun 1972	July-Dec 1972	1973	1974
Car Ownership/Family:					
0 cars	7%				5%
1 car	59				51
2 cars	30				37
3+ cars	4				7
Previous Mode of Travel:					
Drove Alone					38%
Carpool Driver					16
Carpool Passenger					6
Bus					31
Other					9
Transit Access Modes:					
Park-Ride	16%				16%
Kiss-Ride	9				7
Walk	75				77
Daily Air Pollution Emissions Reductions (lbs):					
Carbon Monoxide	6,733		11,679	22,100	32,240
Hydrocarbons (Exhaust)	689		1,194	2,168	3,089
Nitrogen Oxide	511		853	1,576	2,048
Hydrocarbons (Evaporative)	314		417	567	711

until late 1974, peak period income more than offset off peak losses. This occurred in spite of greatly increasing costs and no fare increases since November 1970.

(5) The Demonstration Project has effected a departure from the historical transit service cutback and fare hike syndrome by providing an expanding and attractive service which generates complementary increases in patronage, and stimulates an improved financial situation for the operator.

Evaluation and Conclusions

The exclusive lanes continue to contribute to the reduction of bus travel time and the improvement of bus schedule reliability by providing a high speed, congestion free line haul route. Unfortunately, the extent to which the downtown bus priority lanes have been effective in reducing bus travel times and improving schedule reliability has been difficult to measure because of interference from the construction of the Washington (Metro) subway system.

The demonstration project has also sucessfully met the SMD program objective of increasing area coverage by adding over fifty square miles to the area encompassed by previous transit service.

The corridor wide percentage of potential bus trips which are made by bus has been designated the primary local measure of project effectiveness; this percentage is called the bus market share. The November 1974 peak period corridor bus market share estimate (based on 1974 commuter surveys traffic and bus passenger data) of 41 percent is essentially unchanged since October of 1972; however, an additional 12,000 persons are using corridor transportation facilities, and corridor bus service attracted 4,800 additional bus riders between June 1972 and November 1974. Since the inauguration of the project in 1969, daily bus ridership has increased by 23,000 and bus market share increased from 27 percent (prior to project implementation) to the present 41 percent.

As a consequence of the shift of automobile commuters to the bus service, approximately 7,250 automobiles which would have been expected in the absence of the project were removed from the daily peak period traffic streams as of November 1974. However, the substantial reductions in congestion and automobile travel times on the Shirley Highway that have recently been effected have not been entirely due to the removal of these autos. A considerable part of these reductions can be attributed to the increased capacity provided by the newly opened portions of the reconstructed Shirley Highway. Nonetheless had large numbers of express bus riders not been diverted from auto travel, the highway system would have been considerably more congested than it is and all auto users would have been subjected to additional delays and longer travel times.

Other consequences of the removal of automobiles from corridor highways are reductions in automobile air pollution and gasoline consumption. These reductions were estimated to be about 19 tons of pollutants and about 17,000 gallons of gasoline per day in October 1974.

The project has had a generally positive impact on the bus operation. Utilization of vehicles and labor improved on routes that used the exclusive lanes. Time savings on these routes allowed the same number of buses and drivers to make more trips than would be possible without the reversible lanes. Increased utilization, however, was not enough to accommodate growth in patronage, and additional buses had to be put into service.

Although peak period service has been expanded substantially, net project operating revenue (peak and off peak) for the period June 1971 to April 1974 showed a surplus of $31,365.

Word of mouth promotion was the most frequent means of informing commuters about the service. This implies that while formal advertising methods are required for initial publicity, it is highly desirable to augment patronage by encouraging regular, satisfied patrons to attract others.

The results presented were based primarily on the NBS Report "The Shirley Highway Express-Bus-on-Freeway Demonstration Project/Second Year Results." However, it should be noted that some of the results presented, especially those dealing with cost analysis, do not take into account the considerable amount of service provided by WMATA on non-project routes which also takes advantage of the exclusive lanes. Nevertheless, all statistics on corridor auto and bus passenger flows and the reduction in air pollution emissions and gasoline consumption naturally include all corridor travel, irrespective of roadways used.

References

The National Bureau of Standards has prepared the following reports on the project:

1. National Bureau of Standards, Technical Analysis Division. Shirley Highway Express Bus-on-Freeway Demonstration Project; Project Description, Interim Report 1. Miller, Gerald K. Prepared for U.M.T.A. UMTA-IT-06-0024-71-1 Aug. 1971 PB 218 9635

2. National Bureau of Standards, Technical Analysis Division. Shirley Highway Express Bus-on-Freeway Demonstration Project; First Year Results, Interim Report 2. Miller, Gerald K. and Goodman, Keith. Prepared for U.M.T.A. Nov. 1972 PB214 333/7

3. National Bureau of Standards. Shirley Highway Express Bus on Freeway Demonstration Project; Users' Reactions to Innovative Features, Interim Report 3. Saks, Theodore H., Yates, Richard and Goodman, Keith M. Prepared for U.M.T.A. June 1973 COM-73-11453/OGA

4. National Bureau of Standards. Shirley Highway Express-Bus- on-Freeway Demonstration Project; Second Year Results, Interim Report 4. Nov. 1973

5. National Bureau of Standards. Shirley Highway Express-Bus- on-Freeway Demonstration Project; A Study of Reverse Commute Service, Interim Report 5. NBSIR 74-624 Dec. 1974

APPENDIX B

MINNEAPOLIS (I-35W) URBAN CORRIDOR DEMONSTRATION PROJECT

Project Overview

A major operating demonstration project of the Bus-on-Metered-Freeway concept has been implemented in the I-35W corridor in Minneapolis. The system concept includes:

- Full metering of the I-35W freeway south of Minneapolis to the Minnesota River, approximately 17 miles.
- Real time surveillance, command and control.
- Extensive express bus service in the corridor.
- Priority bus freeway access via exclusve ramps.
- Provision of transit rider amenities: bus shelters, signs, park-and-ride lots.

The freeway varies in width from four lanes at the south end of the project corridor to eight lanes near the CBD. It is flanked on both sides by parallel north-south arterials. Bottlenecks on I-35W are caused by high traffic volumes, weaving maneuvers inherent in cloverleaf designs, the geometrics of the curve in one section, by lane reductions and a lateral restriction across the Minnehaha Creek. There are 17 metered inbound ramps with seven having reserved bus ramps, and twelve metered outbound ramps with one bus ramp providing priority egress from the CBD. The ramp metering system controls 63 percent of the inbound traffic during the peak hours and 52 percent of the outbound traffic.

The project study and plan were completed in September 1970. The construction period ran from May 1972 through November 1973. Data collection and evaluation began in October 1971 and ended December 1974.

The local agencies cooperating in this project are the Metropolitan Council of the Twin Cities, the Minnesota Highway Department, the Metropolitan Transit Commission, and the Bloomington Bus Company.

The project is divided into three phases for operation and evaluation:

- Phase 1, "Before" – Five existing express bus routes and no freeway entry control; October 1971
- Phase 2, "Intermediate" – Fourteen express bus routes and no freeway entry control; December 1972
- Phase 3, "After" – Final express bus service and routine freeway entry control; April 1974 through

It must be noted that this report includes only results from Phase 1 and 2. Phase 3 results will be included in the Final Report along with overall project findings and recommendations.

The estimated total cost of the project, as of 1 October 1974, is $5,869,000. This sum is broken down by source as follows:

Grant	Federal Share	Local Share
UCDP(U.S. DOT)	1,553,000(87%)	232,000
FHWA	2,354,000(90%)	261,000
UMTA	979,000(66.7%)	490,000
Total	4,886,000	983,000

Objectives

The Service and Methods Demostration objectives of the Minneapolis project are:

- Decrease transit travel time
- Increase transit reliability
- Increase transit coverage

The metering control of the freeway entry is intended to restrict the number of vehicles on the freeway within the corridor so that congestion is minimized. The control technique is expected both to reduce vehicle travel time on the expressway and to improve the reliability of bus transit service. Congestion which does occur will take place at the metered entry ramps, and the buses can avoid the ramp queues by use of the exclusive bus ramps (see Figure B-1). In addition, the reduced congestion will smooth traffic flow, thus reducing the number of accidents and permitting the faster clearing of incidents of all kinds.

The closed-circuit television surveillance system (shown in Figures B-2 and B-3), which aids in the detection of traffic problems of all kinds, will help operations controllers report incidents and reduce their duration time. These improvements will also help to reduce bus travel time and increase the reliability of service.

Transit coverage throughout the corridor area has been greatly expanded. Nine new express bus routes have been added to the five existing routes. All express buses circulate through their suburban pickup areas and then proceed non-stop to the CBD on the expressway. Their effective collection areas have been greatly expanded by the establishment of 17 park and ride lots.

In addition to the three SMD objectives, there are seven local project objectives:

Figure B-1. Ramp Meters and Bypass Lane for Buses, I-35W, Minneapolis, Minnesota

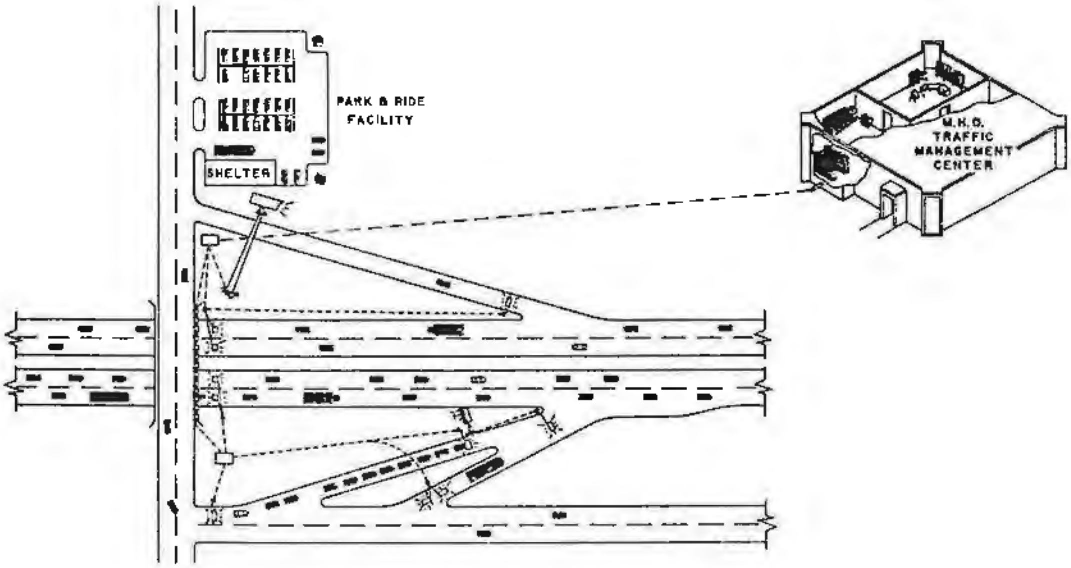

Figure B-2. Bus on Metered Freeway System Concept, I-35W, Minneapolis, Minnesota

Figure B-3. Surveillance and Control Center, I-35W, Minneapolis, Minnesota

- Improve the corridor level of service for all vehicles through metering the traffic entering an urban radial freeway without adverse impact on the traffic operation on other roadways.

- Increase the transit modal split in the corridor.

- Improve the reliability of the freeway operation for all vehicles through the reduction of accidents, reduction of duration time of incidents, and maintenance of an efficient traffic management system.

- Improve the transit system performance through decreased travel times, improved schedule adherence, reduced unit costs, and favorable cost/revenue position.

- Obtain favorable public support for bus-on-metered-freeway systems.
- Obtain a positive environmental impact through reduced energy requirements, noise levels, and exhaust emissions.

- Implement the bus-on-metered-freeway system in a cost effective manner.

Project Description

The Surveillance and Control System permits the Traffic Management Center (TMC) operator to observe and control corridor traffic in order to maintain the desired speed and flow of vehicles. Vehicle detectors determine the presence, number, and speed of vehicles at all key points on I-35W north of County Road 42 (21 road miles), and at certain critical locations on other corridor roads. This information is sent via wire to a digital computer in the TMC, where it is analyzed and displayed to the operator.

When the vehicle volume on I-35W approaches the congestion level, the computer automatically restricts entry at the entrance ramps to maintain the desired expressway speeds and to balance the waiting delays at each ramp. Vehicles are controlled by standard red-yellow-green traffic signals installed on the left side of the entry ramps. In addition to controlling entry traffic, the computer detects any abnormal traffic condition on I-35W and alerts the operator to the location of the abnormality. The operator can override the computer and manually control the entry ramp signals.

A closed circuit television (CCTV) system of 12 cameras provides the TMC operator with a visual check of conditions on I-35W from I-494 northward (12 road miles). The operator uses the displays to detect or confirm problems. The CCTV system also provides confirmation of the proper operation of the automatic control system.

Transit service in the corridor consists of CBD-destined express and local routes run by the Metropolitan Transit Commission (MTC). In addition, the Bloomington Bus Company (BBC) provides express service into the CBD. The express service operates during the 6:30 to 9:00 AM and the 3:30 to 6:30 PM peak periods. Local routes also provide peak period service. Off-peak service is provided only by the local routes, and at greatly increased headways.

Peak Period Transit Service

SERVICE TO/FROM CBD	NUMBER OF TRIPS		HEADWAYS (MINUTES)	
	AM	PM	AM	PM
MTC Express (14) routes	76	75	5-39	8-33
BBC Express (4) routes	10	7	30-53	25-40
MTC Local (7) routes	157	178	4-11	3-14

The service area is divided into fare zones, as shown in Figure B-4. The base, or zone 1, fare is 30 cents, and each additional zone costs 10 cents more. There is also a 5 cent express bus surcharge. Thus the zone 1 express fare is 35 cents, and the zone 5 fare is 75 cents.

A massive marketing campaign was carried out as part of the Phase 2 effort. Beginning in December 1972 and concurrent with the addition of the new express bus routes, a sustained multi-media effort was begun. It included full page newspaper ads, mailed brochures, and radio spot announcements. Television was not used.

Telephone interviews were conducted in October 1973 and October 1974 to determine the penetration and effectiveness of the marketing effort, and to learn the attitudes of various groups to the express bus service.

The project corridor is about 17 miles long and 5 miles wide. At the northern end it includes the Minneapolis CBD and the Nicollet Mall shopping area. The 1970 employment in the CBD was 93,500. The southern end lies in semi-rural countryside, and includes two small towns. The east and west boundaries are major north-south arterial roads.

The total population in the corridor is about 364,000. Population density varies from 12,000 per square mile at the CBD to 500 persons per square mile at the far end of the corridor.

Project History and Status

The express bus on metered freeway concept was first proposed by the Texas Transportation Institute (TTI) in a report issued in December 1968. Their proposed system consisted of three elements:

- Express buses traveling at high speeds on the expressway.
- Expressway entry metering to reduce roadway congestion and the accompanying traffic delays.
- Special bus ramps to bypass entry ramp congestion.

The TTI study concluded that the system could be used at four sites, including the present Minneapolis location. In March 1970 the Metropolitan Council of the Twin Cities applied to USDOT for an Urban Corridor Demonstration Program (UCDP) grant to study the system further and to

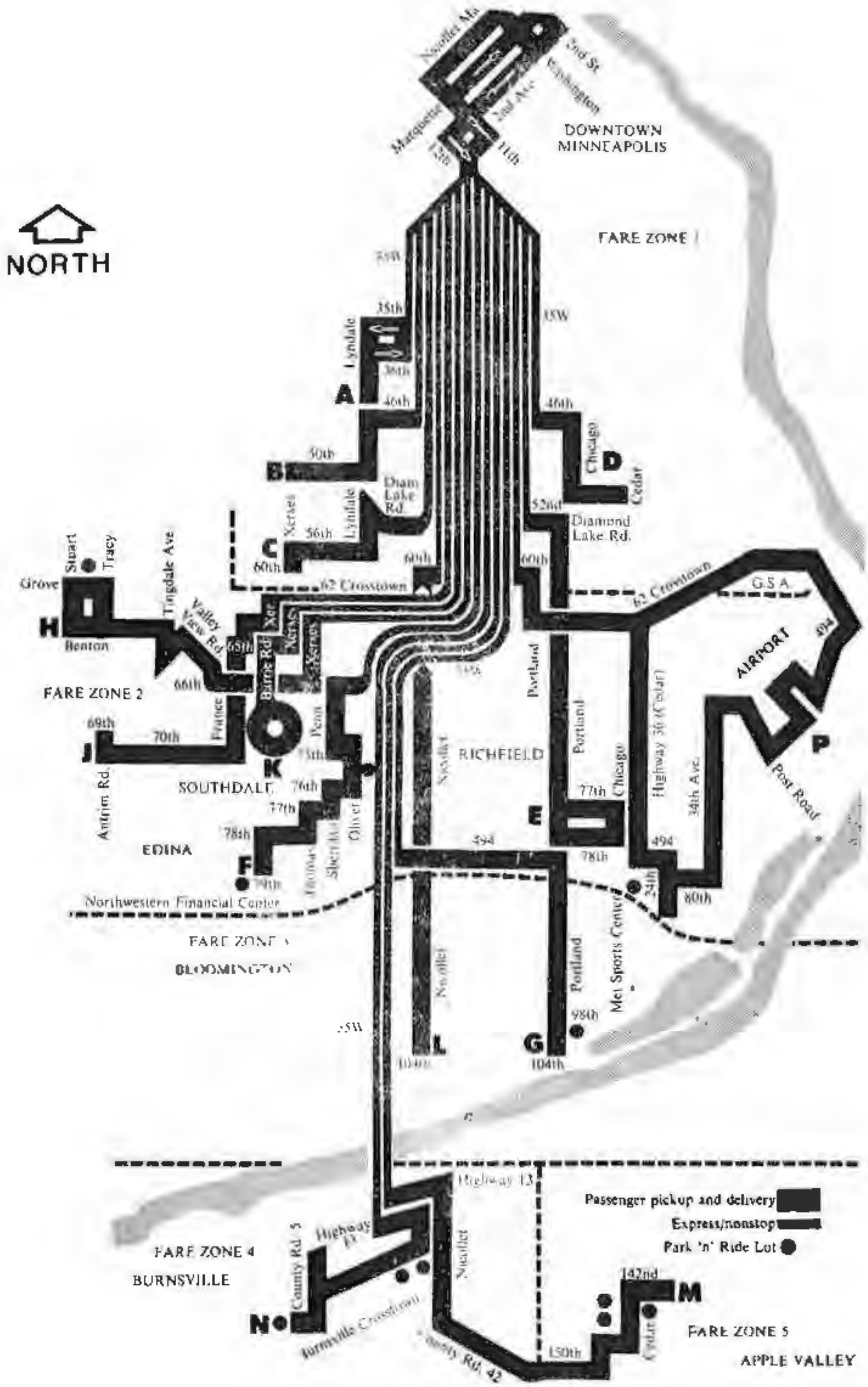

Figure B-4. Transit Service Plan, Minneapolis, Minnesota implement it if it were found to be feasible. The study was completed in September 1971; the system was indeed found to be feasible, and an implementaion plan was presented.

Detailed planning and the preparation of designs and specifications began immediately. The first construction started in May 1972, and the work was largely completed by November 1973.

The project has been organized into three phases for operation and evaluation:

Phase 1 – Existing conditions, with limited (five) express bus routes and no freeway control. October 1971 to November 1972. Report issued December 1973.

Phase 2 – Final express bus service (fourteen routes) but no freeway control. December 1972 to April 1974. Report issued November 1974.

Phase 3 – Final express bus service and surveillance and control system in routine operation. April 1974 through December 1974. Data have been collected and preliminary analysis has been completed. The final report is scheduled for release in August 1975.

The State of Minnesota and the Metropolitan Council plan to continue the routine operation of the express buses and the freeway surveillance and control system after the end of the formal demonstration period in December 1974.

Results

A summary of project costs through Phase 3 and project results through Phase 2 is contained in Table B-1. Salient results are discussd below.

Between Phases 1 and 2 express bus ridership more than tripled and local bus ridership decreased by about 10 percent. Figure B-5 shows that these changes began to occur at the start of Phase 2, when express bus service was expanded from 5 to 14 routes. In a rider survey performed during Phase 2, 40 percent of the express bus users listed another bus as their prior mode of travel. Despite the considerable diversion from local to express service, total ridership sustained an 8 percent increase.

Peak period corridor and freeway vehicle volumes generally increased from Phase 1 to Phase 2. The slight decrease in auto occupancy rates suggests the possibility that the express bus ridership gains may have consisted of disproportionate numbers of passengers rather than solo drivers.

Modal split was determined by counting the number of riders in buses and other vehicles as they passed checkpoints in each evaluation zone. For the AM northbound peak period, the following modal splits were experienced:

TABLE B-1. SELECTED RESULTS: MINNEAPOLIS (I-35W) URBAN CORRIDOR DEMONSTRATION PROJECT

	Phase 2	Phase 3
COSTS: (IN $1000):		
Planning and Implementation Costs		
Planning (all phases)		168
Administration (all phases)		80
Marketing (all phases)		121
Evaluation (all phases)		503
Capital Costs		
Express buses	1,469	
Bus ramps		759
Passenger shelters	122	
Park and ride sites	36	
Surveillance Control Equipment		1,856
Traffic Management Center		277
Operating Costs		
Startup subsidy	93	
Operation and Maintenance		385
Total Cost per Phase	1,720	4,149
RIDERSHIP AVERAGES:	Phase 1	Phase 2
Average Total Daily Ridership	23,686	25,508
Express	1,422	4,749
Local	22,264	20,759
Corridor Vehicle Volumes, Total		
AM Peak Period, by Zone: 1	16,963	18,078
2	16,186	16,696
3	14,361	14,157
4	10,801	12,972
5	4,923	5,687
PM Peak Period, by Zone: 1	19,548	20,121
2	21,087	20,997
3	19,708	21,093
4	15,442	18,682
FREEWAY VEHICLE VOLUMES		
AM Peak Period, by Zone: 1	11,295	11,887
2	11,847	12,280
3	7,912	8,316
4	5,790	7,605
5	4,923	5,687
PM Peak Period, by Zone: 1	12,405	12,352
2	14,898	14,211
3	8,231	9,509
4	6,594	8,445
AVERAGE CAR OCCUPANCY RATE		
Expressway, Persons/Car		
AM Peak Period	1.24	1.21
PM Peak Period	1.35	1.35
Average AM & PM Peak	1.30	1.28
Arterials, Persons/Car		
AM Peak Period	1.25	1.24
PM Peak Period	1.38	1.37

TABLE B-1. SELECTED RESULTS: MINNEAPOLIS (I-35W) URBAN CORRIDOR DEMONSTRATION PROJECT (CONT'D)

	Phase 1	Phase 2
Average AM & PM Peak	1.33	1.32
Average, Expressway and Arterial	1.31	1.30
TRAVEL TIME AND ACCESSIBILITY:		
Average Bus Travel Times, minutes		
Avg AM Peak Express Bus Time	34	36
Avg Change in Travel Time		+2
Avg PM Peak Express Bus Time	41	38.5
Avg Change in Travel Time		-2.5
Avg Change in AM Peak Local Bus Travel Time		0
Avg Change in PM Peak Local Bus Travel Time		+4.5
Average Express Bus Delay Times		
(time when bus is not moving) weighted Average Delay, minutes	6.1	7.5
Average Auto Travel Speeds, miles/hr.		
AM Peak (northbound)	46	44
PM Peak (southbound)	45	38
Average Transit Operating Speed, MPH		
On Expressways		
AM Peak Period	46	44
PM Peak Period	45	38
On Arterials		
AM Peak Period	28	27
PM Peak Period	24	25
On CBD Streets		
AM Peak Period	13	12
PM Peak Period	11	12
Average Vehicle Headways, minutes (as percentage of total buses)		
Express Buses, AM Peak Period		
3-6 minutes	35%	10%
8-12 minutes	0	44
13-18 minutes	0	12
22-30 minutes	53	30
Over 30 minutes	12	4
Express Buses, PM Peak Period		
3-6 minutes	0%	0%
8-12 minutes	40	56
13-18 minutes	0	4
22-30 minutes	10	35
Over 30 minutes	50	5
Local Buses, AM Peak Period		
3-6 minutes	73%	73%
8-12 minutes	27	27
13-18 minutes	0	0
Local Buses, PM Peak Period		
3-6 minutes	78%	78%
8-12 minutes	16	16
13-18 minutes	6	6

TABLE B-1. SELECTED RESULTS: MINNEAPOLIS (I-35W) URBAN CORRIDOR DEMONSTRATION PROJECT (CONT'D)

	Phase 1	Phase 2
Average Route Miles		
Express Routes		
Collection Miles (residential)	19.5	64.5
Line-haul Miles	44.0	93.9
Distribution Miles (CBD)	6.5	18.3
Total Miles	70.0	176.7
Local Routes		
Total Miles	62.2	62.2
Transit Access Modes, All Sites (Percentage by Mode)		
AM Peak Period - Arrive		
Walk	19%	20%
Driver, Park	39	47
Rider, Park	13	7
Rider, Kiss and Ride	29	26
Transit Access Modes, All Sites		
PM Peak Period - Depart		
Walk	12%	29%
Driver, Park	51	49
Rider, Park	12	4
Rider, Kiss and Ride	25	18
Average Time for Access Modes, minutes (Walking Time for 80% of Users)		
To Express Bus	9	7
To Local Bus	6	6
From Express Bus	4	4
From Local Bus	8	8
FARE STRUCTURE/REVENUE:		
Regular Fare Rates (cents)		
Base fare (first zone)	30¢	30¢
Each additional fare zone	10	10
Express surcharge	5	5
Annual Revenue Passengers, thousands		
Express routes, annualized	358	1,197
Local routes, annualized	5,611	5,231
Total all routes, annualized	5,979	6,428
Annual Passenger Revenue, $1000		
Express routes, annualized	167	460
Local routes, annualized	1,358	1,244
Total all routes, annualized	1,525	1,704
UNIT COST MEASURES:		
Operating Costs, Dollars		
Dollars/passenger trip	0.38	0.49
Dollars/vehicle mile	0.13	0.13
Dollars/vehicle hour	5.83	5.83
Dollars/seat mile	0.0029	0.0029
Dollars-peak vehicle/day	32.99	32.99
Dollars/mile	1.13	1.23

TABLE B-1. SELECTED RESULTS: MINNEAPOLIS (I-35W) URBAN CORRIDOR DEMONSTRATION PROJECT (CONT'D)

	Phase 1	Phase 2
Dollars/hour	14.71	16.88
Dollars/vehicle	1,138	1,737
Dollars/day	7,903	11,217
Total dollars	371,000	3,746,000
Operating Revenues, Dollars		
Dollars/passenger trip	0.31	0.31
Dollars/mile	0.91	0.78
Dollars/hour	11.92	10.67
Dollars/vehicle	1,078	1,098
Dollars/day	6,402	7,086
Total dollars	300,900	2,366,700
Cost-Revenue Comparison		
Operating deficit, dollars	70,546	1,379,384
Cost/Revenue ratio	1.23	1.58
Express Routes	1.86	2.15
Local Routes	1.12	1.36
Productivity Measures		
Revenue Passengers/Vehicle-Hour		
Express Routes	24.0	24.1
Local Routes	41.3	38.5
All Routes	38.4	33.9
Revenue Passengers/Vehicle-Mile		
Express Routes	1.21	1.30
Local Routes	3.52	3.34
All Routes	2.94	2.46
Revenue Passengers/Seat Mile	0.0654	0.0548
Passenger Miles/Seat Miles		
Express Routes	0.444	0.637
Local Routes	0.548	0.546
All Routes	0.532	0.582
User Characteristics		
Age Group, percentage of total		
Express Routes		
Under 20	6%	8%
21-40	59	57
41-64	34	34
Over 65	1	1
Local Routes		
Under 20	11	12
21-40	51	51
41-64	35	34
Over 65	3	3
Sex, percentage of total		
Express Routes		
Male	42	43
Female	58	57
Local Routes		
Male	27	24
Female	73	76

TABLE B-1. SELECTED RESULTS: MINNEAPOLIS (I-35W) URBAN CORRIDOR DEMONSTRATION PROJECT (CONT'D)

	Phase 1	Phase 2
Family Income, percentage of total		
Express Routes		
Under $5,000	5%	5%
$5,000-9,999	21	24
$10,000-14,999	32	25
$15,000-24,999	35	37
Over $25,000	7	9
Local Routes		
Under $5,000	16	17
$5,000-9,999	38	40
$10,000-14,999	23	20
$15,000-24,999	19	18
Over $25,000	4	5
Car Availability, percentage of total		
Express Routes		
Yes	72%	74%
No	28	26
Local Routes		
Yes	56	54
No	44	46
Car Ownership, percentage of total		
Express Routes		
0 car	5%	5%
1 car	54	55
2 cars	35	34
3 or more cars	6	6
Local Routes		
0 car	22	23
1 car	56	54
2 cars	17	18
3 or more cars	5	5
Licensed Driver, percentage of total		
Express Routes		
Yes	90%	90%
No	10	10
Local Routes		
Yes	78	78
No	22	22
Previous Mode of Travel, percentage		
Express Routes		
Auto driver	31%	29%
Auto passenger	16	11
Another bus	25	40
No previous trip	28	20
Local Routes		
Auto driver	18	18
Auto passenger	11	9
Another bus	24	20
No previous trip	47	53
SAFETY RECORD:		
Accident Totals, All Vehicles		
AM Peak Period - Northbound		
I-35W mainline	104	80
Entrance ramps	11	12
Total accidents	115	92
PM Peak Period - Southbound		
I-35W mainline	178	146
Entrance ramps	17	12
Total accidents	195	158

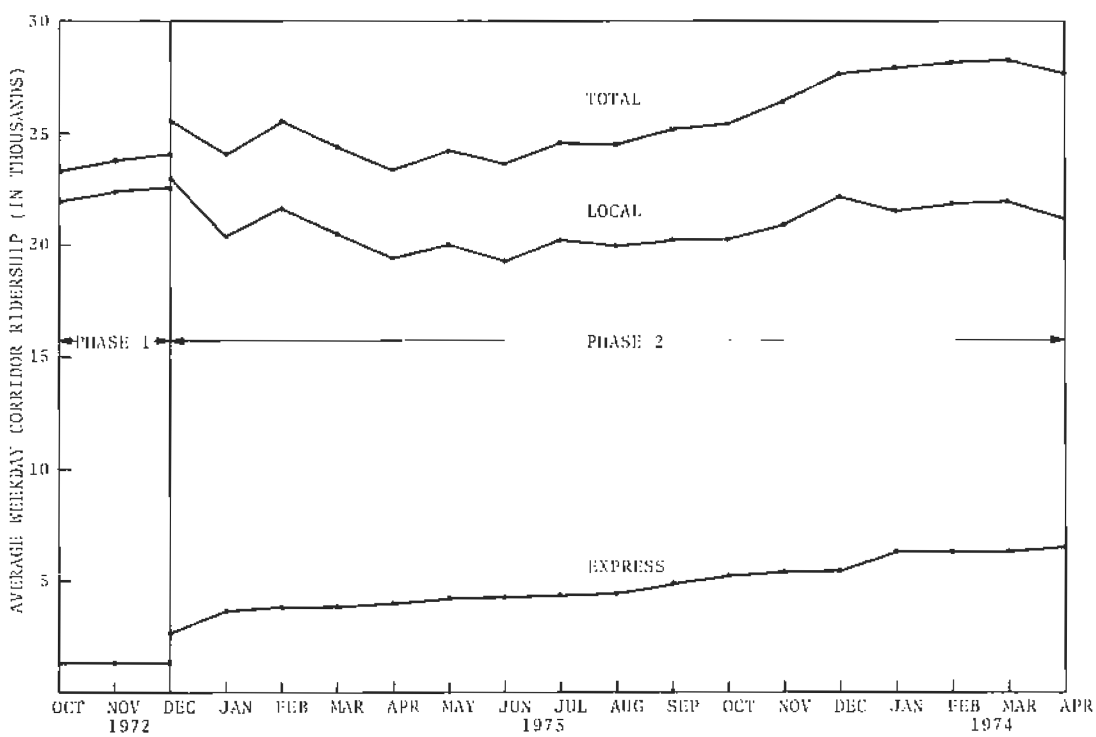

Figure B-5. Average Daily Corridor Ridership, Minneapolis, Minnesota

	Phase 1	Phase 2
Express bus riders as percent of total freeway users	4.7%	13.3%
Local bus riders as percent of total arterial road users	53.1%	48.4%
Total bus riders as percent of total traveler traffic	17.4%	19.9%

As expected, the largest absolute and percentage increases took place on the express bus routes. Further, as previousy shown, some of the express bus riders were diverted from local buses. However, the improved express bus service did attract enough new riders to increase the total bus use as a percentage of all travelers by about 2.5 percentage points.

In comparing the results of the express peak period routes that were operated in both Phase 1 and 2, no significant differences occur with respect to operating speeds in the collection, line haul, or distribution zones of the CBD oriented AM (northbound) service. Speeds in Phase 2 for PM (southbound) peak period service have been decreased by the greater times expended in CBD rider collection due to increased ridership and bus traffic, and by worsening congestion on I-35W due to increased vehicle traffic.

The average operating speeds for all vehicles on I-35W (autos, buses, trucks) during peak periods were lower in Phase 2 than in Phase 1. The decrease in the AM peak period was 4%: in the PM period, 15%. The lower speeds were attributed mainly to increased vehicle counts of 9% and 6%, respectively. However, it is interesting to note that express bus travel times were affected only slightly by the overall decrease in speed and increase in congestion on the freeway in Phase 2.

Thus, in general, the travel times for given routes were not decreased; times either remained stable or increased. However, the travel time savings between express and local bus service for the same origins and destinations ranged between 15% and 46%.

Schedule reliability or on time performance is defined in this project as arriving or departing between 0 and 5 minutes late. The generally accepted standard for metropolitan bus service is that on time performance should be achieved by 75% of all buses surveyed.

The Phase 2 results are not considered to be statistically significant because the sample sizes were too small. However, it appears that express bus reliability improved during the AM peak and remained the same or deteriorated slightly during the PM peak period. The Phase 3 results will reflect the impact of the freeway surveillance control system upon reliability.

In Phase 2 the area served by bus transit was greatly increased by adding new express routes and realigning several existing express routes. The local routes were not changed. The coverage provided by AM and PM express service is essentially the same. The local routes, in general, duplicate the coverage provided by the express routes and thus do not add to the total area. The local buses do add to the total time during which service is provided, as the local buses furnish the only off peak bus service.

The increased coverage between Phases 1 and 2 is measurable in terms of the greater number of express routes (14 vs. 5), the decrease in express bus headways (see Table 3), and the increased express route mileage (177 vs. 70). Since all express routes operate non-stop on the expressway and follow essentially the same CBD distribution paths, the most meaningful comparison of coverage is obtained from the residential collection route miles. The expansion from 19.5 to 64.5 miles represents a more than threefold increase in transit coverage.

Public attitudes toward the new express bus service were surveyed as part of the marketing program. The results indicate an awareness of the increase in coverage. In telephone interviews conducted in October 1974 (Phase 2), the percentage of respondents who agreed with two statements regarding coverage are given below:

	Statement	Freeway Auto User	Express Bus User
1.	An express bus stop is located close to my home	55%	92%
2.	An express bus stop is located close to my final destination	51%	93%

Thus a substantial percentage of corridor travelers feel that their origins and destinations are adequately served by express transit. This is corroborated by the decrease in access time to the express bus service (9 to 7 minutes). Comparable interviews were not conducted in Phase 1, so before and after comparisons cannot be made.

Unit operating cost measures generally increased between Phase 1 and 2, owing to the expansion in express bus service and the upward trend in local service costs despite service cutbacks. Although revenue per passenger remained the same and revenue per vehicle increased between Phases 1 and 2, revenue per hour declined somewhat, reflecting both the fact that ridership increases did not quite keep pace with service expansion and the shorter average trip length of Phase 2 patrons.

The above described changes in costs and revenues are also represented by the 28 percent increase in the operating ratio between Phases 1 and 2. Examination of productivity measures reveals improvements for express service: for example, an 8 percent increase in the ratio of passengers to vehicle miles, nearly a 50 percent increase in load factor, and a 70 percent increase in passengers per peak period vehicle. Local service, on the other hand, sustained a decrease in all productivity measures except passengers per peak period vehicle, which increased by 20 percent. The exact cause of this increase is uncertain, but apparently the use of express service for longer trips permitted the MTC to increase the number of local trips per bus during peak periods because the local bus routes had shorter travel times and distances. Overall MTC operations showed a decline in productivity measures because of the heavy weighting of local bus service upon these measures. For example, in Phase 2, average weekday ridership was 20,759 for local buses and 4,749 for express buses, and the daily total peak period CBD service comprised 335 local and 151 express bus trips.

User characteristics, presented in Table B-1 need no explanation. However, some comments regarding user/non-user attitudes toward express bus service (based on surveys conducted as part of the evaluation) are significant.

Express bus users felt that the bus is the fastest, cheapest, safest and most relaxing way to travel. Freeway auto users felt that their method of travel was fastest, but agreed with bus users that the express bus was the cheapest, safest, and most relaxing way to travel.

It is interesting to note that among express bus users, the percentage who thought express bus was the fastest way to travel to the CBD fell from 68 to 63 percent during the one year interval between interview efforts.

Among those freeway auto users, the most common reasons for not using the express bus were:

	10/73	10/74
No need/car usually available	32%	49%
Need car during day	10%	13%
Bus schedule not convenient	36%	15%
Bus stops too far away	16%	15%
Bus takes longer	0%	8%

The mere availability of a car is thus a prime reason for not using the bus. The combination of car availability and inconvenient schedules accounted for 68 percent and 64 percent of the total reasons for auto users not using transit during Phase 2 and Phase 3 respectively.

The effectiveness of the advertising campaign varied considerably with the method of travel. Of the people who used the arterial roads or local buses on the arterials, only about one third could recall advertising during the preceeding three months. Among freeway bus and auto users, 56 and 62 percent respectively, were aware of the advertising campaign.

No patterns are apparent in the accident data on a year by year basis. In general, the 7:00–8:00 AM and 5:00–6:00 PM hours have the highest numbers of accidents. Most freeway accidents occur on the mainline; there are relatively few ramp accidents. Summarized accident data for the freeway are given below for the period 1970–73.

	Total Number of Accidents			
	1970	1971	1972	1973
Northbound peak period	80	120	115	92
Southbound peak period	192	157	195	158
Total	272	277	310	250

There was a reduction in accidents during Phase 2, which began in mid-December 1972. Phase 3 began in mid-April 1974. The ramp metering system and CCTV surveillance of traffic conditions in Phase 3 is expected to further reduce the number and duration time of all incidents.

Evaluation and Conclusions

In terms of a project evaluation framework, Phase 1 is the "before" or reference period, Phase 2 is the transit service expansion period, and Phase 3 is the travel time and reliability improvement period. As previously discussed, Phase 3 data have been collected, but the results are not yet available. Thus the improvements in vehicle control speeds and traffic stabilization expected from freeway control are not reflected in the current results.

Referring back to the SMD objectives stated earlier, it is clear that transit coverage was increased between Phases 1 and 2 by providing additional express bus service. In response to the expansion of express bus service, the total number of bus riders increased 8 percent and the fraction of corridor travelers using bus transit increased 14 percent.

The public reception of express bus service has been favorable, but the marketing campaign has been less effective than expected, reaching one third of local bus arterial commuters and about 60 percent of the commuters using the freeway.

Progress toward attainment of the other two SMD objectives, reducing transit travel times and increasing transit reliability, was less impressive. Transit travel times, operating speeds, and schedule reliability deteriorated slightly in Phase 2 due primarily to increased corridor vehicle volumes. However, it should be pointed out that the implementation of express service in areas formerly served only by local service resulted in travel time savings as much as 46 percent.

In Phase 3, the freeway surveillance and control system is expected to increase vehicle speeds and smooth traffic flow. It should reduce traffic congestion by limiting the number of vehicles entering the freeway during peak periods and thus improve express bus travel time. The surveillance system will aid in detecting and clearing unusual areas of congestion caused by breakdown accidents. Accordingly, a final assessment of the project effect on travel time and reliability should be postponed until Phase 3 data are available.

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APPENDIX C

THE I-95/N.W. 7TH AVENUE BUS/CARPOOL SYSTEMS DEMONSTRATION PROJECT: MIAMI, FLORIDA

Project Overview

In Miami, Florida a demonstration project is in progress, designed to evaluate peak period express bus service on two different types of highways, a major arterial and a freeway, which run parallel for the entire length of the demonstration corridor. Bus priority treatments, park-and-ride facilities, and bus/carpool lanes on the freeway are important components of the demonstration project. There are two phases of the project: Phase 1 is the implementation and evaluation of bus priority methods on the major artery, N.W. 7th Avenue; Phase 2 is the implementation and evaluation of reserved bus/carpool lanes on the freeway, I-95.

The demonstration project provides express bus/carpool service between populous residential suburbs to the north of Miami and four major employment centers in central Miami. The project corridor, depicted in Figure C-1, is approximately ten miles long, extending from the Golden Glades Interchange south along N.W. 7th Avenue and I-95 to downtown Miami, the Civic Center, the Airport, and N.W. 36th Street.

The demonstration project, which began in the spring of 1973, entered Phase 1 of the actual operations (preferential bus treatment on the major arterial) on August 26, 1974. Phase 1 will continue until the completion of bus/carpool lanes on the parallel freeway, expected in April 1976. Then Phase 2 will commence and will continue through June 1976.

Three levels of government are taking part in the operation and evaluation of the Miami I-95/N.W. 7th Avenue Bus/Car Pool Systems Demonstration Project. At the federal level the participants are the Urban Mass Transportation Administration (FL-06–0006) and the Federal Highway Administration. At the state level the participants are the Florida Department of Transportation and the University of Florida. At the local (county) level the participants are the Metropolitan Dade County Commission and the Metropolitan Dade County Transit Authority (renamed the Metropolitan Transit Agency in October 1974).

Funding for the demonstration project is shared as follows:

Local/State	$ 3,393,000
FHWA	20,205,000
UMTA	3,500,000
Total	$27,098,000

Objectives

comprise the Miami express bus/carpool concepts are intended to further the following objectives of the Service and Methods Demonstration (SMD) Program:

- To reduce trip time for transit travelers
- To increase transit reliability

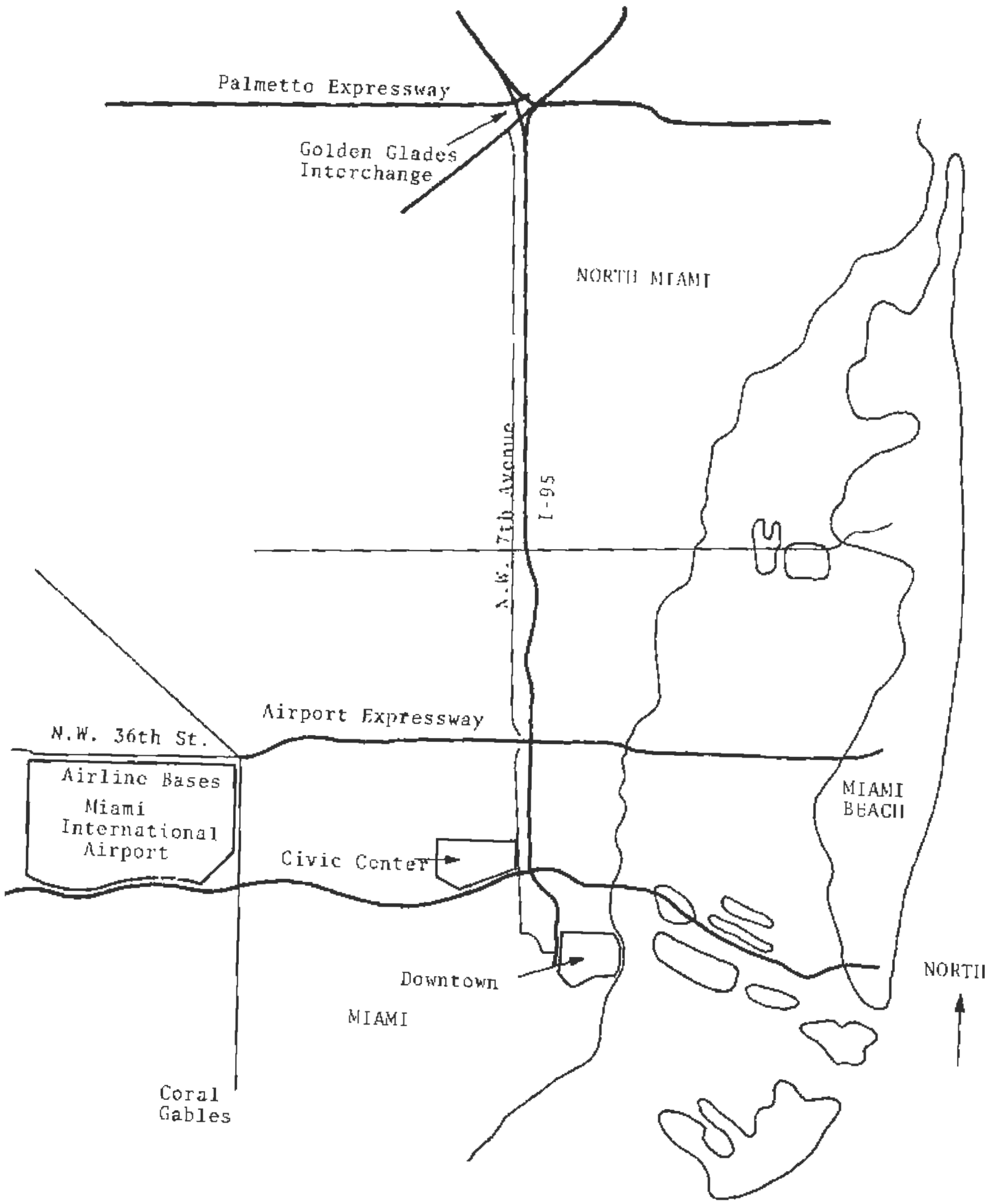


Figure C-1. Project Corridor, I-95/N.W. 7th Avenue, Miami, Florida

- To increase transit coverage

- To increase transit vehicle productivity

In particular, the Miami demonstration project emphasizes the objectives of reducing trip time and increasing transit reliability. The various preferential strategies for buses on N.W. 7th Avenue and the reserved bus/carpool lanes on I-95 will presumably result in decreased travel time and increased reliability (decreased variability in travel time) by virtue of the physical and/or operational separation of buses from the rest of the traffic stream. These travel time and reliability improvements will not only benefit the existing transit users, but should also divert additional commuter trips in the project corridor from low occupancy autos to express buses and carpools, thereby reducing congestion in the corridor and saving travel time for transit and auto users alike.

The Miami project serves to expand transit coverage by provision of park-and-ride facilities at the Golden Glades Interchange and new express bus service in the corridor. The objective of increasing transit vehicle productivity is expected to be accomplished via the decreased travel time, increased reliability and anticipated ridership increases.

At the local level, the Miami project has four primary objectives:

- Improve the passenger carrying capacity of N.W. 7th Avenue and I-95

- Encourage the use of public transit

- Demonstrate alternative surveillance, detection, and control systems to improve travel times by public transit

- Identify the impact of these system changes on the rider, operator, the public and industry

Because of the national significance of the demonstration project a comprehensive evaluation is being carried out. The evaluation study serves as a tool for measuring the effectiveness of the demonstration project, the extent to which it meets SMD and local objectives, and the degree of public acceptance. It is expected that the evaluation methodologies developed for this project may be applied to similar projects throughout the nation.

Project Description

The basic strategy of the I-95/N.W. 7th Avenue Bus/Car Pool Systems Project is to provide peak period express service for bus/carpool commuter trips between residential suburbs to the north of Miami and major employment locations in central Miami. The project involves the provision of express bus ("Orange Streaker") service using two operational procedures: (1) various combinations of bus priority treatments on an arterial highway, N.W. 7th Avenue; and (2) reserved bus/carpool lanes on a parallel freeway, I-95.

Figure C-2 is a map of the ten-mile long project corridor and market area. The parking facilities located at the Golden Glades Interchange (the confluence of five major highways) constitute the northern end of the corridor, with the parallel portions of N.W. 7th Avenue and I-95 leading to the downtown, the Civic Center, and the Airport.

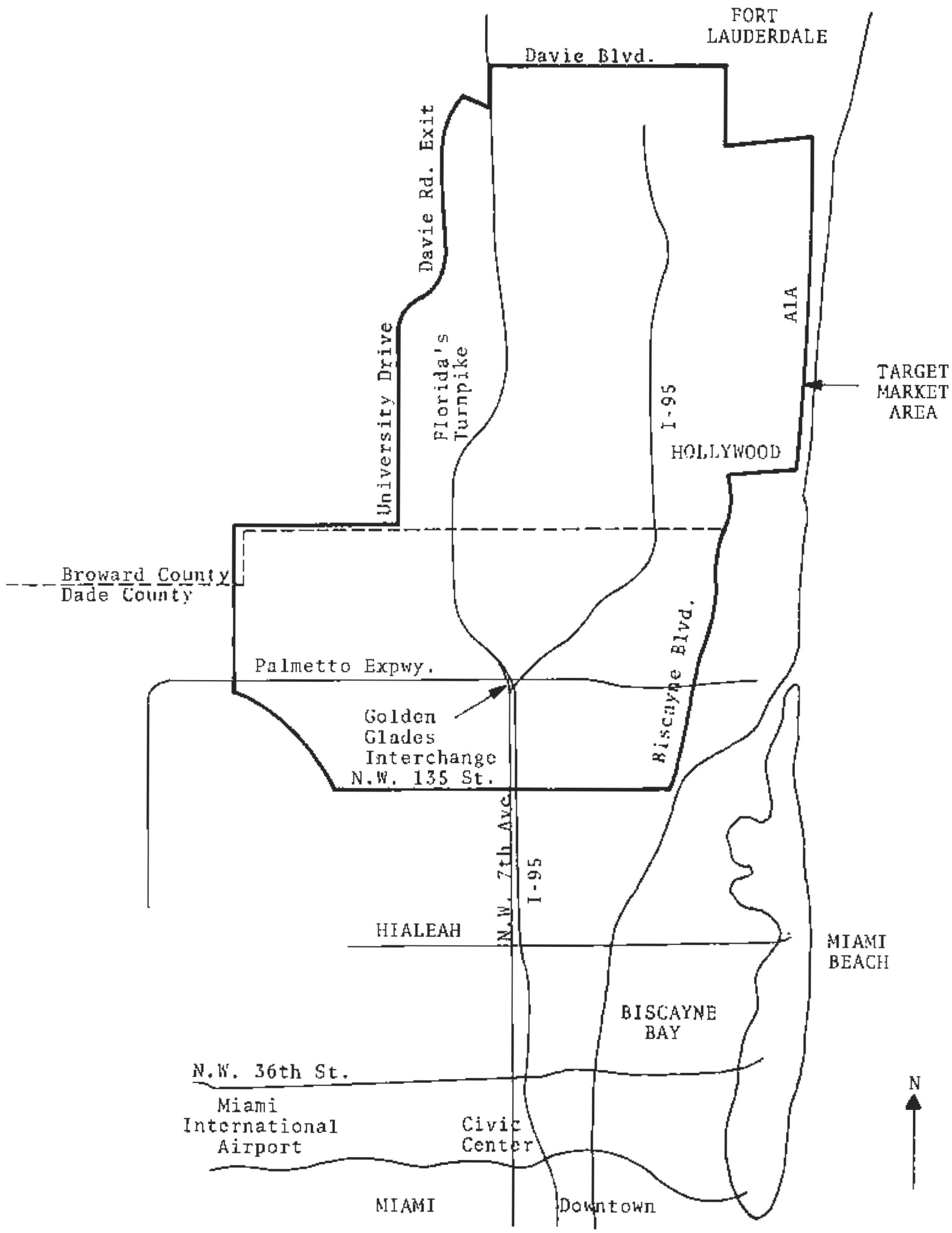


Figure C-2. Target Market Area, I-95/N.W. 7th Avenue, Miami, Florida

The project market area (delineated with a heavy line in Figure C-2) extends to the east, north, and west of the Golden Glades Interchange through northern Dade County and southern Broward County. Relevant information on the area is presented below:

Land area	125 square miles
Population (1970)	385,000
Density (1970)	3,080 person/sq. mi.
Employment (1970)	137,000
Median income (1970)	$9,600
Average auto ownership	1.5 cars/household
Transit model split	2-5%[1]

The area consists mostly of single-family dwelling units with some apartments. Transit service is radially oriented in a north-south direction and consists of local and peak period express bus service. The local bus service in the corridor has remained unchanged (300 trips per day; 45 cent fare) while the express service has been expanded as part of the demonstration project.

Phase 1A of the project, from April 29 to August 25, 1974, constituted a "pre-priority treatment" period during which Orange Streaker buses operated in mixed mode along I-95 from the Golden Glades Interchange to the four employment locations. Thirty specially designed 47 passenger buses equipped with bucket seats, carpeting and air conditioning were purchased for the express bus service. Figure C-3 is a picture of I-95 during a typical evening rush hour in this phase.

Phase 1 of the project involves the transfer of express bus service to N.W. 7th Avenue and the implementation of various bus priority treatments (see Figure C-4). In this phase, emphasis is on evaluating the operational effectiveness and future applicability of techniques for providing priority bus treatment on an arterial street. The strategies being tested, in order of implementation, are:

1. Traffic signal preemption.
2. Reversible reserved lane and signal preemption.
3. Reversible reserved lane and signal progression.
4. Reversible reserved lane and signal progression and preemption.

[1]The range shown reflects data from two different sources.

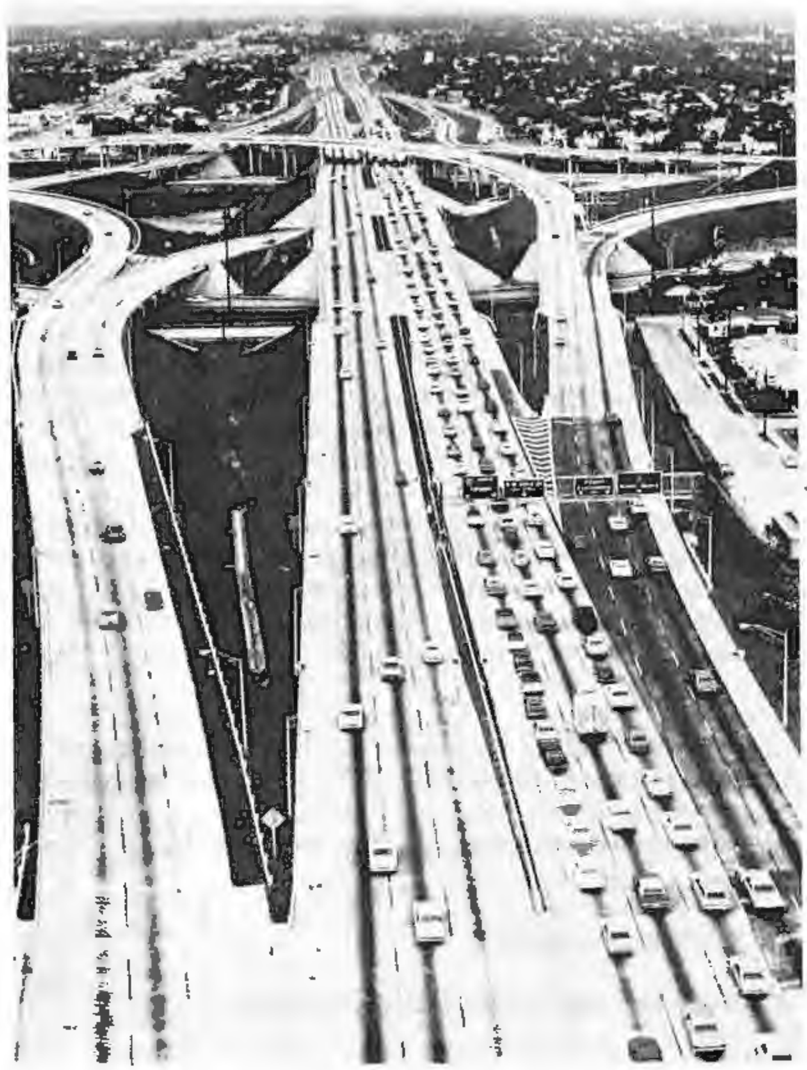


Figure C-3. Evening Rush Hour, I-95, Miami, Florida

Figure C-4. Bus Priority Treatments, N.W. 7th Avenue, Miami, Florida

5. Reversible reserved lane and centrally controlled progression and preemption.

Under the first strategy, the Orange Streaker buses operate in mixed mode along N.W. 7th Avenue. 3M OPTICOM equipment consisting of an emitter on top of the bus, a detector, and a signal phase selector enables the bus to preempt traffic signals; that is, change the signal from red to green or hold the green phase until the bus passes through the intersection. The second strategy involves a combination of signal preemption and use of a reversible reserved lane in the middle on N.W. 7th Avenue for the entire length of the corridor. The third treatment consists of locally, preset signal progression (whereby the signals are set to change at prescribed intervals so as to favor express bus movement) and use of the reserved lane. The fourth strategy supplements the third with bus preemptive capability. The fifth scheme upgrades the fourth strategy by introducing central computer control of signal operations. In the event that the signal progression and movement of the bus become out of phase, the computer will reset the progression. In addition, the computer controls the operation of traffic signals in the corridor so as to maintain optimum traffic flow.

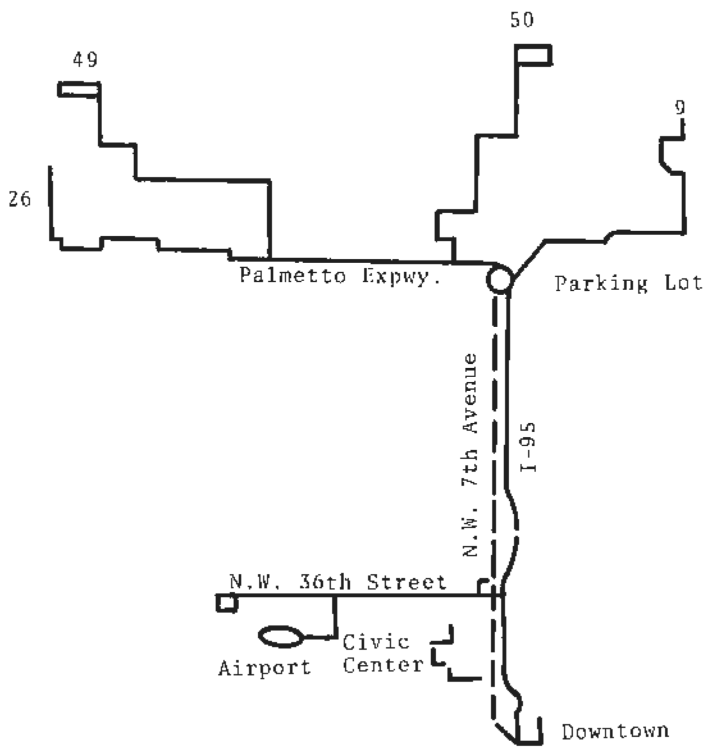
Phase 2 of the project involves the operation of Orange Streaker buses along reserved lanes on I-95. Two additional median lanes (one in each direction of traffic flow) are being constructed for the use during peak periods of buses and carpools with three or more occupants. These lanes will not be separated from the adjacent traffic lanes by any type of barrier or cone, but will be delineated by special signing and pavement markings. An important objective of this phase of the demonstration project will be to measure the operational feasibility, ease of lane violation enforcement, and safety of non-separated reserved lanes.

Throughout the project, park-and-ride facilities are provided as a loading/staging area for bus patrons and carpoolers. A 900-space parking lot was constructed for use during Phases 1A and 1; a second parking lot with capacity for 1,300 vehicles and a ramp directly connecting the parking lot and freeway lane are under construction for Phase 2. In addition, Phases 1 and 2 include extensive advertising.

A significant feature of this project is its amenability to comparatve evaluation. Since all phases essentially serve the same market area, it is possible to assess the incremental effects of each service change and each type of preferential treatment on transit usage and carpool formation in the corridor.

The Orange Streaker service implemented at the beginning of Phase 1A represents an expansion and rationalization of pre-existing express bus service in the corridor. Prior to this project, there were three express bus routes operated by the Metropolitan Dade County Transit Authority which provided service between residential communities in northern Dade and southern Broward Counties and two employment centers, downtown Miami and N.W. 36th Street. There were 18 daily trips (nine per peak period), six of which were retained after the introduction of Orange Streaker service. The fare was 50 cents per trip, regardless of whether the trip originated (terminated) in Dade or Broward County.

Figure C-5 shows the configuration and route length of the four express bus routes in the demonstration corridor. For the morning southbound service, some bus runs originate at the Golden Glades Parking Lot, while others perform local collection service (taking 20 to 30 minutes) before converging at the Lot to pick up park-and-ride, kiss-and-ride, and transfer passengers. The buses then travel south along N.W. 7th Avenue (Phase 1) or I-95 (Phase 2), destined for one of the four major employment centers shown in the figure. The trip to the employment centers via N.W.



Feeder Service to Parking Lot	Route Length (mi)
Route # 9	8.9
Route # 26	6.7
Route # 49	8.7
Route # 50	9.3

Express Service from Parking Lot to:	Route Length (mi.)		Number of A.M. Trips
	N.W. 75h AVe.	I-95	
Downtown	11.4	11.0	13
Civic Center	10.0	10.0	5
Airport	12.4	12.2	2
N.W. 36th St.	11.5	11.3	5

Figure C-5. Orange Streaker Routes, I-95/N.W. 7th Avenue, Miami, Florida

7th Avenue takes approximately 25 to 30 minutes. The fare is 60 cents for trips originating or terminating in Dade County and 75 cents for trips to or from Broward County. There is no charge for transfers or for parking at the Golden Glades facility.

Service is provided only during the peak periods, with bus departures from the Golden Glades Parking Lot between 6:00 A.M. and 8:25 A.M. and arriving there between 3:50 P.M. and 6:30 P.M. Under the original schedule 74 express trips per day were made, 37 in the morning peak period and 37 in the afternoon peak period. However, this schedule was found to have too many duplicative and low patronage trips. Analysis of ridership information led to a 39 percent reduction in the number of trips on September 9, 1974 in order to bring service levels in line with service demand. Under this new schedule, 45 express trips per day were made. In response to passenger suggestions and further analysis, additional operational adjustments (rerouting, rescheduling, additional trips) were made on September 23 and October 7. As of the latest schedule (in effect since October 1974), there are 49 daily express bus trips between the parking lot and the various employment centers. Figure C-5 shows the distribution of the 25 morning trips among the four destinations.

For September 1974, the first full month using bus preferential treatment on N.W. 7th Avenue, the total vehicle hours and vehicle miles of operation by route were as follows:

Route	Vehicle Hours	Vehicle Miles
9	515	3,887
26	436	3,383
49	577	4,309
50	1,367	9,883
Total	2,895	21,462

The projected annual vehicle hours and vehicle miles would be somewhat less than twelve times the amounts shown above, which reflect the schedule adjustments made during the month.

Project History and Status

The Miami Bus/Car pool Project developed out of a study completed in January 1971 by Alan M. Voorhees and Associates for the Federal Highway Administration, entitled "Feasibility and Evaluation Study of Reserved Freeway Lanes for Buses and Carpools." This study, performed in the context of Cleveland's eight-lane I-90 Memorial Shoreway, concluded that the concept of reserving freeway lanes for buses and carpools was basically sound and worthy of demonstration. Following Cleveland's rejection of the demonstration proposal, on grounds that enforcement of the reserved lane ordinance could not be achieved, the Federal Highway Administration solicited proposals for a demonstration. In July 1971 the Florida Department of Transportation responded with its proposal involving I-95. While grant negotiations were underway the proposal was expanded to include the N.W. 7th Avenue phase which would coincide with the I-95 construction period. The FHWA and UMTA grants were approved in the early part of 1973, and construction was initiated that summer.

The duration of the demonstration project is approximately four years. Phase 1A, consisting of peak period operations on I-95 without priority treatment, ran from April to August 1974. Phase 1, which is expected to continue until the spring of 1976, involves the interim operation of express bus service on N.W. 7th Avenue during the construction of the reserved bus/carpool lanes on I-95. This phase is divided into five stages, corresponding to the bus priority schemes described previously. Phase 2 of the project involves the transfer of express bus service to the median lanes of I-95, which are reserved during peak periods for use by buses and carpools. At the conclusion of Phase 2 of the demonstration project in mid-1977, revenue service operations will be continued under local auspices.

Stage 2 of Phase 1, consisting of signal preemption and use of a reversible reserved lane on N.W. 7th Avenue, is currently underway. All data collection through Stage 1 (signal preemption only) has been completed; however, data analysis is still in progress so the results in the next section are not reflective of the entire period.

Upon or before completion of the demonstration project, the reversible reserved lane on N.W. 7th Avenue will be converted to a reversible auto lane, and the signal preemption equipment will be removed from N.W. 7th Avenue and installed elsewhere in Dade County or other appropriate sites in Florida. The lanes on I-95 will continue to be reserved for buses and carpools; however, restrictions regarding specific periods of preferential use and minimum size of carpools may be altered.

It has not been possible to ascertain the effects of either the energy crisis or the recession on the demonstration project; however questions will be asked in connection with the onboard passengers surveys (planned for the spring of 1975) to shed some light on these exogenous influences.

Results

Since the demonstration project is in its early stages the results reported here are necessarily tentative and incomplete. Table C-1 presents project cost data and Table C-2 presents selected results prior to demonstration service implementation (before April 29, 1974), for Phase 1A (April 29, 1974-August 23, 1974), and for Phase 1 – Stage 1 (August 26, 1974-January 17, 1975). It should be noted that a large portion of the data presented for Phase 1 – Stage 1 does not reflect the entire period, but only covers operations through November or December, 1974.

Corridor transit coverage, as measured by the number of express bus trips, increased substantially after initiation of project service. Not only did the service represent a net increase in the number of trips, but also an increase in the market area served: at the northern end of the corridor, Orange Steaker buses provide increased residential coverage to the northwest and northeast of the Golden Glades Interchange; at the southern portion of the corridor, the buses serve two employment centers (Civic Center and Airport) formerly not served by express buses. The Golden Glades Parking Lot, by acting as a transfer point for the four feeder routes as well as a park-and-ride and kiss-and-ride facility, enables travel between any point in the residential market area and any employment destination, whereas the former express bus service only operated between selected origins and destinations, with no transfer capability. Furthermore, the four

TABLE C-1. PROJECT COSTS: I-95/N.W. 7TH AVENUE BUS/CARPOOL SYSTEMS DEMONSTRATION PROJECT, MIAMI, FLORIDA

	PROJECT COSTS	
PLANNING AND IMPLEMENTATION[1]:		$1,047,000
Evaluation	$802,000	
Marketing	$127,000	
Contingencies	$118,000	
CAPITAL COSTS:		$25,240,000
Construction 2 new reserved lanes, parking and ramp	$22,450,000	
30 buses	$1,600,000	
Traffic Control	$950,000	
Signal preemption	$240,000	
OPERATION COSTS:		
Operations 1974-1976		$600,000
Subsidy (operating deficit)		$211,000
TOTAL		$27,098,000

[1]Transportation planning had been done previously or was contributed and not charged to project.

Orange Streaker feeder routes provide far more efficient and direct service in the residential area than the three express bus routes that they replaced.

Table C-2 shows an increase in peak period ridership between Phase 1A and Phase 1 – Stage 1, despite the bus service reduction which occurred early in September. As is apparent from Figure C-6, the weekly averages of daily A.M. and P.M. ridership were rather scattered about the mean during Phase 1A, but have been increasing fairly steadily throughout Stage 1 of Phase 1.

The number of vehicles parked at the Golden Glades park-and-ride ride facility has ranged between 230 and 330 thus far during the project, tending to increase with the duration of the project. Carpool formation has also increased, going from 4 in May 1974 to a high of 44 in October 1974.

Average auto occupancy on N.W. 7th Avenue and I-95 remained fairly constant before and during Phase 1A, suggesting that the additional express bus service attracted solo drivers and carpoolers in proportion to their relative numbers.

Bus travel times between the Golden Glades Parking Lot and the Civic Center decreased slightly between Phase 1A and Phase 1 – Stage 1. It is difficult to evaluate travel time changes for the other three employment centers, because the transfer of operations from I-95 to N.W. 7th Avenue involved decreases in route length. However, examination of speed data by employment destination for the two periods indicates a 10 percent speed increase for the downtown, and an 8 percent decrease in speed for the airport and N.W. 36th Street. It is difficult to determine to what extent these speed changes are attributable to changes in traffic flow conditions or to rerouting of the buses necessitated by the transfer of service from I-95 to N.W. 7th Avenue. However, viewing the changes relative to the four destinations in the aggregate, it is reasonable to infer that bus travel times in mixed mode conditions on I-95 are roughly equivalent to those with signal preemption equipment on N.W. 7th Avenue. A more meaningful intepretation of travel time changes will not be possible until additional bus priority strategies are implemented on N.W. 7th Avenue.

Auto travel times did not change with the introduction of Orange Streaker service; this is not surprising, since the service only carried 600 out of approximately 18,000 peak period corridor trips.[1] Although no data is available for average delay time, schedule reliability checks in September 1974 showed about 30 percent of the buses arriving at the Golden Glades Parking Lot behind schedule. September's on time performance was sub-standard relative to Phase 1A, due to new bus drivers and OPTICOM malfunctions along N.W. 7th Avenue. Average bus headway increased considerably between Phase 1A and Phase 1 – Stage 1, reflecting the Sepember 9 service reduction from 74 to 45 daily trips.

Preliminary data on transit access mode, calculated from records of total bus ridership, the number of vehicles parking or dropping off passengers, and vehicle occupancy rates, indicates that the majority of Orange Streaker users access the service via the parking lot. This finding, coupled with the increased percentage of park-and-ride and kiss-and-ride users between Phase 1A

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[1]This number of corridor trips was calculated on the basis of vehicle volume and occupancy data for N.W. 7th Avenue and I-95.

TABLE C-2. SELECTED RESULTS: I-95/N.W. 7TH AVENUE, BUS/CARPOOL SYSTEMS DEMONSTRATION PROJECT, MIAMI, FLORIDA

	Before April 1974	Phase 1A April-August 1974	Phase 1 – Stage 1 September 1974-January 1975
RIDERSHIP AVERAGES:			
Daily Express Bus Trips			
Non-Orange Streaker (MTA)	18	6	6
Orange Streaker	-	74	45-49
Average A.M. Peak Orange Streaker Ridership[1]	NA	605	672
Average P.M. Peak Orange Streaker Ridership[1]	NA	554	630
Average Daily Park-and Ride Lot Usage	NA	247	309
Average Daily Carpool Formation at Lot[1]	NA	11	39
Average Daily Express Bus Ridership			
Non-Orange Streaker (MTA)	597	190[2]	190[2]
Orange Streaker	-	1,159	1,302
Average Daily Vehicle Volumes			
N.W. 7th AVE.	NA	14,050	14,714
I-95	NA	162,947	157,205
Average A.M. Peak Period Vehicle Volumes			
N.W. 7th Ave.	NA	1,422	1,410
I-95	NA	12,750	13,327
Average Peak Period Auto Occupancy Rate			
N.W. 7th Ave.	1.3 A.M./1.5 P.M.	1.3 A.M./1.5 P.M.	NA
I-95	1.3 A.M./1.3 P.M.	1.2 A.M./1.3 P.M.	NA
TRAVEL TIME AND ACCESSIBILITY:			
Average In-Vehicle Travel Times			
Feeder service to pkg lot	Travel time for comparable	20-30 min	20-30 min
Pkg lot to Civic Center	Trip not available	20.6 min	22.6 min
Average Auto Travel Time	34	34	NA
Average Vehicle Headway			
A.M.	NA	3.9 min	6.0 min
P.M.	NA	4.6 min	7.2 min
Average Transit Operating Speed			
On expressway	NA	35 mph[5]	NA
On arterials	NA	NA	25 mph[5]
On CBD streets	10.6 mph	10.6 mph	10.6 mph
Transit Access Mode (Parking Lot)			
% park-and-ride	NA	49	53
% kiss-and-ride	NA	13	18
% Orange Streaker feeder service	NA	38	29

TABLE C-2. SELECTED RESULTS: I-95/N.W. 7TH AVENUE, BUS/CARPOOL SYSTEMS DEMONSTRATION PROJECT, MIAMI, FLORIDA (CONT'D)

	Before April 1974	Phase 1A April-August 1974	Phase 1 - Stage I September 1974-January 1975
TRAVEL TIME AND ACCESSIBILITY: (Cont'd)			
Average Time for Access Modes			
Park-and-ride	NA	NA	NA
Kiss-and-ride	NA	NA	NA
Orange Streaker feeder service[6]	NA	25.2 min.	24.4 min.
Fare Structure/Revenue (Express Service)			
Regular Fare Rates		[7]	
Dade County	50¢/trip	60¢/trip	60¢/trip
Broward County	50¢/trip	75¢/trip	75¢/trip
Transfer Fare Rates	Free	Free	Free
Special Fares	-	-	-
Annual Revenue Passengers[8]			
Non-Orange Streaker	154,000	49,000	49,000
Orange Streaker	-	299,700	336,600
Annual Passenger Revenue (Orange Streaker)[8]	NA	$165,200	$187,800
Revenue/Rev. Passenger (Orange Streaker)	NA	$.58	$.59
Operating Ratio (Cost/Rev.)(Orange Streaker)	NA	3.6	2.0
Annual Operating Deficit (Orange Streaker)[8]	NA	-$428,000	-$194,000
PRODUCTIVITY MEASURES:			
Passenger/Veh. Mi.	NA	.76	1.26
Passenger Miles/Seat Miles (load factor)	NA	.35 A.M./.32 P.M.	.57 A.M./.56 P.M.
Passengers/Seat-Mile	NA	.02	.03
UNIT COST MEASURES:			
Operating Costs			
$/Veh. trip	NA	$31.00	$29.70
$/Pass. trip	NA	2.00	1.10
$/Peak vehicle (daily)	NA	77.00	49.00

TABLE C-2. SELECTED RESULTS: I-95/N.W. 7TH AVENUE, BUS/CARPOOL SYSTEMS DEMONSTRATION PROJECT, MIAMI, FLORIDA (CONT'D)

Footnotes to TABLE C-2.

1 Based on monthly averages of daily A.M. and P.M. statistics. Phase 1A is an average of May through August; Phase 1-State 1 is an average of September through December (January data was not available).

2 Scaled from Phase 0 data, taking into account which particular trips were eliminated.

3 Average of occupancy rates at three locations along corridor.

4 Travel times for feeder service to the parking lot were obtained from MTA schedules. Times between the parking lot and Civic Center are based on actual measurements

5 Expressway speed is based on speeds for buses operating between the parking lot and two destinations, the airport and N.W. 36th St., in mixed mode on I-95 and other freeways. Arterial speed is based on speeds for buses operating between the parking lot and two destinations, the downtown and the Civic Center, in mixed mode with signal preemption on N.W. 7th Avenue.

6 Times shown are weighted averages of total travel times between the parking lot and the Terminus of each feeder route.

7 For the first week of this phase, a no-fare introductory service was provided. Ridership data for Phase 1A excludes the first week of operations.

8 Annualized based on average monthly figures.

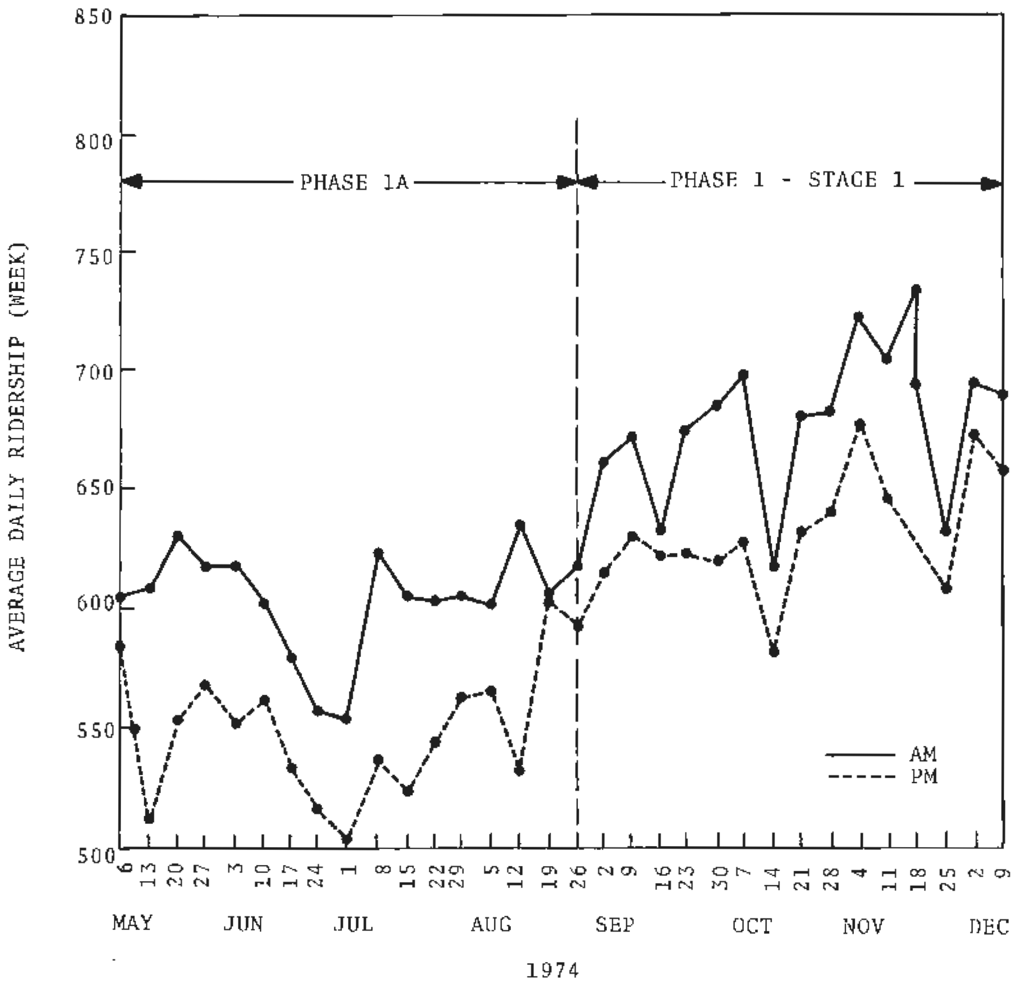

Figure C-6. Average Daily Ridership, Orange Streaker Routes, Miami, Florida and Phase 1 – Stage 1, suggests that the Golden Glades facility has been an important factor in expanding service coverage and attracting ridership.

Revenue, cost, and productivity data for Orange Streaker service indicates a substantial improvement between Phase 1A and Phase 1 – Stage 1. This is attributable to two factors: the more than 30% reduction in service at the beginning of Phase 1 – Stage 1, and the increase in ridership levels, despite the service cutback.

Although no data on equipment reliability appear in Table C-2, it is appropriate to discuss this performance measure since it relates to one of the local project objectives. Phase 1 – Stage 1 of the demonstration project was hindered by malfunctioning of signal control equipment, particularly during the months of September and October. In response to these difficulties, training courses in the repair of signal controls were conducted so as to eliminate the necessity of returning equipment to the manufacturer for repairs. By the end of November the hardware situtation on N.W. 7th Avenue had improved considerably, and it was expected that further problems would be largely eliminated when special OPTICOM equipment arrived.

At this stage of the demonstration project there are no data available concerning user characteristics, previous mode of travel, safety, noise and air pollution impacts, energy conservation, and relief of congestion. These will be included in subsequent reports as they become available.

Evaluation and Conclusions

At the present time it is somewhat premature to evaluate the I-95/N.W. 7th Avenue Project in terms of the SMD and local objectives listed above. In the first place, the results presented and discussed in the previous section are incomplete and subject to further modification. Second and more important, it seems inappropriate to draw conclusions based on changes between Phase 1A (express bus service on I-95 without preferential treatment) and Phase 1 – Stage 1 (signal preemption on N.W. 7th Avenue), when the emphasis in this project is to evaluate alternative bus priority treatments. A full interpretation and assessment of the project should be postponed until data is available for the various stages of bus priority treatment on N.W. 7th Avenue and I-95.

However, there is no doubt that one of the SMD objectives, increasing transit coverage, has been achieved. The introduction of Orange Streaker express service increased transit coverage within the project corridor in several ways: (1) by expanding the number of peak period express bus trips; (2) by expanding the residential and employment areas served; and (3) by providing more efficient and direct residential feeder service. The parking facilities at the Golden Glades Interchange also expanded transit coverage by permitting park-and-ride and kiss-and-ride access to the Orange Streaker express service.

So far, substantial productivity improvements have been achieved as a result of judicious reductions in Orange Streaker service during a period in which overall ridership has continued to increase. It remains to be seen how the various bus priority treatments to be implemented, which constitute the major thrust of this demonstration, will affect vehicle productivity.

Still another observation is that Orange Streaker service appears to be satisfying a latent demand for express bus transit in the corridor. This service, representing an increased frequency and coverage over that previously offered, has attracted increasing numbers of riders since its inception in April 1974.

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APPENDIX D

INTERSTATE 495-NEW JERSEY APPROACH TO THE LINCOLN TUNNEL: CONTRAFLOW BUS LANE

Project Overview

The I-495 bus priority demonstration consists of an AM peak period contraflow bus lane for eastbound buses along the 2.5 mile segment of I-495 between the New Jersey Turnpike (interchanges 16 and 17) and the Lincoln Tunnel Toll Plaza. The reserved bus lane is officially open to regular public buses only during the morning peak period of each weekday from 7:15–9:45 A.M..

The contraflow bus lane was opened on an experimental basis in mid-December 1970. At the end of the first year of operation, a thorough evaluation concluded that the bus lane was highly successful, and it subsequently became a permanent operation on I-495.

The I-495 contraflow bus lane crosses the jurisdictional limits of three operating agencies: the New Jersey Turnpike Authority (NJTA), the New Jersey Department of Transportation (NJDOT), and the Port of New York Authority (PONYA). All three of the above agencies plus other participating agencies have been involved to some extent in either the funding, administration, or operation of the contraflow bus lane.

The Urban Corridor Demonstration Project grant for the I-495 contraflow project, FH-11–7646, was in the amount of $500,000, and covered a major portion of the capital expenditures during the first year of the project.

The breakdown of shares for the capital costs is as follows:

Agency	Amount
FHWA/UMTA grant	$500,000
Port of N.Y. Authority and	54,642
Tri-State Regional Planning Commission	
N.J. Turnpike Authority	134,000
(for access roadway to bus lane)	
Total First Year Capital Costs	$688,642

The first year's operating expenses, borne by the N.J. Department of Transportation (2/3) and the Port of New York Authority (1/3) were $176,000.

As of this date, the I-495 contraflow bus lane has been in operation for four years. A permanent central traffic control system (Plan II) has been designed and approved for federal funding. It is estimated to be completed and in operation by early 1977.

Objectives

The main Service and Methods (SMD) objectives to which this project relates are: (1) reduction of travel time for transit users; (2) improvement of the reliability of transit service; and (3) increase in transit vehicle productivity. The I-495 contraflow bus lane accomplishes the first two objectives by segregating buses from other traffic, thereby reducing transit delays due to congestion. As a result of decreasing travel time and improving transit reliability, passenger demand, bus load factors, and bus operating speeds are increased, thereby causing an increase in vehicle productivity.

The following is a list of the local objectives for the I-495 contraflow bus lane:

1. Improve accessibility to Manhattan by providing more capacity and better transportation service (i.e., improve the efficiency of the existing highway system).

2. Provide better public transportation by increasing the travel speeds, reliability, convenience, and comfort of public transit (i.e., make transit more attractive).

3. Relieve severe congestion on I-495 and its approaches and thus reduce air pollution levels.

Project Description

Eastbound buses traveling on a 2.5 mile segment of I-495, reserved between the New Jersey Turnpike and the Lincoln Tunnel Toll Plaza, are diverted onto a contraflow lane during the A.M. peak period (7:15–9:45 A.M.). The contraflow portion of the I-495 bus lane officially ends at the toll plaza; however, during the morning peak period the buses use the center, reversible tube of the Lincoln Tunnel which flows into a bus access ramp leading to the Port Authority Bus Terminal. Figure D-1 is an eastbound view of the contraflow bus lane in operation. Figure D-2 shows the project area, participating agencies, and traffic flow pattern for the morning peak period and for the remainder of the day.

In the New York metropolitan area, the North New JerseyManhattan CBD corridor reaches approximately 15 miles into the suburbs of northeastern New Jersey. The spine of this east-west corridor consists of I-495 (the most congested freeway in the corridor), N.J. Route 3, and US Route 46 (between Route 3 and I-80). The major north-south highways that cross the corridor are the N.J. Turnpike (I-95), the Garden State Parkway, and N.J. Route 21. A map of the corridor is provided in Figure D-3.

Plan I of the I-495 contraflow project consisted of an elaborate traffic control plan that was developed by the Port Authority. Directional signals placed on overpasses and sign bridges along the westbound roadway of I-495 (Figure D-4) and message signs inform both the bus drivers in the contraflow lane and westbound auto drivers of the operating status of the lanes.

The contraflow lane is delineated from the two remaining westbound lanes with cylindrical, yellow plastic traffic posts placed at 40-foot intervals, which are manually inserted each morning

Figure D-1. View of I-495, N.J. Approach to Lincoln Tunnel Showing Eastbound Bus Lane

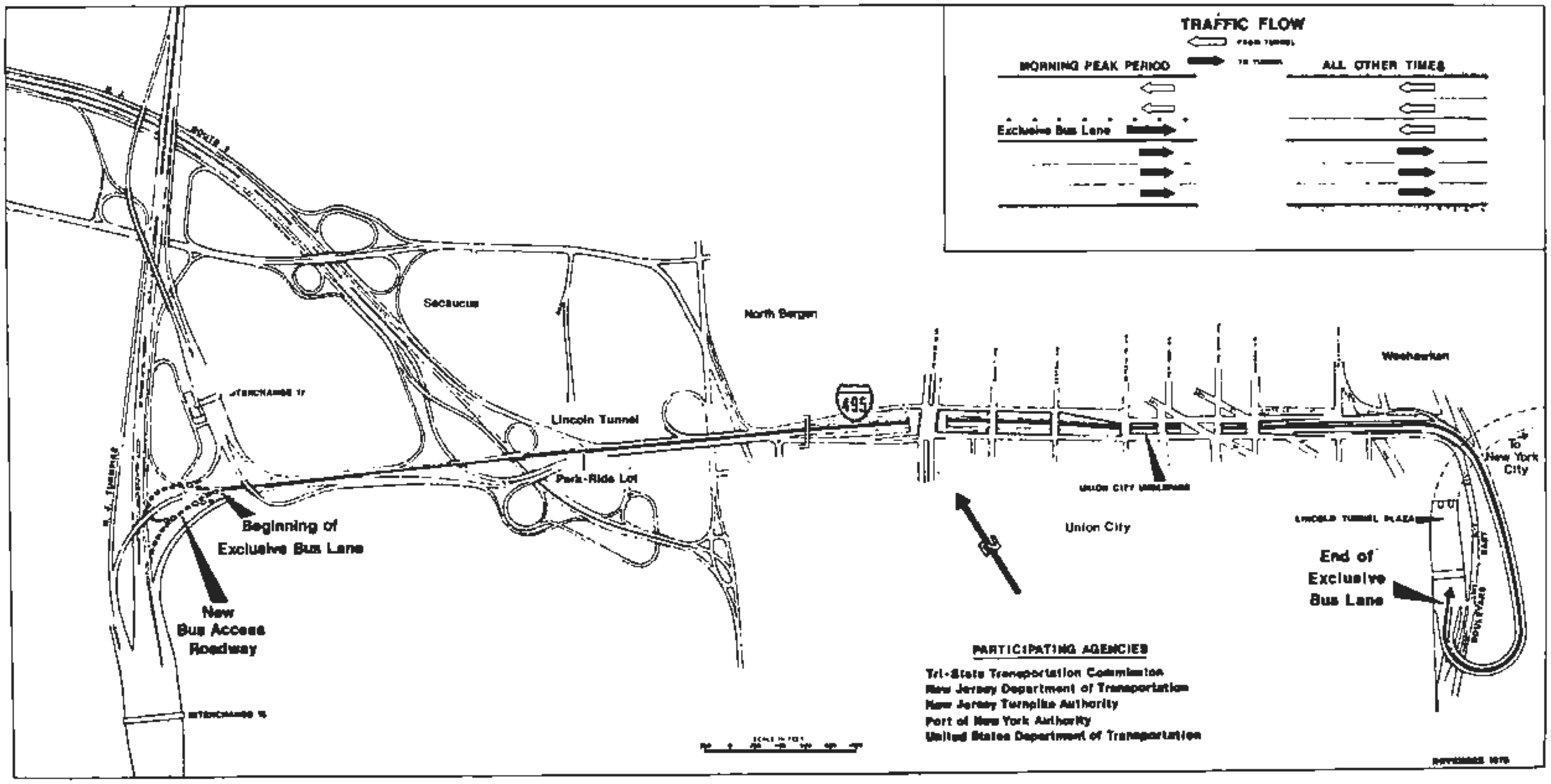

Figure D-2. Project Area and Traffic Flow Patterns, I-495, N.J. Approach to Lincoln Tunnel

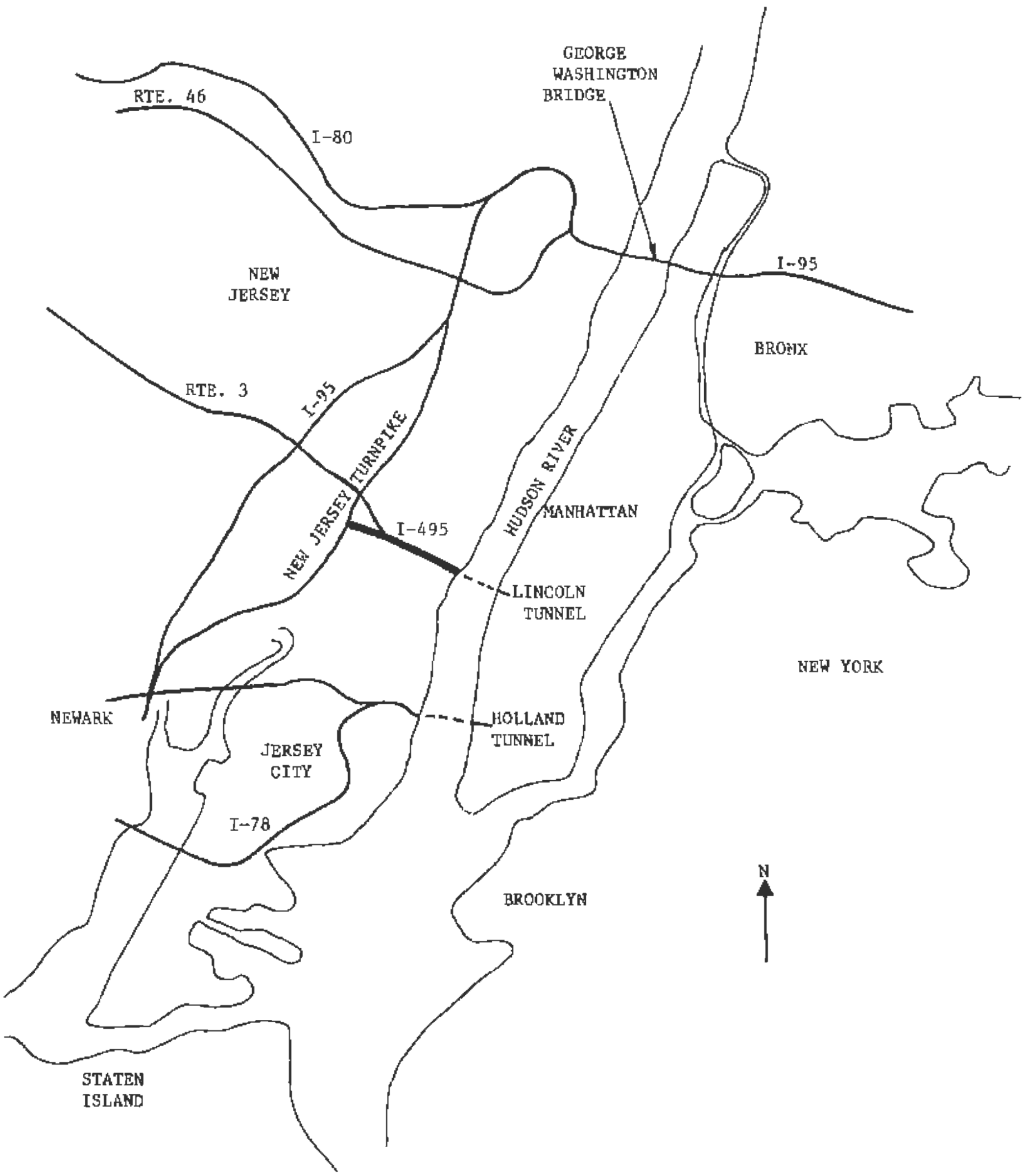

Figure D-3. Project Corridor, I-495, N.J.
Approach to Lincoln Tunnel

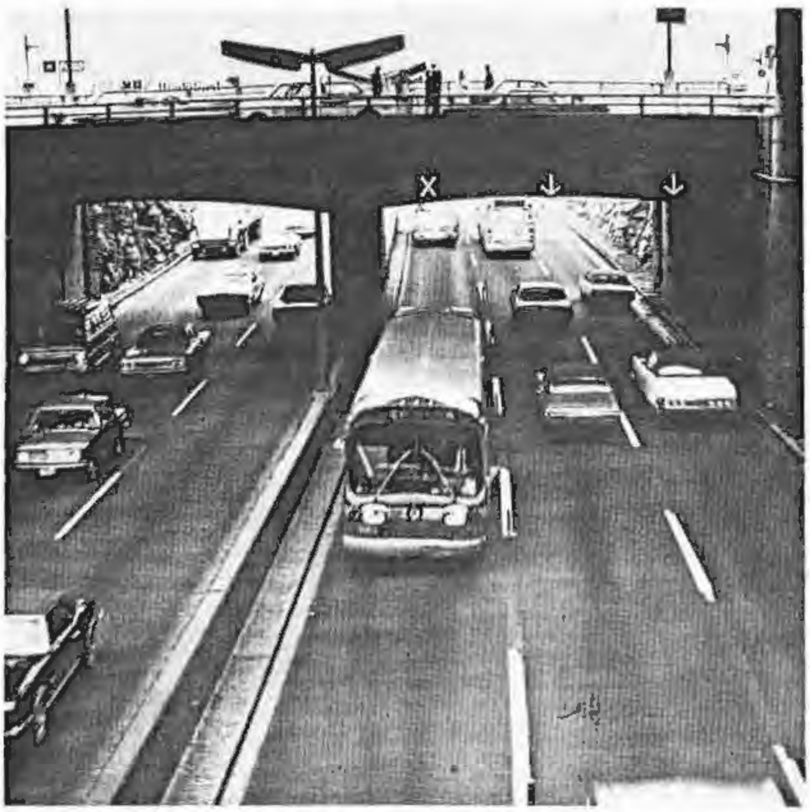

Figure D-4. Contraflow Bus Lane, I-495, New Jersey, Approach to Lincoln Tunnel. Directional Signals on Overpasses Show Operating Status of Lanes into predrilled holes in the pavement. The bus lane is usually open every work day morning from 7:15–9:45 A.M.; however, these hours are flexible, depending upon the morning peak traffic volume along I-495 and N.J. Route 3.

Daily travel to Manhattan is overwhelmingly transit oriented, primarily because of the costs and congestion associated with driving autos into the central city. During the course of each workday nearly 100,000 commuters cross the Hudson River from northeastern New Jersey into Manhattan. The typical commuter in this corridor travels about 15 miles and spends more than an hour making the trip. Auto commuters are well dispersed throughout the corridor, whereas bus commuters are heavily concentrated in the close-in areas.

In January 1973, a Bus Priority Traffic Management System (BPTMS) was implemented on I-495. This automatic surveillance system consists of induction loop traps placed in all traffic lanes, and in all entrance and exit ramps of the eastbound roadway. The BPTMS will provide data with which to evaluate the benefits of the contraflow bus lane, and to monitor its operational performance.

Another important feature of this project was the comprehensive public information program launched prior to the implementation of the bus lane. It consisted of news releases, specific advisory material distributed to motorists, bus drivers, and bus passengers, and an intensive bus company orientation of bus drivers on the operations of the bus lane.

Project History and Status

In the early 1960's, eastbound traffic on I-495 was chronically congested during the morning commuting period. At the same time westbound traffic was relatively light. It was this condition that prompted the idea and the subsequent studies of the feasibility of adapting the contraflow concept.

The Port Authority prepared its first report in December 1963, which evaluated several bus lane schemes and recommended the basic plan which was ultimately implemented. After field tests were conducted to determine its feasibility, a contraflow bus lane was strongly recommended by the Port Authority in January 1967. In late 1970, the N.J. DOT authorized construction of the I-495 contraflow bus lane.

Plan I of the I-495 contraflow bus lane project was completed and put into operation on December 18, 1970. Plan II, which involves the implementation of a permanent central traffic control system, has already been designed and approved for federal funding. Final design and engineering should be completed by spring 1976, with construction starting at that time. The Port Authority estimates that the traffic control system will be in operation by early 1977. It will include the following:

1. Additional overhead lane use control signals.

2. Centrally controlled, electric changeable message signs.

3. A closed circuit television surveillance system.

4. A centrally controlled gate at the bus lane entrance.

5. Additions to the fixed-message, regulatory guide signs.

6. A permanent telephone equipped police booth.

Results

The information in Table D-1 is a combination of both current data and data reported by the Tri-State Regional Planning Commission in its July 1972 report. The date of the information is noted in the table.

Bus volumes and ridership levels have always been high on the 2.5 mile stretch of I-495, even before the bus lane. In fact, there was an immediate increase of only 6% (2,300 new daily bus riders) in daily peak period ridership as a result of the contraflow lane. Ridership has continued to increase over the four years the lane has been in operation. Bus volumes have increased proportionately in order to handle the gradual increase in demand. Bus occupancy has always been high and has stayed relatively constant. The market share of transit (trips by bus/total person trips on I-495) during the peak hours (7:45–8:45 AM) has been approximately 84 percent since the end of the first year of operation (1972).

Average peak period auto occupancy in the eastbound lanes decreased approximately 4 percent after the bus lane was implemented. The decline during the peak hour was almost 10 percent. It is likely that most if not all of this decline can be accounted for by the shift of some carpoolers to the buses.

An important result of the contraflow bus lane has been the time savings, varying from 8–25 minutes (average of 10 minutes), which accrues to the bus commuters. The average time savings of 10 minutes has held constant over the four years the bus lane has been in operation. Eastbound auto commuters also experienced time savings after the lane was put into operation. However, as a result of increased auto speeds, cars from the two other main routes to Manhattan (George Washington Bridge and the Holland Tunnel) have shifted to I-495 and congestion has nearly reached its former level.

Another effect of the bus lane has been the 16 percent increase in the weekly usage of the park and ride lot which is located at the junction of N.J. Route 3 and I-495. These increases can be attributed to the improvement in shuttle bus service between the lot and the Port Authority bus terminal due to use of the bus lane.

The productivity measure which showed the greatest increase was passengers per vehicle-hour. The main reason for the increase from 177 passengers per vehicle-hour in 1970 to 498 passengers per vehicle-hour in 1971 is the increased speeds of the buses and the accompanying reduction in travel time as a result of operating on the contraflow bus lane. Passengers per vehicle-mile remained relatively unchanged over the years because both passenger volumes and bus volumes increased proportionately.

The proportion of bus passengers using transit 4–5 days a week increased from 82% to 92% after the contraflow bus lane was implemented.

The bus passenger survey taken in May and June of 1971 revealed that 81 percent of the bus riders were riding the same bus they did before the bus lane was implemented. Another 9

TABLE D-1. SELECTED RESULTS: INTERSTATE 495, NEW JERSEY APPROACH TO THE LINCOLN TUNNEL, CONTRAFLOW BUS LANE

	BEFORE	AFTER	
CATEGORY	1970	1971	1975
COSTS:			
Planning & Implementation Costs	$ 60,325		
Capital Costs of Bus Lane Impl.	$564,817		
Operating Costs		$176,000/yr.	4,200,000/yr.
Total Costs (first year of operation)		$810,000	
RIDERSHIP AVERAGES:			
Average A.M. Peak Period Ridership (7:15-9:45 a.m.)	32,000	34,000	44,000
Average A.M. Peak Hour Ridership (8:00-9:00 a.m.)	N/A	21,1000	23,000
Average A.M. Peak Period Bus Volume (7:15-9:45 a.m.)	724	818	1,020
Average A.M. Peak Hour Bus Volume (8:00-9:00 a.m.)	N/A	480	500
Morning Peak Hour Flow (all east bound vehicles)	3,290 (3 lanes)	4,530 (4 lanes)	N/A
Average Peak Period Bus Occupancy Rate (load factor)	44 pass/bus	42 pass/bus	43 pass/bus
Average Peak Hour Bus Occupancy Rate (load factor)	N/A	44 pass/bus	46 pass/bus
Average Car Occupancy Rate (Peak period 2.5 miles of I-495)	1.6 pass/car	1.54 pass/car	
LEVEL OF SERVICE:			
Average Bus Travel Time (Peak period -2.5 miles of I-495)	15-20 min.	5 min.	5 min.
Average Auto Travel Time (Peak period -2.5 miles of I-495)	15-20 min.	10-12 min.	15 min.
Average Bus Headway (Peak period -2.5 miles of I-495)	12.4 sec.	11.0 sec.	8.8 sec.
Average Bus Headway (Peak Hour -2.5 miles of I-495)	-	7.2 sec.	7.2 sec.
Average Transit Operating Speed (Peak Period-2.5 miles of I-495)	10 mph	30 mph.	30 mph
Transit Access Mode; Park-and Ride Lot (No. of Vehicles Parked Per Wk.)	6,450 veh./wk.	7,140 veh./wk.	7,500 veh./wk.
FARE STRUCTURE:			
Park-and-Ride Lot Shuttle Service to Port Authority Bus Terminal a. Round trip fare from P-N-R-lot b. With all-day parking			 $1.40 $2.25
Round Trip Fare Averages for Public Bus Companies Operating on the Bus Lane a. Short-Haul Routes (0-9 miles) b. Medium-Haul Routes (10-19 miles) c. Long-Haul Routes (20-30 miles)			 $1.00-1.80 $2.00-2.50 $2.40-3.50
Annual Revenue Passengers Using Buses	8,160,000	8,670,000	11,220,000

TABLE D-1. SELECTED RESULTS: INTERSTATE 495, NEW JERSEY APPROACH TO THE LINCOLN TUNNEL, CONTRAFLOW BUS LANE (CONT'D)

	BEFORE	AFTER	
CATEGORY	1970	1971	1975
PRODUCTIVITY:			
Passengers/Vhe.-Hour (for 2.5 miles on I-495 during peak period)	177 pass./ veh. hr.	498 pass./ veh. hr.	518 pass./ veh. hr.
Passengers/Veh.-Mile (for 2.5 miles on 1-495 during peak period)	17.7 pass./ veh. mi.	16.6 pass./ veh. mi.	17.3 pass./ veh. mi.
UNIT COSTS: (after 1st year)			
Capital Cost Dollars/Passenger		$.07/pass	
Capital Cost Dollars/Peak-Vehicle		$764/peak veh	
Capital Cost Dollars/Lane-Mile		$250,057./ lane mile	
TRANSIT USAGE:			
Usage: 4-5 Days/Week	82%	92%	
PREVIOUS MODE OF TRAVEL:			
Previous mode			
a. Auto		4%	
b. Same Bus		81%	
c. Different Bus		9%	
d. Railroad		2%	
e. No Trip Made		3%	
f. PATH Transit		1%	
SAFETY:			
Annual No. of Accidents Involving Transit Buses (during the peak period)		2/yr	2/yr
a. No. of injuries		-	1
b. No. of fatalities		0	0

percent came from different buses, while the remaining 10% had shifted from auto, railroad, PATH, or no trip made at all.

The safety record of the bus lane in its four years of operation has been excellent, as is evidenced from accident data in the table. Since the lane's opening, there have only been seven accidents on the bus lane, one of which involved an injury to a bus driver.

Some of the additional impacts of the demonstration (relating to other modes, the community, and energy consumption) are described below.

The remaining traffic on the eastbound roadway (cars, trucks, small buses) experienced reduced congestion, increased speeds, and increased peak hour flow as a result of the bus lane. Westbound traffic flows very smoothly over the entire 2.5 miles of I-495 during the peak period of each working day. The 35 mph speed limit for westbound traffic during the operation of the bus lane is only of minor inconvenience over the short stretch of highway.

Public reaction to the I-495 exclusive bus lane was very enthusiastic, as evidenced by numerous commendatory news articles, editorials, and letters from the public. The vast majority of all surveyed groups of bus patrons and drivers, eastbound and westbound motorists, bus company managements, and police regarded the contraflow lane favorably. Furthermore, the additional people moving capacity provided by the bus lane has decreased the likelihood that a major expansion of I-495 will soon be needed.

Although the evaluation studies excluded any specific mention of energy savings as an indirect result of the bus lane, the decrease in congestion for all the eastbound, peak period traffic alone should account for a substantial savings in the amount of gasoline consumed.

Evaluation and Conclusions

It is apparent from the discussion of the results in the previous section that all three of the SMD objectives related to the bus contraflow lane project have been met successfully. As noted before, bus travel times have been decreased substantially, with an average of 10 minute time savings accruing to bus passengers. This represents a 44 percent reduction in peak period travel time on the 2.5 miles of contraflow lane for bus commuters. Travel time for all inbound vehicles decreased by about 23 percent for the 2.5 mile section of I-495. Clearly, the overall percentage decrease in travel time would depend upon the total length of the trip.

Improvement in the reliability of transit during the peak period was shown by the fact that congestion delays for buses have essentially been eliminated; thus former highly variable bus travel times on I-495 have been reduced to a constant 5-minute ride along the bus lane. Constant bus travel times mean better bus schedule adherence both for the shuttle bus service and the service provided by the other 40 bus companies which use the bus lane during the peak period. Another indicator of increased transit reliability is found in the results of the user survey in which passengers themselves indicated that bus service along I-495 was more reliable.

Vehicle productivity (in terms of passengers per vehicle-hour) showed a dramatic increase as a result of the implementation of the contraflow bus lane. It is worth noting that this objective was reached as a result of the reduction in bus travel time while on the bus lane. By increasing the eastbound capacity of this section of I-495, traffic has diverted to it from other major routes, thus increasing the overall throughput of the corridor.

The local objectives of testing the operational feasibility of the contraflow concept, and its ability to reduce congestion and increase the capacity and efficiency of the existing highway system have also been accomplished to a high degree. This was shown by the reductions in bus travel times and the increases in passenger and bus volume flows through the corridor during the peak period. Other local objectives of increasing the comfort and convenience of public transit were also achieved, as is evidenced by the results of bus rider surveys, which were administered to select groups in May and June of 1971.

Groups that were surveyed consisted of bus patrons, bus drivers, eastbound and westbound motorists, bus company management, and police. A summary of the results from this survey are as follows:

1. The vast majority in all groups were extremely favorable toward the contraflow bus lane. Only 12 percent of the westbound motorists were not.

2. Eighty-eight percent of the bus drivers felt more relaxed and 75 percent felt safer driving on the bus lane than before its implementation. A majority of both eastbound and westbound motorists also felt driving conditions had been improved.

3. All patron groups surveyed felt they saved a substantial amount of time on their trips. Fifty-four percent of the bus patrons and drivers indicated that the bus lane saved them 10–19 minutes. Some 75 percent of the eastbound motorists also saved time.

4. Approximately 95 percent of the bus passengers indicated they experienced more reliable travel times. Some 86 percent said that their trips were more enjoyable, and the remaining 14 percent indicated that there was no change.

5. A majority of the bus company managements reported small increases in patronage due to the bus lane. Some 75 percent of the bus company managements reported reductions in driver overtime costs as a result of the travel time savings.

Perhaps the most significant indication of the success of this contraflow bus lane project is its adoption as a permanent transportation feature along the I-495 corridor, with plans for further improvement.

References

1. Link, Dan, "Freeway contraflow bus lanes: some policy and technical issues," Traffic Engineering V.45, N.I., Jan., 1975, pp. 31–34.

2. Tri-State Regional Planning Commission, Urban Corridor Demonstration Program; Exclusive Bus on Interstate 495, New Jersey Approach to Lincoln Tunnel. Final Report, UCDP-73–4, July, 1972.

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APPENDIX E

U.S. 101 EXCLUSIVE AND RESERVED BUS LANES, MARIN COUNTY, CALIFORNIA

Project Overview

The Golden Gate Bridge, Highway and Transportation District Bus Lane project involves the operation of commuter bus service on contraflow and concurrent flow lanes on U.S. 101. The bus lanes are located immediately north of the Golden Gate Bridge, which represents the northern boundary of the city of San Francisco.

Twelve different bus routes use the exclusive and reserved lanes. Operation of PM peak northbound contraflow and concurrent flow bus service began in September of 1972. The extension of the PM peak concurrent flow lane and the institution of AM peak service in a concurrent flow lane occurred on December 20, 1974.

The cost of operating the project is shared by the Golden Gate Transportation District and the California Department of Transportation (CALTRANS). These agencies split the operational costs of the bus lanes 50–50. However, buses used on the bus lanes and in other Transportation District operations, have been acquired through the UMTA capital grant process. The SMD program is funding the evaluation of this demonstration.

Objectives

Three of the objectives of the Service and Methods Demonstration program are encompassed in this project. Through the use of reserved bus lanes, buses can avoid automobile congestion and thus reduce transit travel times and increase transit reliability. As a result, buses serving the routes can be utilized more intensively, increasing transit vehicle productivities.

An experimental objective encompassed in this project is the evaluation of the operational and safety aspects of a no barrier reserved bus lane.

The two most prominent local objectives of this project are: (1) to test the operation of reserved freeway lanes with a minimum of barriers separating the buses from the auto lanes, and (2) to evaluate the increased overall improvement of efficiency of the freeway by assigning certain lanes to buses during peak periods.

Project Description

Figure E-1 schematically portrays the preferential treatment accorded buses on U.S: 101. During the morning peak period (6–9 A.M.) at a point eight miles north of the Golden Gate Bridge, inbound buses enter the inside southbound concurrent flow bus lane. The buses run for four miles in this lane, then cross over into the outside non-reserved lane, in order to be correctly positioned to cross the Golden Gate Bridge.

During the afternoon peak period (4–7 P.M.), buses flow northbound from the Golden Gate Bridge on the inside southbound traffic lane. The adjacent southbound lane is used as a buffer zone and is delineated by pylons which are inserted into holes in the pavement (see Figure E-2). At

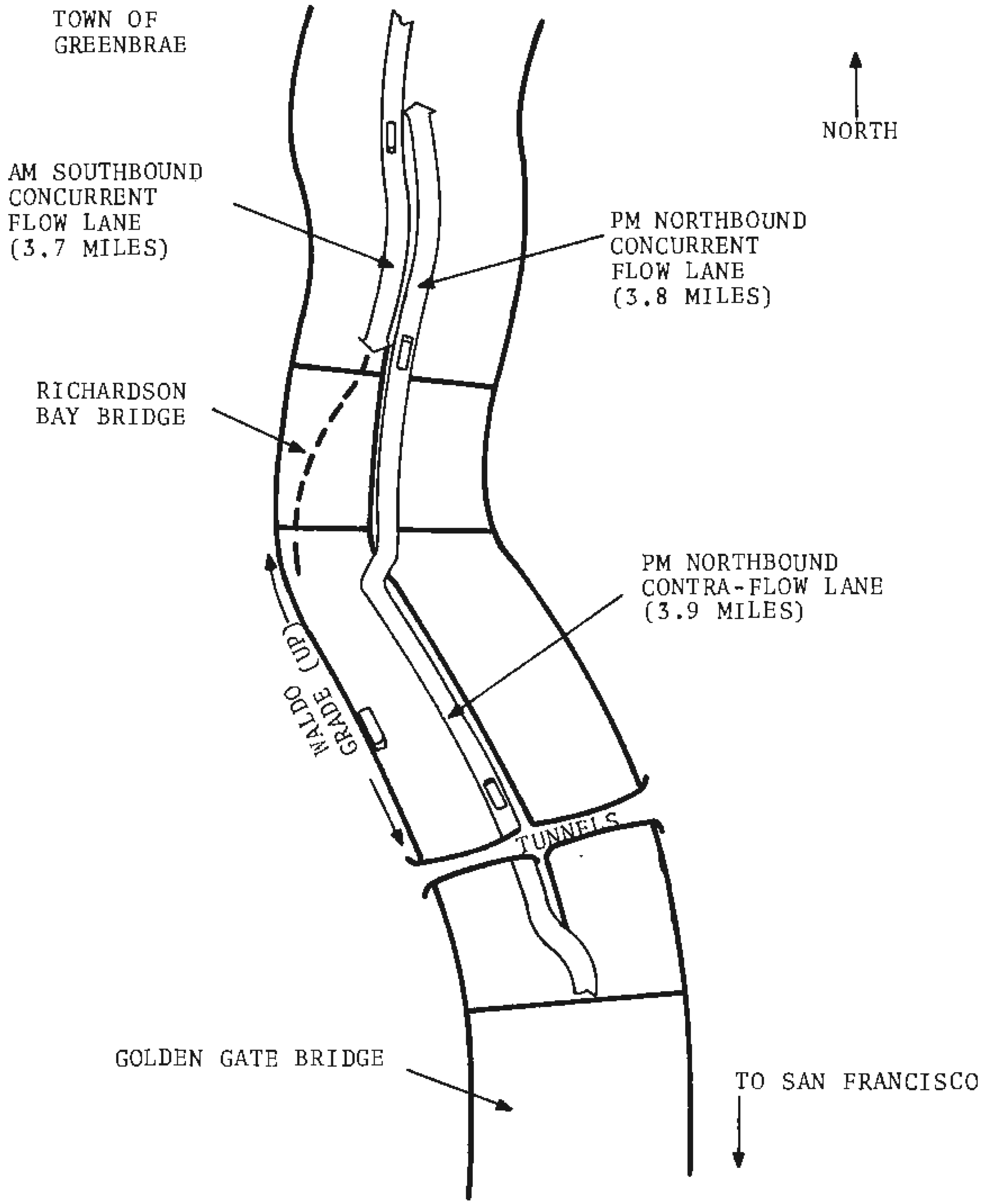

Figure E-1. Preferential Bus Treatment, U.S. 101,
Marin County, California

Figure E-2. Contraflow Bus Lane, U.S. 101,
Marin County, California

Figuee E-3. Bus Crossover Point, U.S. 101,
Marin County, California

a point four miles north of the bridge, buses cross over through a break in the median strip (Figure E-3) into the inside northbound lane, which acts as a concurrent flow reserved bus lane. This lane continues northbound to a point about eight miles from the Golden Gate Bridge.

Approximately 130 bus trips are made over the bus lanes during the morning peak period, with intervals between buses dropping to almost 30 seconds during the height of the peak. The commute trip fare ranges from $.75 to $1.50 depending on the length of the trip. A majority of the commuters are middle to high income professional persons.

The feature which distinguishes this bus lane project is the provision of concurrent flow bus lanes with no barriers of any kind, either permanent or temporary, separating the bus lanes from the other traffic lanes. Identification of the bus lane is accomplished through signs positioned every 800 feet.

Project Status and History

The bus lane project is currently in its second phase. The first phase was the implementation, in September 1972, of the PM peak contraflow lane and a short segment of a concurrent flow lane. The expansion of the concurrent flow lane and the addition of AM peak concurrent flow service constituted a second phase which commenced operation in December 1974. The concurrent flow reserved lanes were extended an additional one-half mile in February of 1975. Plans are being considered for reserved bus lanes on the San Francisco side of the bridge.

Results

Of the 10,400 AM peak trips across the Golden Gate Bridge, about 5,000 or nearly 48 percent are being carried on buses. For the peak hour the transit share is 60 percent. Travel time savings on the bus lanes range from 0 to nearly 15 minutes according to the length of the trip, the degree of congestion on a given day and the time within the peak period when the trip is made. This time savings has allowed buses to be used more intensively to provide an additional 15 bus trips (675 passenger trips) during the peak period.

Ridership is currently restricted by the number of buses in service. Average load factor for the bus lane service is nearly 90 percent. Significant ridership growth will not occur until additional buses are put into operation. It is uncertain when this will occur.

References

None

APPENDIX F

CINCINNATI SUN RUN EXPRESS BUS SERVICE

Project Overview

The Sun Run Express Bus Service consists of two express bus routes linking the Mt. Washington residential area with the Cincinnati CBD. In conjunction with the express bus service the following elements were included in the demonstration:

- Curb side shelters and a park-and-ride terminal.
- Traffic enforcement program.
- Marketing program.
- Roadway and traffic engineering improvements.

The Ohio-Kentucky-Indiana Regional Planning Authority was the coordinating agency for the project. Other agencies directly involved in the planning and implementation of the program included: the City of Cincinnati; Cincinnati Transit Inc.; the Ohio Department of Highways; the East End Area Council; Cincinnati Model Cities Agency; and Southwest Ohio Regional Transit Authority. The total cost of the project was $1,410,280. The agencies involved in the funding and their shares are as follows:

U.S. DOT:	
UMTA/FHWA (UCDP)	$506,650
UMTA (TOPICS)	353,030
State of Ohio	176,510
City of Cincinnati	374,090

The Urban Corridor Demonstration Project (UCDP) grant funded Sun Run service from October 1973 through April 1974. Queen City Metro has since acquired Cincinnati Transit, Inc., and continued operation of all Sun Run routes. All other elements of the UCDP project, except for the roadway improvements, were completed and evaluated by July 1974. The final report is expected to be completed by June 1975.

Objectives

The Cincinnati demonstration project encompasses all three of the SMD objectives related to improved transit service. Decreased travel times result from the implementation of express bus routes and traffic light synchronization. Increased transit coverage is achieved by the establishment of the new express bus service. Increased transit reliability results from roadway improvements and traffic light synchronization.

The local objectives of the Mt. Washington corridor program are the following:

- Improve bus service to the downtown CBD area from Mt. Washington.

- Decrease congestion by providing acceptable levels of service on major corridor facilities during the peak periods.

- Relieve congestion at bottleneck locations through traffic operation techniques and intersection improvements.

- Provide nearly door-to-door service for as many potential transit riders as possible, utilizing a suburban terminal concept in conjunction with collection/terminal routes.

- Create a favorable attitude toward transit through a comprehensive marketing and public information program.

- Provide a high level of transit service at minimum cost to the user.

- Test the effectiveness of outlying terminals in conjunction with express bus service to the central area, for promoting greater utilization of transit for travel to the central area.

- Test the effectiveness of various preferential traffic engineering and operational control techniques for express vehicles operating in mixed traffic on arterial roadways.

Project Description

Two new express routes were added to existing bus routes in the Mt. Washington corridor (see Fig. F-1). The Sun Run – Beechmont route provides 13 round trips per weekday between the Beechmont Shopping Mall and the CBD. A park-and-ride terminal at the Beechmont Mall provides free all day parking. The Sun Run-Rainbow route between residential neighborhoods and the CBD is also served by 13 round trips per weekday. Eleven passenger waiting shelters were constructed along the two miles, including a shelter at the park-and-ride lot.

A total of ten buses are used on both of the Sun Run routes, operating with average a.m. and p.m. peak period headways of 15–20 minutes and average midday off peak headways of 70 minutes. Express bus movement in the corridor was facilitated by the implementaton of seven bus turnouts and several intersection improvements (widening of street intersections) along Eastern Avenue. In addition, all of the traffic lights along the express bus routes were synchronized to allow better traffic flow.

An enforcement program was established in order to enhance the operation of the Sun Run service along Eastern Avenue and in the CBD, where traffic congestion was most severe. It consists of removing parking violators and disabled vehicles as quickly as possible to enable the Sun Run buses to move more freely.

A vigorous promotional and marketing program was conducted to attract new riders to the system. Promotional elements included an informational brochure describing the service and extensive media coverage. The Sun Run logo the project's identification symbol, was used extensively on posters, mailers, bus stop signs, Park-and-Ride terminal, etc. An inauguration

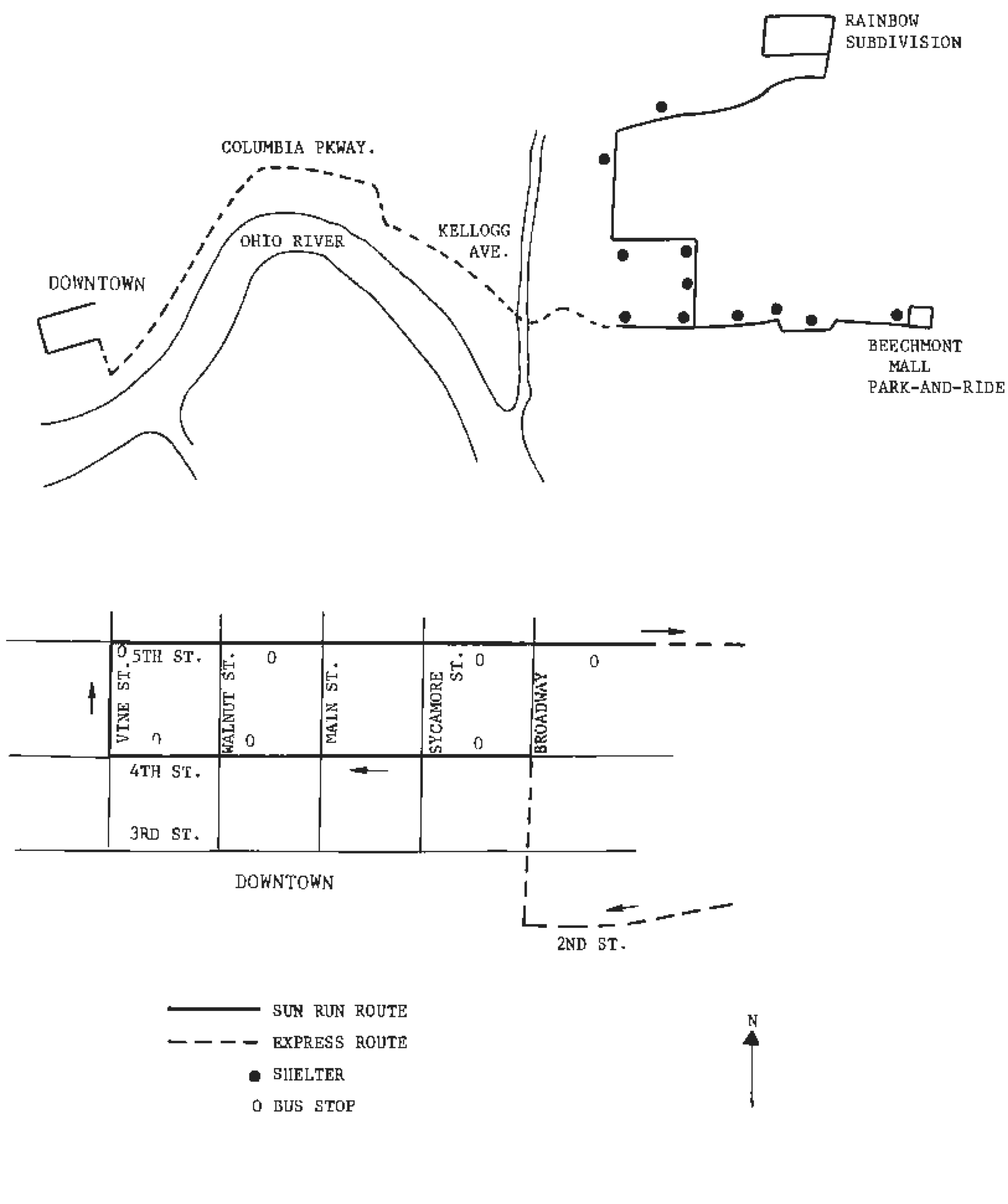

Figure F-1. Sun Run Routes, Cincinnati, Ohio ceremony held at the start of the express bus service enabled the project to achieve a high level of user recognition in the corridor.

Project History and Status

The federal grant under the UCDP, secured in June 1971, covered the Mt. Washington corridor project and Sun Run bus service operations from mid-October 1973 until April 1974. With the exception of the physical improvements along Eastern Avenue, all of the projects in the UCDP were completed as scheduled.

A second federal grant was obtained in June 1972 under FHWA's TOPICS (Traffic Operations Program for Increased Capacity and Safety) Program. This grant covered a portion of the roadway improvements to the Mt.Washington project.

As a result of the success of the two existing Sun Run routes, Queen City Metro (QCM) has planned for the implementation of at least 3 new Sun Run routes to the north, northwest and west of the CBD during 1975. Plans include using existing freeways where possible. In addition, the possibilities of using reserved lanes and bus signal preemption in the CBD are being studied.

Results

The project results, including ridership, cost and revenues, and user profile are listed in Table F-1.

Evaluation and Conclusions

The objective of increased transit coverage has been met with the addition of six square miles to the transit service area and the park-and-ride and shelter access points in the suburbs. There are no comparable "before" data to permit determination of the amount of decreased travel time or increased transit reliabilty.

There were, however, several findings from a preliminary examination of the Cincinnati project. They are as follows:

- Ridership on Sun Run routes and existing routes
- Forty percent of the new patrons on the Sun Run routes
- Forty-one percent of the users have family incomes in
- Of those who formerly traveled by car and switched to

exist for a premium type service, and that former auto riders can be induced to switch to public transit offering quality service at a lower cost than auto travel.

References:

None

TABLE F-1. SELECTED RESULTS: SUN RUN EXPRESS BUS SERVICE, CINCINNATI, OHIO

CATEGORY	
COSTS:	
Oct. 1973 - April 1974	
Annual Operating Cost (monthly figure annualized)	$134,436
Annual Subsidy (monthly figure annualized)	$ 60,840
Subsidy as a Percentage of Cost	47%
Cost of Marketing Program	$ 18,436
RIDERSHIP AVERAGES:	
October 1973	
Average Total Daily Ridership	1,014
April 1974	
Average Total Daily Ridership	1,209
February 1975	
Average A.M. Peak Ridership (2 hrs.)	467
Average P.M. Peak Ridership (2 hrs.)	542
Trip Demands/Sq. Mi./Hr.	1.64
Average Car Occupancy Rate	1.2
LEVEL OF SERVICE:	
February 1975	
Transit Access Mode-	
a. Park-n-Ride; Kiss-n-Ride	88%
b. Bus Transfer	10%
c. Walked	2%
Average Time For Access Modes	
a. Park-n-Ride; Kiss-n-Ride	10 min.
FARE STRUCTURE/REVENUE:	
February 1975	
Regular Fare Rates	25¢+5¢ Zone
Transfer Fare Rates	Free
April 1974	
Annual Revenue Passengers (monthly figures annualized)	290,400
Annual Passenger Revenue (monthly figures annualized)	$ 73,596
Revenue/Passenger	$ .25
PRODUCTIVITY MEASURES:	
February 1975	
Passengers/Vehicle-hour	31.2
Passengers/Vehicle-mile	1.65

TABLE F-1. SELECTED RESULTS: SUN RUN EXPRESS BUS SERVICE, CINCINNATI, OHIO (CONT'D)

CATEGORY	
UNIT COSTS:	
April 1974	
Operating Cost/Passenger Trip	$ .45
Operating Cost/Peak Vehicle[1]	$13,444
USER CHARACTERISTICS:	
February 1975	
Age Groups	
a. Under 20 Years	11%
b. 20-44 Years	36%
c. 45-64 Years	47%
d. 65 Years and over	6%
Sex	
a. Male	50%
b. Female	50%
Family Income	
a. Under $5,000	16%
b. $5,000 - $9,999	39%
c. $10,000 - $14,999	41%
d. $15,000 and over	4%
Car Ownership	
a. 0 Cars	12%
b. 1 Car	36%
c. 2 Cars	44%
d. 3 Plus Cars	8%
Car Availability	
a. Yes	73%
b. No	27%
Transit Usres	
a. 5 Days/Week	56%
b. 3-4 Days/Week	19%
c. 1-2 Days/Week	13%
d. 1 Day/Week	6%
PREVIOUS MODE:	
February 1975	
Previous Mode of Travel	
a. Auto Driver	40%
b. Auto Passenger	6%
c. Bus	50%
d. No Trip Made	2%
e. Other	2%

[1]The number of vehicles operating in the peak period.

APPENDIX G

WASHINGTON, D.C. "DOWNTOWNER" BUS SERVICE DEMONSTRATION

Project Overview

The "Downtowner" was a demonstration of fixed route service on medium sized ("midi") buses during the mid-day off peak. It connects southwest and northwest employment areas of Washington D.C. through the downtown shopping core. The demonstration began in December 1972 and ran until June 30, 1974, when the service was taken over by the Washington Metropolitan Area Transit Authority and was made a permanent part of the transit system.

The project was funded 100 percent by UMTA through a Demonstration Grant (DC-06–0069) in the amount of $346,000 and was managed by the Washington, D.C. Dept. of Highways and Traffic. An UMTA capital grant was used to purchase the fleet of 15 buses.

Objectives

The program primarily served the SMD objective of increasing transit vehicle productivities. This was accomplished by the attraction of increased ridership through a unique fare structure and a service tailored to the particular land use and travel demand of downtown Washington.

The local sponsor of the project had the following program goals:

- Reduction of downtown congestion through increased use of mass transit,
- Reduction in the size of transit coaches in the city core area,
- Reduced air pollution,
- Assistance and support of downtown revitalization efforts, and
- Achievement of a revenue cost ratio of 0.5.

Project Description

The Downtowner operates between N St. and Connecticut Ave. N.W., and 6th and K Sts., S.W., (3.4 route miles, one way). It provides circulation within the retail core and access to the core from northwest and southwest employment areas. (See Figure G-1).

Thirteen buses operate over the route between 10 A.M. and 3:30 P.M. Monday thru Friday (71.5 vehicle hours/day). Headways have been 5 minutes between 10 and 11 A.M., increasing to 6 minutes after 11 A.M. due to traffic conditions. The vehicles used are TC-25 Transit Coaches with seating capacity of 25 and 15 standees. The buses are considered by the operator to be faster and to have greater maneuverability in traffic than standard sized buses.

A zonal fare structure was used to allow riders traveling only within the downtown area to pay $.10, while riders boarding outside the core paid $.25 or presented a free transfer pass from a

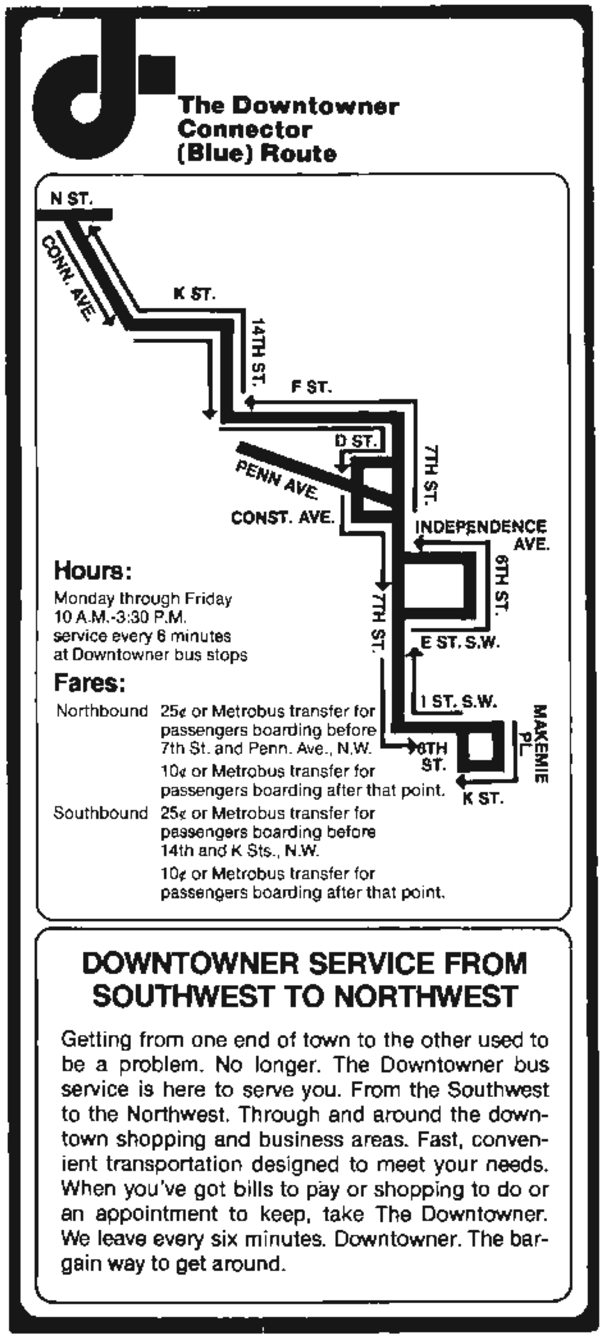

Figure G-1. Downtowner Service, Washington, D.C.

regular route bus. Thus, a person making a round trip from the northwest or southwest to the retail core paid a total of $.35; $.25 inbound and $.10 outbound.

Project History and Status

Downtowner service was initiated in December, 1972. The fare structure described above went into effect following a no-fare introductory period between December 18, 1972, and January 8, 1973.

During the 18 month demonstration period, obstacles to the provision of the intended level of service were created by the construction of the subway system which caused detours from the initial route and made adherence to schedules difficult. The project has been completed and service is being maintained under the auspices of the Washington Metropolitan Area Transportation Authority.

Results

The statistics reported in Table G-1 were obtained almost entirely from two on board surveys, one conducted on March 15, 1973 and the other on March 6, 1974.

Evaluation and Conclusions

On the basis of the statistics reported above, it can be seen that the service was successful in increasing transit vehicle productivities. Between March of 1973 and March of 1974 average daily ridership increased by 40 percent, (from 2,638 to 3,686) and vehicle productivities rose 29 percent, (from 7.45 passengers per/revenue mile to 9.60 passengers per/revenue mile). During the last month of the service (June 1974), 10 percent of the passengers were new, indicating that ridership growth was continuing at a substantial rate.

Although no quantitative data are available to assess the impact on downtown business, merchants felt that the Downtowner provided a positive stimulus to sales, and they actively advocated continuation of the service after the demonstration period. This viewpoint would seem to be supported by the data reported for trip purpose, although there was a substantial shift from shopping and eating purposes towards personal business between 1973 and 1974.

The implementing agency felt that its objectives of reducing automobile congestion and resultant air pollution were met, as the Downtowner attracted many of its riders from automobiles or taxis. However, no quantitative data are available to confirm this.

The objective of obtaining a revenue/cost ratio of 0.5 was more than met; as of March 1974, this ratio was 0.60.

Overall, it can be concluded that the provision of improved circulation and accessibility between employment locations and retail activity centers during the mid-day off peak can be a successful transit service in an appropriate area.

TABLE G-1. SELECTED RESULTS: "DOWNTOWNER" BUS SERVICE DEMONSTRATION, WASHINGTON, D.C.

Category	After 1973	1974
RIDERSHIP AVERAGES:		
Average Daily Passengers	2,638	3,686
Average Daily Passengers Between 12 Noon and 1 P.M. (Peak Loading Period)	1,170	1,485
LEVEL OF SERVICE:		
Average Vehicle Headway		
a. 10 A.M. - 11 A.M.		5 min.
b. 11 A.M. - 3:30 P.M.		6 min.
Average In-vehicle Travel Time	16.3 min.	17.8 min.
Average In-vehicle Trip Length[1]	1.4 miles	1.69 miles
Average Transit Operating Speed	5.14 mph.	5.7 mph.
FARE STRUCTURE/REVENUE:		
Regular Fare Rate		\$.25
Fare within Core Zone		\$.10
Transfer Fare Rate		Free
Annual Revenue Passengers (Monthly figures annualized)	696,528	928,965
Annual Passenger Revenue[2]	\$104,479	\$139,341
Average Revenue/Passenger	\$.15	\$.15
Operating Ratio (Operating Costs/ Revenue)	2.40	1.60
PRODUCTIVITY:		
Passengers/Revenue-Mile	7.45	9.60
Passengers/Revenue-Hour	36.89	51.55
UNIT COST MEASURES:		
Operating Costs		
a. Average Cost/Revenue-mile	\$2.42.	\$2.33
b. Average Cost/Passenger-mile	\$0.0215	\$0.0144
USER CHARACTERISTICS:		
Trip Purpose		
a. Shop	53.5%	42.0%
b. Work	22.7%	17.0%
c. Eat	18.5%	7.0%
d. Business	4.0%	0.0%
e. Personal Business	10.0%	34.0%

1 The increase in average trip length reflects a change in route and thus in route miles
2 Straight multiple of est. annual passengers and average fare.

References

1. District of Columbia, Dept. of Highways and Traffic. Downtowner Bus Service Ridership Survey, March, 1973.

2. District of Columbia, Dept. of Highways and Traffic. Downtowner Bus Service Ridership Survey, 1974.

APPENDIX H

XENIA MODEL TRANSIT SERVICE DEMONSTRATION

Project Overview

A new fixed route system has been implemented in the city of Xenia, Ohio, as part of the redevelopment of the community after it was struck by a tornado. Xenia, with a population of 27,642, is in the Dayton metropolition area. The Xenia Model Transit Service Demonstration Project (OH-06-0022) sponsored by UMTA, began August 1974 and was established as a one year demonstration program.

The project funding is shared by UMTA, U.S. Dept. of Manpower Administration, and the City of Xenia. The actual grant shares were:

Federal	$300,000	(UMTA)
Federal	100,000	(Manpower Administration)
Local(facilities)	18,510	

Objectives

By providing transit for a community whose mobility has been drastically affected by the tornado, this project addresses the SMD objective of increased transit coverage.

The local objectives of this demonstration project are to provide implementation and growth of a transit system as an integral part of the complete community redevelopment and provide a portion of the school trip needs to demonstrate how small city transit can cost effectively coordinate city and school transit trips. Automobile ownership is being monitored to determine whether the transit system affected reacquisition of autos lost in the disaster. Service development is an ongoing process of monitoring transportation needs and adapting the service as necessary.

Project Description

Other than a private taxi company, Xenia Transit Service is presently the only form of public transportation within the community of Xenia. The service orientation is fixed route with the anticipated accommodation of subscription service for work trips and a demand responsive service during the off peak periods.

The original fleet of seven city transit buses of Miami Valley (Ohio) Transit Authority have been replaced with 10 Flexible Flxette vehicles (nine 19–25 passenger and one specially equipped handicapped service vehicle). These radio equipped coaches are operating on four fixed routes between the hours of 6:30 am and 6:30 pm, providing fixed route and school trip services. Based on need and an analysis of ridership and revenues, special fare experiments such as prepaid passes are being considered for implementation.

Transportation monitoring will be undertaken by the Montgomery-Greene County Transportation Coordinating Committee in the light of overall regional considerations.

Table H-1 contains transportation related characteristics of the Xenia community.

Project History and Status

The tornado that struck the community on April 3, 1974, caused destruction and damage to 40 percent of the residences and resulted in loss of employment to 33 percent of the working population. Sixty percent of the automobiles and school buses were destroyed. An extensive planning and community emergency relief activity began immediately after the disaster. Part of the basic plan of this relief activity was a no fare, twelve hour a day transit service.

Transit service improvements are being planned for future months. The first such option is a prepaid pass program. Monthly and student passes would be distributed based on the period of a ridership month. For a student, such a fare would equal 2 trips per day for a 20 day period. In June a dial-a-ride system was implemented to augment the existing transit service schedule. Demand responsive vehicles are in operation evenings, Sundays and holidays.

Results

The Xenia Transit Service is in its early phase of operation and a complete evaluation cannot be made at this point. Two activities have been completed; data collection to establish the socioeconomic characteristics of the area, and the telephone and on board surveys of transit users.

Since the vehicles went into operation on september 1st, the ridership has increased 38 percent to over 825 riders per day. This ridership is approximately 4,950 per week (excluding Sunday special service). These statistics assume a productivity (passenger/vehicle hour) of 10.

Trip purposes of the transit users are as follows:

35%	work trips
33%	shopping trips
11%	personal business trips
11%	school trips
7%	business trips
3%	social trips

Forty three percent of the users are between the ages of 26 and 64 years of age, 16 percent are 64 years and over, and 41 percent are below the age of 26 years.

As shown above, 11 percent of the trips are school trips. The regular base fare is $.25. In November, Xenia Transit Service introduced a 10 cent reduced fare program for students. The effects were significant; approximately 31 percent of those students living too close to school to be eligible for school bus service began riding the Xenia transit buses.

The major factors contributing to the accessibility of this service are the type and location of boarding stops and transfer points, the vehicle headways, and the location of the routes. Seventy

TABLE H-1. SELECTED CHARACTERISTICS RELATED TO TRANSPORTATION NEEDS: MODEL TRANSIT SERVICE DEMONSTRATION, XENIA, OHIO

POPULATION:	
Total Population of Xenia	27,642
Population in Disaster Area	9,448 (34%)
HOUSEHOLDS:	
Total Households in Xenia	8,953
Households in Disaster Area	3,349 (37%)
TRANSPORTATION DEPENDENT:	
Age Groups:	
Elderly (62 yrs. and over)	9%
Young (under 18 yrs.)	35%
Total	44%
Households without an Automobile	53.5%
FAMILY INCOME:	
$0 - $4,999	12.9%
$5,000 - $8,000	19.0%
$8,000 +	68.1%

five percent of the current users live within one and one half blocks of a transit stop. To date the service has run quite effectively with only minor maintenance problems. Parts availability seemed to be the greatest cause of service interruption.

The experience of the existing service has shown that marketing has been the single most important influence to the success of the system. Though radio and news media are effective methods of publicity, citizen involvement has been the greatest selling force.

References

Xenia, Ohio, Model Transit Service Demonstration Project, First Quarter Progress Report, December, 1974.

APPENDIX I

INTEGRATED TRANSIT DEMONSTRATION: ROCHESTER, NEW YORK

Project Overview

The Rochester Dial-a-Ride demonstration involves the operation of a demand responsive "small bus" system in medium density suburbs. It will be conducted in Greece, Irondequoit, and Henrietta (Figure I-1), suburbs of Rochester, N.Y. The significant areas of innovation will be the introduction of a fully computerized dispatching system, expansion of service to multiple service areas, provision of subscription services, and integration of Dial-a-Ride with the existing fixed route system.

The project began on April 1, 1975 and will run for 2–1/2 years. Dial-a-Ride (PERT) service has been in operation in Greece since August 1973. Expansion to Irondequoit and Henrietta will occur during the demonstration period.

The demonstration will be conducted by the Regional Transit Service, an operating susidiary of the Rochester-Genesee Regional Transportation Authority (RGRTA). The project has an operating budget of:

Federal	$2,028,330	73%
Local	754,770	27%
Total	$2,783,100	

In addition, there is a capital budget of:

Federal	$1,183,100	80%
Local	295,800	20%
Total	$1,478,900	

Objectives

The project should meet all five of the SMD objectives. Of primary importance is the increase of transit coverage, through the provision of demand responsive door-to-door transportation in suburban areas that previously had limited or no public transportation. Additionally, steps will be taken during the demonstration to improve the coordination between fixed route and PERT services and to make the dispatching and routing of PERT vehicles more efficient. These improvements should decrease travel times and improve transit reliability. Overall improvements in the level of service and efficiency of operation (particularly as achieved through computerization and integration with the fixed route system) should increase transit vehicle productivities. Finally, a specially equipped vehicle (with a wheelchair lift) and specially tailored services will improve service to the handicapped and elderly.

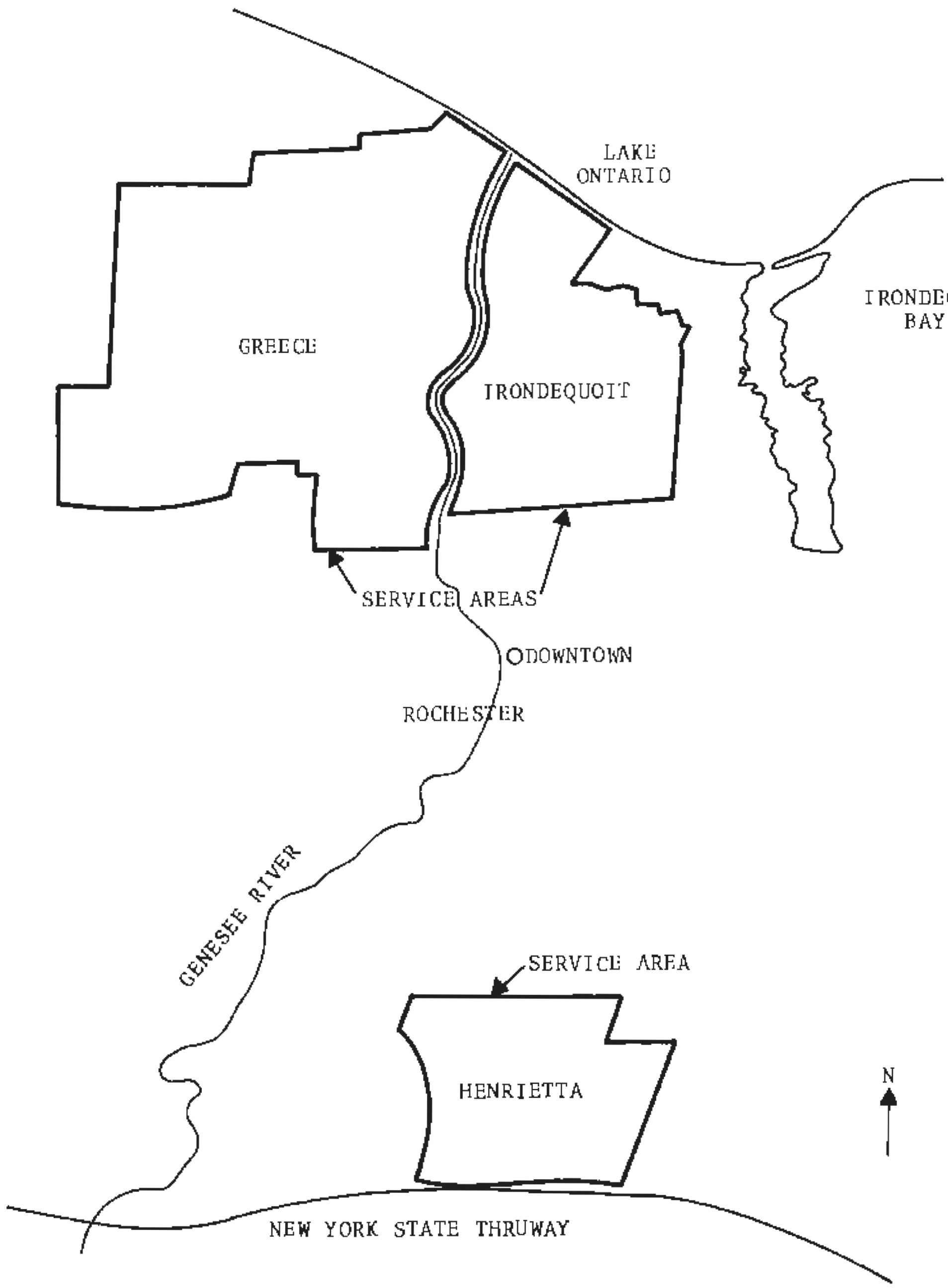

Figure I-1. PERT Dial-A-Ride Service Areas, Rochester, New York

Beyond the SMD objectives, the Rochester Transit Authority has stated the following objectives:

- Increase the level and quality of transit service,
- Balance peak, off peak, and evening service, and
- Develop a system providing easy transfer between system elements.

Project Description

The PERT system currently operates in Greece, with manual vehicle dispatching and using digital communications between the control center and the vehicles (See Figure I-2). Demand-responsive service is available Monday through Saturday from 8 A.M. to 10 P.M. Peak period subscription services operate to and from fixed route buses serving downtown Rochester, and to and from the Kodak Park Employment Center in Greece. The PERT buses begin operations at 6 A.M. A few special weekly services between a housing project for the elderly and shopping areas are offered. In addition, PERT provides some house to school services for children to whom regular school bus service is not available. The system currently operates with a total of 12 small vehicles with average seating capacity of 20. One vehicle is electrically powered, and one is equipped with an automatic wheelchair lift (Figure I-3).

During the demonstration, demand responsive service hours may be expanded to begin earlier in the morning and to run until midnight. As the vehicle fleet is expanded, the Greece service area will be enlarged, and separate operations will begin in the suburbs of Irondequoit and Henrietta. Computerized dispatching will be introduced in January, 1976, in Greece and Irondequoit and in Henrietia in September, 1976. particular attention will be given to expanding the number and nature of services provided to special market segments (handicapped, elderly, young), as well as expanding the house-to-school and house-to-work services.

An important element of the demonstration wll be the integration of PERT with the existing fixed route system. This will consist of substituting PERT for fixed route service in areas and at times of day where PERT can more efficiently serve demand.

Finally, some experimentation with the base fare level, as well as different fares for different market groups and different types of service, will take place. Currently the base fare is $1.00, with a subscription commuter fare of $7.00. PERT has a group ride policy which allows riders traveling together between common origins and destinations to pay only $.25 for each rider in excess of one.

The first demonstration service change was to substitute PERT feeder service for off peak fixed route service on Route 10 within the Greece service area, while maintaining fares constant at the level ($.50) paid for fixed route service.

Table I-1 summarizes the major service area, demographic and vehicle data.

Figure I-2. Control Center, PERT Dial-A-Bus
Rochester, New York

Figure I-3. PERT Dial-A-Bus Vehicle, Rochester, New York

TABLE I-1. DEMOGRAPHIC, COVERAGE AND VEHICLE DATA: INTEGRATED TRANSIT DEMONSTRATION, ROCHESTER, NEW YORK

	Greece (present)	Greece (planned)	Irondequoit (planned)	Henrietta (planned)
Population	66,500	100,000	50,300	21,000
Area	16 sq. mi.	25 sq. mi.	10.8 sq. mi.	7 sq. mi.
Population Density	4150/ sq. mi.	4000/ sq. mi.	4650/ sq. mi.	3000/ sq. mi.
Median Family Income	$13,600	$13,600	$13,600	$13,000
Car ownership				
0 car	5%	5%	6%	2%
1 car	62%	62%	55%	50%
Elderly (65 and over)	8%	11%	11%	4%
No. of Vehicles at Start of Service	12	15	10	5
No. of Vehicles at End of Demonstration		20	15	10

Project History and Status

Phase I: April 1975 – December 1975

In The Greece Area:

- Improve coordination between PERT and fixed route service,
- Replace some fixed route service with PERT in conjunction with fare experiment,
- Phase in computer dispatching, and
- Design special services for handicapped and elderly.

Phase II: January 1976 – September 1976

- Expand Greece service area,
- Computer dispatching fully operational in Greece,
- Begin service in Irondequoit with computer dispatching,
- Investigate possible service between Greece and Irondequoit,
- Add more companies to home-to-work subscription service in Greece and Irondequoit,
- Expand home-to-school service in Greece and Irondequoit, and
- Continue replacing and coordinating with fixed route service in Greece and Irondequoit.

Phase III: September 1976 – September 1977

- Begin service in Hentietta with computer dispatching, and
- Develop special market and subscription services in Herietta.

At the end of the demonstration, RGRTA plans to continue expansion into more suburban areas. Eventually eight service areas will be established, completely surronding the Rochester area.

Results

Since the demonstration only started in April 1975, evaluations and conclusions cannot be made at this time. Some interesting data from the pre-demonstration operations are presented in Table I-2. Ridership and cost data are for the month of February 1975, the latest month for which data are available. Socio-economic and trip characteristic data were obtained from an on board survey in February, 1974.

References: none

TABLE I-2. SELECTED RESULTS: INTEGRATED TRANSIT DEMONSTRATION, ROCHESTER, NEW YORK

CATEGORY	PRE-DEMONSTRATION DATA
COSTS:	
Capital Equipment Costs	$226,000
Operating Costs	$286,500/yr.
Depreciation and Amortization	$ 22,600/yr.
RIDERSHIP AVERAGES:	
Subscription Service	
a. Trip Demands/Day	165
b. Passengers/Day	189
Dial-A-Bus and Special Services	
a. Trip Demands/Day	392
b. Passengers/Day	515
Total Trip Demands/Sq. Mi./Day	34
Average Total Trip Demands/Sq. Mi./Hr.	2.5
Average Total Passengers/Sq. Mi./Hr.	3.14
LEVEL OF SERVICE:	
Average In-Vehicle Travel Time	13-14 min.
Average Wait Time	17-18 min.
FARE STRUCTURE/REVENUE:	
Base Fare (plus $.25 for each additional person traveling in a group)	$1.00
Subscription Commuter Fare	$7.00/week
Transfer to Fixed-Route Transit	$ .05
Monthly Passenger Revenue[1]	$11,256
Average Revenue/Passenger	$ .66
Monthly Revenue Passengers[1]	16,921
Operating Deficit	$32,379
Operating Ratio (O.C./Revenue)	3.87
PRODUCTIVITY:	
Passengers/Vehicle-hour	5.93
UNIT COST MEASURES:	
Operating Costs	
a. Operating Cost/Passenter	$ 2.58
b. Operating Cost/Vehicle/Vehicle-mile	$ 1.39
c. Operating Cost/Vehicle-hour	$ 15.31

[1]Data from month of February, 1975.

TABLE I-2. SELECTED RESULTS: INTEGRATED TRANSIT DEMONSTRATION, ROCHESTER, NEW YORK (CONT'D)

CATEGORY	PRE-DEMONSTRATION DATA
UNIT COST MEASURES: (CONT'D)	
Capital Costs	
a. Capital Cost/Trip	$ .32
b. Capital Cost/Passenger	$ .25
c. Capital Cost/Vehicle-mile	$ .05
d. Capital Cost/Vehicle-hour	$ 1.33
USER CHARACTERISTICS	
Age Group	
a. 24 and under	38.5%
b. 25 -44	32.0%
c. 45-64	18.8%
d. 65 and over	10.7%
Sex	
a. Male	21.8%
b. Female	78.2%
Family Income	
a. $0 - $4,999	17.1%
b. $5,000 - $9,999	28.9%
c. $10,000 - $14,999	32.9%
d. $15,000 +	21.1%
Car Availability	
a. Yes	13.3%
b. No	68.3%
c. Yes, but inconvenient	18.4%
Cars in Household	
a. 0	17.1%
b. 1	52.8%
c. 2+	30.1%
Licensed Driver	
a. Yes	45.9%
b. No	54.1%
Transit Usage	
a. Daily	24.0%
b. 2-3 days/week	24.0%
c. 1 day/week	26.0%
d. 1-2 days/month	24.0%

APPENDIX J

THE UNIVERSITY OF MASSACHUSETTS AT AMHERST FREE-FARE TRANSIT DEMONSTRATION PROJECT

Project Overview

The University of Massachusetts at Amherst has conducted a demonstration of (1) free-fare bus service and (2) limitations on parking, directed largely at off campus commuters. The demonstration began in February, 1973, when a 4 bus, on campus shuttle service operated by students was expanded to include off campus routes leading to Amherst Center, Sunderland, Belchertown, and South Deerfield, and to several large apartment complexes. In September 1973 campus core parking was reduced, while additional campus peripheral parking was provided with shuttle bus service.

The Urban Mass Transportation Administration (UMTA) funded the major portion of the capital and operating expenses of the demonstration project which ran from February 1973 to June 1974. The breakdown of project funding is as follows:

Agency	Capital	Operating	Administration + Evaluation	Total
UMTA	$373,410	$74,396	$219,585	$667,391
U. of Mass.	65,090	140,038	58,342	263,470
Total	$438,500	$214,434	$277,927	$930,861

The University is now continuing the service without UMTA support. Service has been extended to evening, weekends, and holidays by request of the Student Senate, which is providing the necessary additional funding. The Council plans to continue to reduce on campus parking, and eventually to make the campus core area an auto free zone.

The University Administration in cooperation with the Student Senate is responsible for the policy making and planning of the transit system. Actual transit service is managed and operated entirely by students with overall supervision of the University Administration.

Objectives

The project encompassed two Service and Methods Demonstration program goals: increased transit coverage and improved vehicle productivity. Coverage has been extended from the campus to the community, providing previously auto dependent commuters with transit service for the first time. The free fare policy is intended to maximize productivity, expressed as ridership per vehicle mile, for the level of service offered.

The University's stated objectives in performing the demonstration are:

- To measure the effect on transit usage of free bus service, increased parking fees, and associated restrictions on the use of automobiles on the campus,

- To estimate the benefits and costs to users, non-users, the University and to the town of Amherst, and
- To measure how changes in transportation service affect community attitudes toward public transportation.

The University objective in continuing the service is to provide an attractive alternative to auto use so as to reduce congestion and encourage a more orderly flow of traffic on and around the campus and the town center.

Project Description

The University campus is located within the town of Amherst. The population of Amherst is 27,000, including 16,500 resident students (the University enrollment was 23,000 in 1973, but many students commuted from other towns). In spite of a relatively small population within its 28 square mile area, Amherst has a highly concentrated traffic pattern. The university campus is the major destination for work trips or class attendance; daytime population on campus reaches 30,000.

From its inception in 1968, the Amherst campus transit operation offered free fare service to all persons, whether or not they were affiliated with the University. The UMTA Demonstration project began in February 1973, when the service was expanded from four buses and 14 on campus route miles to 13 buses travelling 88 route miles, including off campus routes (see Figures J-1 and J-2). The fleet consisted of two 45 seat buses, one 33 seat bus, and ten 31 seat buses. The service was operated from 7:30 AM to 6 PM. On-campus headways were 20 minutes during the day and 45 minutes during the evening. The other routes did not operate with constant headways, but the average headway was 60 minutes during the day and 85 minutes at night. There were 120 vehicle hours of service per day. No changes in parking fees were introduced at this time.

In the fall of 1973 three more 45 seat buses were added to the fleet. Service to two outlying points was cut back to several off peak runs per day. The remaining routes were cut by 17 percent to 35 round trip route miles, and a new campus shuttle route of 3 route miles was added to serve the parking lots. Headways were cut to 10 minutes during the peak and 20 minutes off peak. There were 170 vehicle hours of service per day.

In order to discourage automobile commuters from driving in to congested core campus parking areas, in the fall of 1973 the number of core parking spaces was cut from 3,900 to 2,100, annual fees were raised from $5 to $5 per peripheral parking, $17 for edge parking, and $41 to $55 for core parking, and the ratio of core parking permits to core parking spaces was also reduced from 1.8 to 1.1. In addition, shuttle bus service was established to previously unused peripheral parking lots.

Project History and Status

The grant demonstration period began in February 1973 and ended in June 1974. The original on campus free fare transit service was expanded in February 1973. Parking changes were not introduced until September 1973 so that their impact could be observed separately from the impact of the original expansion. Service frequencies were raised at the same time (September 1973). During January 1974 to June 1974, the energy shortage was added as an additional experimental variable.

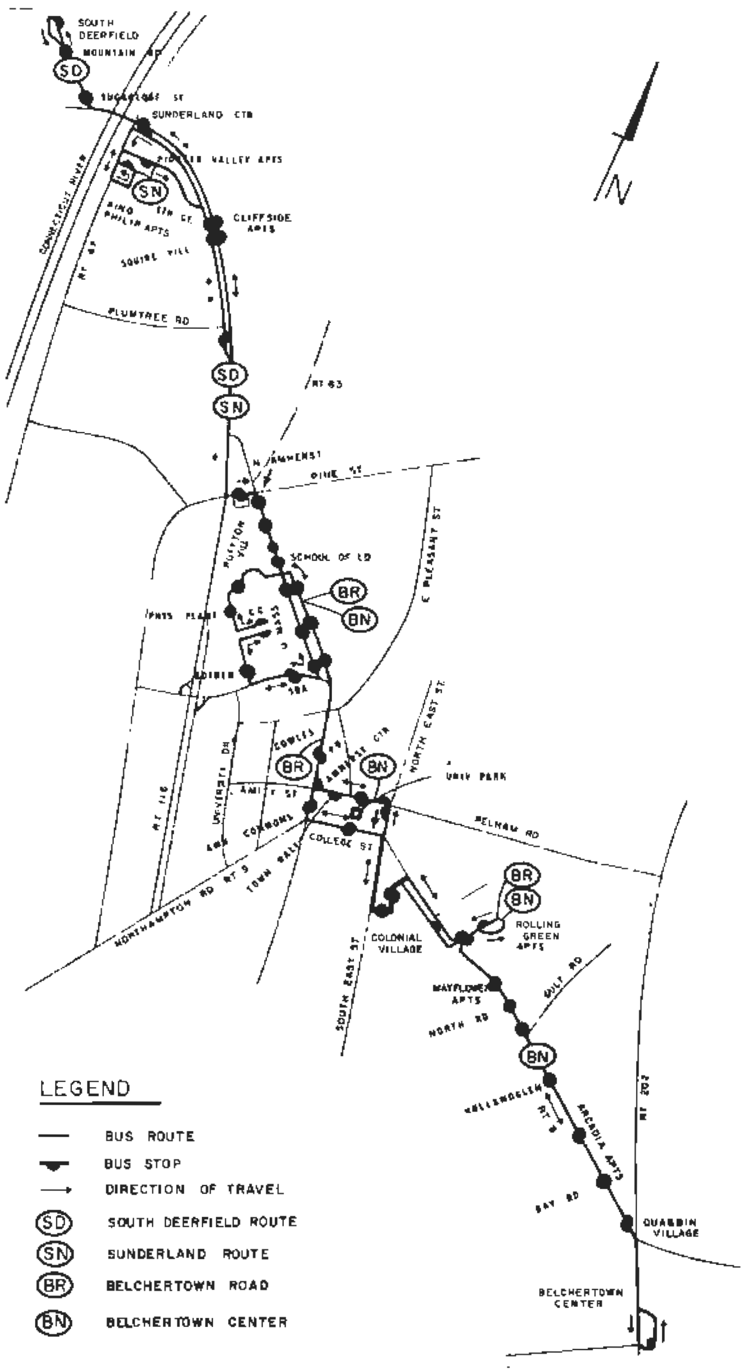

Figure J-1. Off Campus Bus Routes, Amherst, Massachusetts

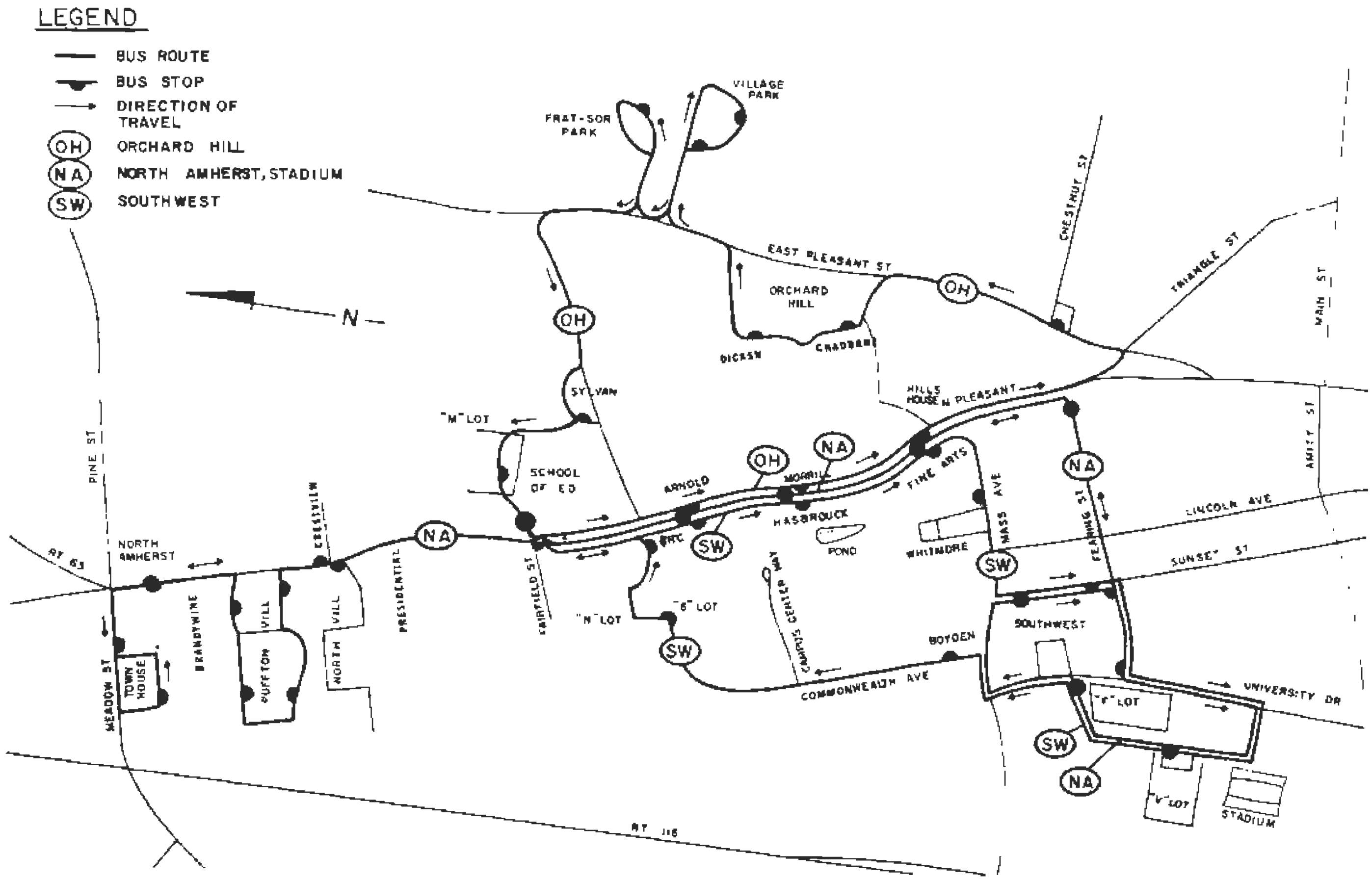

Figure J-2. On Campus Bus Routes, University of Massachusetts, Amherst, Massachusetts

The service is now being continued by the University without UMTA funding. The Student Senate has provided the necessary funds to expand service to include evenings, weekends, holidays, and summers. The University plans to gradually reduce core parking spaces to zero, creating an auto free zone in the central campus, and to continue the free fare bus service.

Results

The results are presented in Table J-1. Ridership rose from 2,500 per day before the begining of the demonstration to 6,500 in the spring of 1973, to 13,000 in the fall of 1973, and to a peak of 17,000 during the gasoline shortage in the spring of 1974. Productivity reached 90 passengers per vehicle hour. By fall, 1973, 50 percent of those living within a one-quarter mile of a bus stop were using the system. Labor rates were relatively low; student drivers and administrators were paid wages ranging from $2.25 to $4.00 per hour. Buses operated at approximately 80 percent over the seated capacity during the peak hours. Although traffic volume increased slightly in the spring of 1973, traffic flow improved, and the rate of increase was lower than that predicted on the basis of the previous years' experience.

In spite of the increase in parking fees, permits for core parking spaces sold out immediately in the fall of 1973. The number of cars parking in the campus core area was reduced, due to the reduction in the number of spaces available and in the number of permits offered for sale.

Despite increased enrollment at the University, traffic volume fell after the imposition of the September, 1973 parking restriction. Peak hour travel times for the heaviest traffic days continued to fall.

Amherst Center, the intersection of Main and Pleasant Streets (see Figure J-2), has experienced a noticeable increase in retail business since the route expansion took place. In addition, rent increases have been higher and vacancy rates lower in apartment complexes along the bus routes than in other apartment complexes in Amherst.

The strongest opposition to the increase in parking fees came from the classified staff who objected that the increased parking fee represented a heavier burden to them than to the other University employees whose salaries are significantly higher. However, they did not object as strongly to the limits on the number of core parking spaces, which is the probable direction future parking restrictions may take.

Evaluation and Conclusions

The increase in route miles has extended coverage to areas previously not served by transit. Bus ridership capacity during the 1973 fall semester was at 13,000 per day, and increased to 17,000 per day during the 1974 spring semester, when the demand exceeded the practical capacity of the bus system.

Traffic congestion was successfully reduced to satisfactory levels during the course of the demonstration. One element contributing to the improved flow of traffic may have been the reductions in the number of hitch hikers. Actual traffic volumes dropped only when restrictions on parking were enforced. Apparently the economic disincentive to park had little effect since the core lots sold out immediately. It may be noted that the highest fee changed, $50 a year for core lots, is

TABLE J-1. SELECTED RESULTS: FREE FARE DEMONSTRATION PROJECT UNIVERSITY OF MASSACHUSETTS, AMHERST

COSTS	
Capital Costs	
Purchase of 13 buses	$333,000
Other	$ 99,500
Operating Costs (excludes depreciation)	
Total over period of January 1973 - June 1974	$220,000
RIDERSHIP	
Average Daily Ridership	
Before Demonstration (1972)	2,500
During Demonstration (Spring 1973)	6,500
During Demonstration (Fall 1973)	13,000
During Demonstration (Spring 1974, affected by energy crisis)	17,000
After Demonstration (Spring 1975)	17,000
DISTRIBUTION OF RIDERSHIP (1973)	
Morning 7:30 - 9:30	35%
Midday 9:30 - 3:30	36%
Afternoon 3:30 - 6:00	29%
TRAVEL TIME AND ACCESSIBILITY	
Average Vehicle Headway	
On Campus	
Before Demonstration (1972)	15 min.
During Demonstration (Spring 1973)	20 min. peak, 30 min. off-peak
During Demonstration (Fall 1973)	5 min. peak 10 min. off-peak
Off Campus	
Before Demonstration (1972)	No Service
During Demonstration (Spring 1973)	30 min. peak 60 min. off-peak
During Demonstration (Fall 1973)	10 min. peak 20 min. off-peak
Average In Vehicle Trip Length	2.75 miles (approx.)
Percent of Population of Town of Amherst Living within 1/4 mile of Bus Stop	65%
Average Operating Speed (includes stops)	12 mph
FARE STRUCTURE	
Free Fare Service	

TABLE J-1. SELECTED RESULTS: FREE FARE DEMONSTRATION PROJECT, UNIVERSITY OF MASSACHUSETTS, AMHERST (CONT'D)

USER CHARACTERISTICS (Fall 1973)

Occupation	Percent of Ridership	Income	Percent Without Access to Auto
Undergraduate students	61%	2,000-5,000	24%
Graduate students	24	3,000-8,000	8
Faculty	3	15,000-25,000	3
Professional Staff	2	12,000-25,000	4
Classified Staff	6	5,000-12,000	6
Other	4	NA	NA

ALTERNATE MODE OF TRAVEL

(In answer to the question "If there were no bus service, how would you normally commute?" October 1973, on-board survey.)

Auto Driver	35%
Hitchhike	33
Other Auto Passenger	4
Walk	21
Bicycle	5
Other	2

not expensive when compared with rates routinely charged at many other campuses and urban areas.

The shift from automobile must be considered significant, in that forty five percent of the bus passengers would otherwise have traveled by automobile.

References

1. University of Massachusetts, Amherst, Research and Project Description for Transportation Program, Goss, William P. and Shuldiner, Paul W., Dec., 1972.

2. University of Massachusetts, Amherst, Bus Research and Demonstration Grant, Preliminary Conclusions, Goss, William P. and Shuldiner, Paul W., March 9, 1974. 1974.

APPENDIX K

SANTA MONICA FREEWAY: RESERVED WITH-FLOW BUS-AND-CARPOOL LANE

Project Overview

A bus priority operation on a portion of the Santa Monica Freeway (I-10) connecting Santa Monica with the Los Angeles central business district is scheduled to begin in mid June, 1975(Figure K-1). Bus service will be operated by both the Southern California Rapid Transit District and the Santa Monica Municipal Bus Lines. The California Department of Transportation will provide engineering support, and the California Highway Patrol will enforce the metered ramp and preferential lane restrictions. The total length of the lanes to be assigned to priority usage is approximately 12 miles.

The project includes these elements:

- reservation of concurrent flow freeway lanes for exclusive use of buses and other high occupancy vehicles such as carpools,
- metering of entrance ramps,
- new bus routes, and
- new park-and-ride lots.

The demonstration will last for one year after which local funds will be used to continue it if it is judged successful.

The expected cost breakdown for the one year period is:

CAPITAL:	
Calif. Dept. of Trans.	100,000
OPERATING:	
Local and County	2,200,000
UMTA	807,800
FHWA	127,650
Interagency Transfer Funds	107,000

Objectives

The project is designed to achieve several objectives of the Service and Methods Demonstration program. Besides reducing travel time for present transit and carpool travelers, the project will improve the schedule reliability of the bus service and likely increase transit productivity by the efficient utilization of buses operating in uncongested lanes with higher occupancies. the

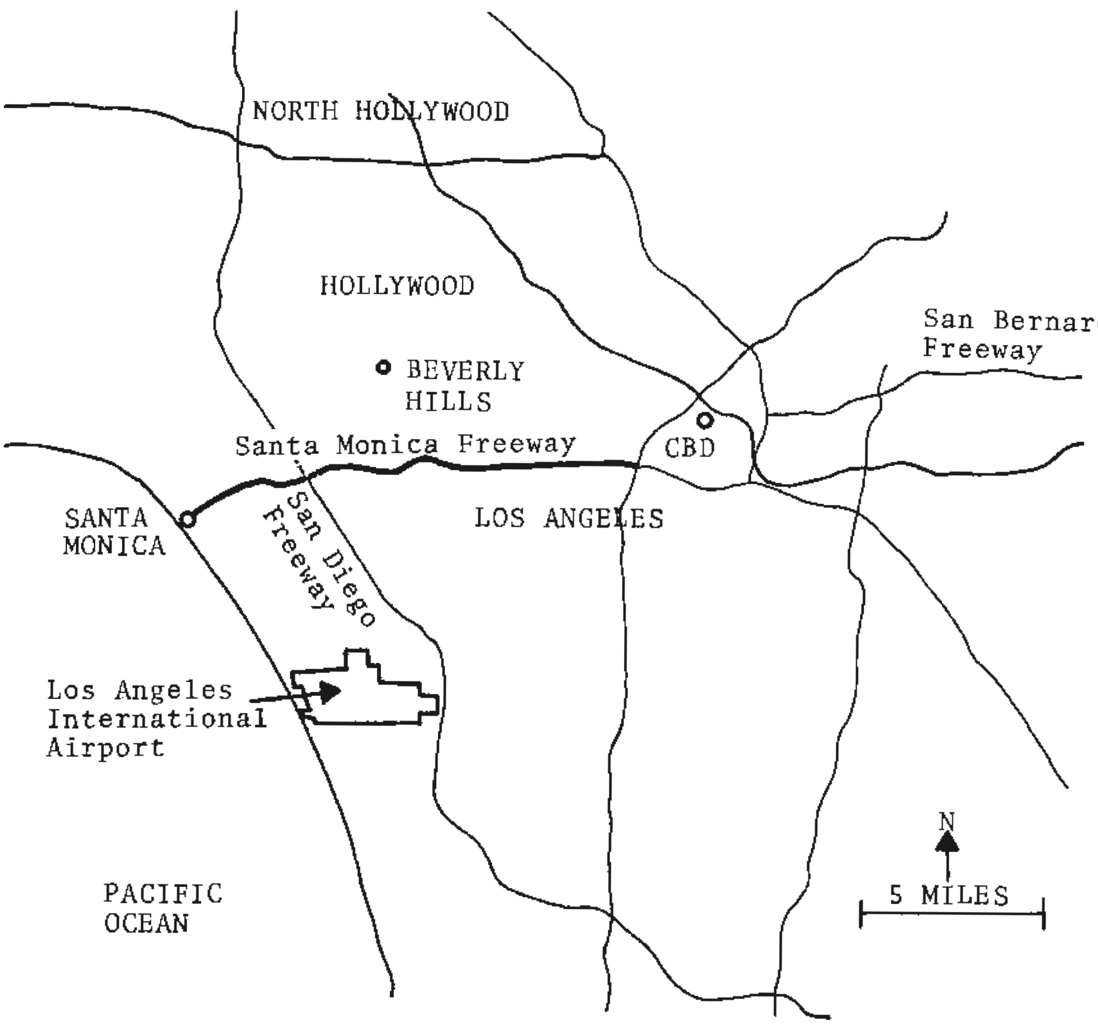

Figure K-1. Location Map, Santa Monica Freeway, Los Angeles, California coverage of the area will also be increased by adding approximately 75 bus trips during each peak period.

An important local objective is the improvement of air quality in the neighborhood of the freeway and throughout the Los Angeles basin through the reduction of vehicle miles of auto travel. It is part of a general strategy of VMT reduction in the Greater Los Angeles area.

Project Description

This project involves the reservation of the left hand lanes in both directions on the Santa Monica Freeway (I-10) in West-Central Los Angeles and Santa Monica for the exclusive use by buses and high occupancy vehicles twenty-four hours per day. This demonstration will be the first time that freeway lanes have been reserved without barriers between adjacent lanes for use by concurrent flow bus and carpool vehicles. Access and egress to and from the reserved lanes will be accomplished by weaving across the unreserved lanes to the normal entrance and exit ramps. At the western end of the freeway, buses will enter on a metered ramp and leave by weaving from the reserved lane through general traffic to the exit ramp. At the CBD end an exclusive bus entry ramp may be provided.

In addition to the median lane reservation, a number of entrance ramps in both directions will be metered in order to limit freeway congestion. Some of the westbound entry ramps to the freeway are presently metered to control traffic flow. The result has been that westbound traffic in peak hours moves at 35–40 mph as contrasted to a prevailing 25 mph speed in the unmetered eastbound lanes. During the project, ramp metering will be extended to the eastbound lanes of the highway, with priority entrance in both directions being given to buses and carpools. The extension of ramp metering is important to the success of the project, in order to facilitate the weaving of buses and carpools into and out of the reserved lanes.

The Southern California Rapid Transit District (SCRTD) and the Santa Monica Municipal Bus Lanes (SMMBL) will operate a total of eleven new bus routes between the westside of Los Angeles and the Los Angeles central business district (CBD). Three of these routes will be from newly established park-and-ride lots. The three park-and-ride lots will be established on the westside of Los Angeles and in Santa Monica to accommodate 600 to 1300 automobiles. The other eight routes will operate as suburban local buses picking up passengers along the major arterial streets in the westside area and then operate express on the freeway. These lines will be supplemented by existing local lines in the area, which will act as feeders, plus four new feeder and crosstown services. Approximately 75 bus trips will be operated during each peak period.

The buses will use the preferential lanes for only a portion of their trip. In several cases, the mileage on the preferential lane will be less than half of the total one way route milage. Most of the buses follow a 2.8 mile surface distribution route in the Los Angeles CBD after departing from the reserved lane. Peak hour headways on individual routes will vary between 10 and 20 minutes, even though buses will be entering the reserved lane in the evening peak period at rates up to one per minute. Between 20 and 30 of the buses traveling in the minor flow direction will provide passenger service during peak hours. A total of 24 mid-day trips in each direction on all routes is also planned.

Travel time savings are estimated at about 10 minutes for the two bus routes which presently use the freeway, and up to 45 minutes for buses which presently use parallel arterials. In the case of the longer routes, a 20 minute time savings would reduce commuting time by about 25 percent. Freeway auto commuters switching to bus are not expected to enjoy as significant time savings over present travel times as bus passengers.

The West Los Angeles corridor which the freeway serves is demographically diverse, but it is anticipated that most users of the bus service will be on the higher side of the income scale. Westwood, Beverly Hills, West Los Angeles, Marina Del Rey, Brentwood, Pacific Palisades, and Santa Monica itself are above average in income level and should contribute significant traffic to the freeway. The bus routes serving the Venice area will attract lower income travelers. The overall income composition of bus riders is expected to be above the average of the metropolitan area. Both the income profiles of travelers and their previous commuting mode will be measured in the evaluation of the project.

The California Highway Patrol (CHP) will have the responsibility for enforcing the preferential status of the lane. On the San Bernardino Freeway, the CHP were able to keep the rate of illegal auto use of an exclusive lane very low. This may not be possible on the Santa Monica freeway.

The plan is part of a general "short-range program" for high occupancy vehicles under consideration for several freeways in the metropolitan ara. At the present time, the request for at least $2 million of operating funds from the County for the Santa Monica Freeway project is under consideration.

References

Southern California Rapid Transit District, Santa Monica Freeway Preferential Lane Treatment, March, 1975.

APPENDIX L

DOUBLE DECK BUS DEMONSTRATION PROJECT

Project Overview

The Double Deck Bus Project involves the purchase and operation of double deck buses in New York City and Los Angeles. The purpose of this project is to examine, through daily revenue service, the operational feasibility and public acceptance of the doble deck bus. The project duration will be approximately three years, two of which cover revenue service.

Participating in this project under two separate UMTA grants are the New York Metropolitan Transportation Authority (with operations to be conducted by the New York City Transit Authority and its subsidiary, the Manhattan and Bronx Surface Transit Operating Authority) and the Southern California Rapid Transit District. The New York Metropolitan Transit Authority (MTA) will purchase eight Mancunian vehicles from British Leyland (the UMTA grant covers the purchase of four of these), and will operate them on heavily patronized arterial lines in Manhattan. The Southern California Rapid Transit District (SCRTD) will acquire two German Neoplan buses (manufactured by Gottlob Auwater KG) and operate them on routes characterized by relatively light traffic conditions and high average speeds. Relevant information on project funding is presented below. The grants essentially cover purchase costs of the vehicles and spare parts but do not include operating expenses or costs associated with data collection.

Double Deck Bus Project Funding

	New York City	Los Angeles
UMTA Project No.	NY-06-004	CA-06-0069
Grant Receipient	New York Metropolitan Transit Authority (MTA)	So. California Rapid Transit District (RTD)
Federal Share	$415,984	$334,375

Both grants were approved late in fiscal year 1974. Delivery of the eight British Leyland vehicles in New York is scheduled for December, 1975. Allowing one month for acceptance testing, revenue service will begin in January 1976. The SCRTD received its first German Neoplan vehicle in December 1974. En route from the East Cost to Los Angeles, this vehicle was exhibited in various cities accross the country. Initiation of revenue service on the El Monte Busway began in April 1975. The second Neoplan bus is scheduled for delivery in June and will begin operating in revenue service about one month later.

Objectives

The Double Deck Bus Project has as its objective the increased productivity of transit vehicles. Double deck buses have considerably greater passenger capacity than conventional buses (70–85 vs. 45–50 seats). They require only one driver, use approximately the same amount of street space, and have less than proportional increases in vehicle operating expenses. When deployed on routes where a high capacity is required, these vehicles improve the productivity of the transit system by increasing the ratio of passengers to vehicle miles, resulting in lower operating cost per passenger trip. Still another way in which this project may serve the SMD objective of increasing vehicle productivity is by stimulating increased transit ridership. It is possible that the upper level of the bus may attract sightseers who want a better view of the surroundings.

While double deck buses have been used extensively in Europe there still remain some significant issues to be investigated and evaluated, such as their public acceptance in this country, safety aspects related to use of the stairs and upper deck, passenger flow characteristics, and route restrictions caused by vehicle height.

Project Description

In New York, the New York City Transit Authority (NYCTA) and its subsidiary, the Manhattan and Bronx Surface Transit Authority (MABSTA) will operate the eight double deck vehicles under agreement with MTA. Service will be provided on two downtown Manhattan routes which are characterized by congested traffic conditions, heavy passenger loadings, frequent stops , and frequent turnover. These routes traverse a variaty of neighborhoods in Manhattan (Figure L-1). The buses will generally be operated in regular revenue service, replacing the convential transit bus normally assigned to that run.

In Los Angeles, the SCRTD operates the two Neoplan vehicles on the El Monte Busway between El Monte and downtown Los Angeles. This is a route characterized by relatively uncongested traffic conditions, high average speeds, and infrequent passenger turnover. If operationally feasible, the vehicles will subsequently be used on different routes so as to test the vehicle configuration under varying traffic conditions and examine the adaptability of the vehicle to different types of service (Figure L-2).

Table L-1 contains information about the routes in New York City and Los Angeles where double deck service is being implemented. It is anticipated that the introduction of these buses will require only minor changes in routing and transit company facilities.

Figure L-3 and L-4 show the two vehicle types and the table below presents information on vehicle capacity and dimensions. The British Leyland Mancunian vehicle is best suited for heavy transit operations with frequent stops at relatively low operating speeds, whereas the Gottlob – Auwater Neoplan vehicle is best suited for longer haul high speed service. The cost of the vehicles is $83,500 and $125,000, respectively, including duty and shipping charges.

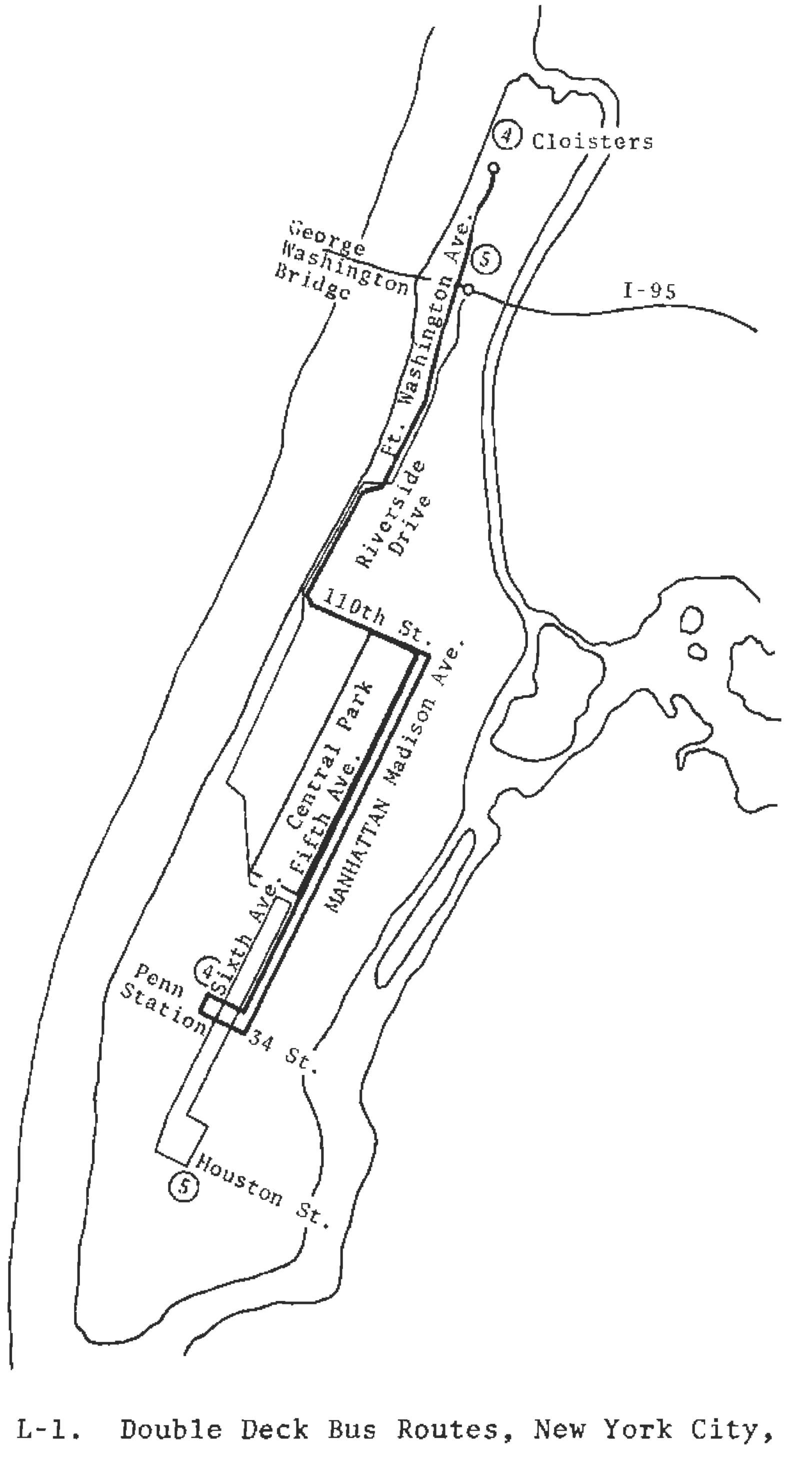

Figure L-1. Double Deck Bus Routes, New York City, New York

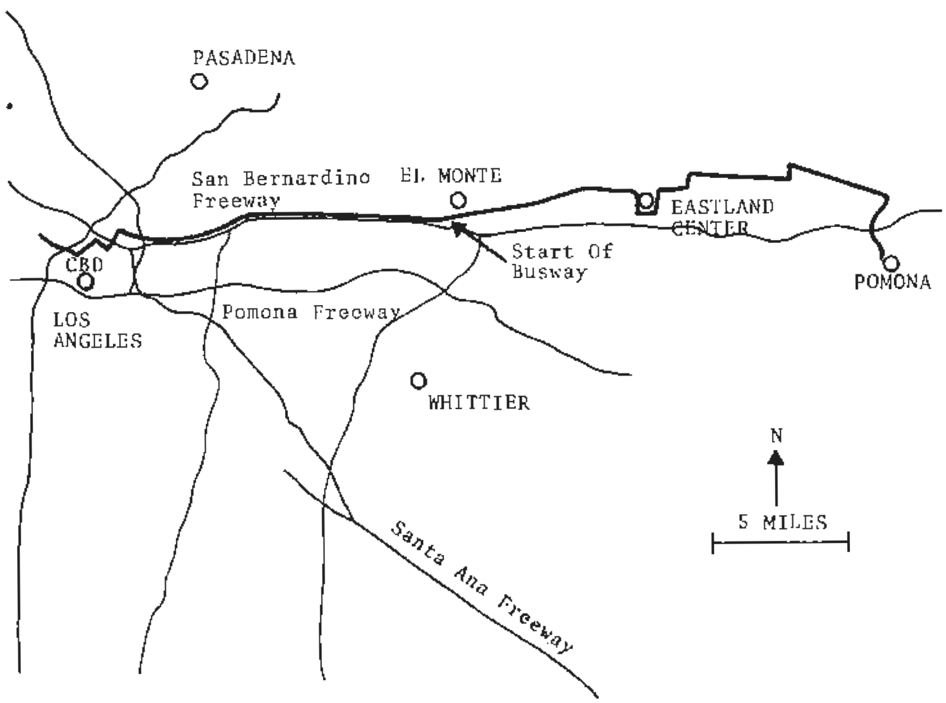

Figure L-2. Double Deck Bus Routes
Los Angeles, California

TABLE L-1. PROPOSED ROUTES, DOUBLE DECK BUS DEMONSTRATION PROJECT, NEW YORK CITY AND LOS ANGELES

	NEW YORK CITY		LOS ANGELES
	Route 4	Route 5	Line 402
Route Location	Cloisters - Riverside Drive - Fifth Ave. - Penn Station	George Washington Bridge - Riverside Drive - Fifth Ave. - Houston Street	(a) Pomona - El Monte Busway - downtown L.A. - Wilshire Boulevard at Union Avenue (b) Eastland Center - El Monte Busway - downtown L.A. - Wilshire Boulevard at Union Avenue
Route Length (one-way)	10.5 miles	10.3 miles	(a) 40 miles (11.5 Busway) (b) 30 miles (11.5 Busway)
Annual Passengers	9.8 million	7.4 million	1.2 million
Annual Vehicle Miles	1.4 million	1.3 million	0.6 million
Peak Headway	3 minutes	2 minutes	(a) 60 minutes (b) 6-8 minutes
Number of Buses Serving Routes (weekday mornings)	50	47	19

Figure L-3. Mancunian Double Deck Buses to be used by the New York MTA

Figure L-4. Neoplan Double Deck Buses to be used by the Southern California Rapid Transit District

Selected Double Deck Vehicle Specifications

	Mancunian (NY)	Neoplan (LA)
Passenger Capacity		
Seated - upper level	43	57
Seated - lower level	25	27
Seated - total	68	84
Standees (lower level only)	19	
Length	33.3 ft.	39.3 ft.
Width	8.3 ft.	8.5 ft.
Height	14.5 ft.	14.0 ft.
Wheelbase	18.5 ft.	22.5 ft.
Cost	$83,500	$125,000
Cost/seat	$1,228	$1,488

Note: Current cost of typical U.S. 47–53 seat buses is approximately $1,000 – $1,200 per seat.

Project History and Status

Rising transit labor costs, peak period crowding of riders, and concern about the environment and scarce fuel resources have spurred interest in high capacity buses such as the double deck bus and the articulated single deck bus. Although foreign cities have had extensive experience with double deck buses, there are many questions concerning the feasibility of such vehicles in a U.S. urban application. Accordingly, in the latter part of FY 1974 UMTA decided to sponsor this project by making demonstration grants to the MTA and SCRTD to purchase and operate two different types of double deck vehicles.

The Double Deck Bus Project is divided into two distinct phases: acquisition of the vehicles (approximately one year) and revenue service operation (two years). The vehicle acquisition phase consists of the preparation of bid specification, manufacture, and delivery of the vehicles, acceptance testing, pilot runs, and driver/mechanic training. A comprehensive evaluation will be conducted concurrent with the operational phase of the project.

The vehicles for the MTA are scheduled to arrive in December, 1975. The first SCRTD vehicle entered revenue service in April 1975. The second vehicle arrived in Los Angeles in June.

Evaluation

The evaluation will provide descriptive information about the project and evaluate the feasiblity of double deck vehicles for U.S. operation.

The descriptive portion of the evaluation effort will involve collecting and reporting information about the demonstration project in each city. Topics to be addressed include vehicle specifications, vehicle deployment and utilization, vehicle capital and operating costs, equipment reliability, vehicle operating characteristics, vehicle environmental impacts, and driver and mechanic training. These "for the record" items will provide background information against which to interpret evaluation results and provide other interested localities with the results of two different applications of double deck buses.

Measures of double deck feasibility to be considered include operational feasibility, usage levels, productivity, safety, public acceptance, and suitability for elderly and handicapped passengers. Particular features of the vehicle to be evaluated are the existence of an unattended second level with its associated additional capacity, more stringent vertical clearance problems, the internal stairway which can be used while the vehicle is in motion, greater crime and vandalism potential, and novelty appeal. The emphasis will be on the applicability of the double deck design for U.S. operation, rather than the specific advantages and disadvantages of the two versions of the double deck vehicle.

References

U.S. Dept. of Transportation, Transportation Systems Center, Double Deck Bus Project Evaluation Plan, Working Paper, WP-230C, 3–44. Oct. 24, 1974.

APPENDIX M

NAUGATUCK TRANSIT SERVICE FOR HANDICAPPED AND ELDERLY

Project Overview

A multifaceted experimental demonstration with special emphasis on the handicapped and elderly has been operational in the Lower Naugatuck Valley of Connecticut since January, 1973. The system has included limited fixed route service, flexible route demand responsive service over a wider area, and contract bus service for social service agencies and other groups in the Valley. An automated fare collection system uses credit cards and monthly billings to eliminate the need for cash payment. Fare subsidization of agency sponsored handicapped and elderly citizens is facilitated by a computerized system which bills sponsoring agencies according to use of the service by their clients during the previous billing period.

The initial local contribution to the project consisted of $10,000 from each of the four municipalities in the service area: Ansonia, Derby, Seymour, and Shelton. The total cost breakdown for the project CT-06–0003 is:

July 71 - June 74	*Cost*	*%*
U.S. Dept. of Transportation (UMTA)	$625,000	90
State Dept. of Transportation (Conn.)	27,750	4
Local Municipalities (10,000 each)	40,000	6
Total Grants	$692,750	100
June 74 - June 77		
Amended Cost (UMTA)	$494,500	100
Total	$1,187,250	

Objectives

The project is directly relevant to the Service and Methods program objective of improving transit service for the handicapped and elderly. It also serves to increase the coverage of transit service, in terms of both geographical area and the population group using the system.

An additional local objective is to provide public transit service which can effectively meet the transportation needs of health and social service agencies.

Project Description

The Valley Transit District currently provides two types of service:[1]

1) Demand responsive service with subscription and call in elements, and

2) Contract service for both persons and goods being moved by social service agencies and other groups.

VTD offers two varieties of demand service. The subscription service provides the rider with door-to-door service on a regular basis (ranging from daily to weekly service) without the necessity of telephoning VTD for each trip. The service provides pick up at prescheduled times and may or may not be tied to prescheduled destinations.

The call in service provides the rider with demand responsive door-to-door service with a two to three hour delay. The call in service is staffed by two dispatchers who handle calls from the riders, schedule the pick ups, and communicate with the drivers on a two way radio. Buses carrying subscription riders are diverted to pick up riders receiving call-in service. Thus, the demand service is flexible route many to many service. Demand services are available from 6:00 AM to 6:00 PM, Monday through Friday.

Social agencies arrange with the VTD for contract service. The VTD provides the agencies with charter bus service on a regular prescheduled basis and at a pre-arranged price. Other groups may obtain contract service during evenings and weekends. Evening and weekend service may be arranged as late as one day in advance depending upon the competition among the groups for the use of this service. Contract service is in essence a many to one type of operation.

With its various arrangements, the VTD system offers its users the following services and benefits:

- Transportation to all destinations including special provisions for the handicapped.
- Door-to-door transport of persons, groups, and meals.
- Access to employment and educational opportunities.
- Outpatient care rather than in hospital care thereby reducing hospital, local, and patient costs. Access to training and therapy.
- Social contacts to a transit dependent group.
- Work trip service for primarily non-captive riders.

The original service area for the many to many trip service was relatively large (59 square miles), with a low density of eligible users. The entire area population is 73,700 of which 9.2

[1]The VTD offered fixed route service in Phase I.

percent (about 7,00 persons) is elderly and handicapped. In 1973 the average density of V-card holders (which includes persons which were not elderly or handicapped) was 34 per square mile.

The equipment for the entire project consists of six medium sized buses (21 passenger capacity) and three vans (13 passenger capacity). Each bus is equipped with a special lowered front step to assist elderly or slightly handicapped persons in boarding and leaving the bus. One vehicle has a hydraulic lift to accommodate wheelchair riders. Each of the buses is equipped with special FAIRTRAN fare boxes that are used in conjunction with the billing system.

One of the unique features of the Valley service is the automated billing system known as FAIRTRAN. Every registrant receives a V-card which is inserted into the special fare boxes on boarding and alighting from the bus. This system records every use of a V-card and "remembers" the origin and destination of each trip during the billing period, the occupancy of the vehicle during the trip, the hour at which the trip occurred, and the length of time the passenger was on the vehicle.This data is used to determine the charge for each trip. The basic fare is 10.5 cents per vehicle minute, but is adjusted to account for vehicle occupancy, time of day, and the elderly and/or handicapped status of the user, as well as other factors. FAIRTRAN recognizes the sponsoring agency, if any, for each rider and bills the agency directly. This procedure for payment has been labelled "fare share", or the third party payment plan.

Since information about the traveler, such as age and income is collected when the V-card is issued, it is possible to relate trip patterns to the socio-economic characteristics of travelers. This data is useful for analytical purposes.

Figure M-1 is an illustration of a typical customer's bill and a portion of the log for a typical day's operation.

An important element in the viability of the entire project has been the participation of the U.S. Department of Health, Education, and Welfare through its Health Transportation Project (HTP). THE $289,500 HEW funding to social agencies in the Valley has enabled them to subsidize the transportation cost of their clients. HEW subsidized the agencies' cost for the demand-responsive service at 75 percent initially, but lowered it to 50 percent in 1974. For the contract bus service, the agencies and other groups are billed by VTD at the rate of $11 per hour. HEW in turn reimburses the agencies $5 a month for each client that makes use of the contract service.

History and Status

Limited intra-Valley public transportation was available to the residents of the Naugatuck Valley District before the Valley Transit District service was initiated. Private bus transportation is provided by two companies: The Connecticut Company and the Valley Transportation Co. The Valley also has a taxi service operating primarily between the business districts of Ansonia, Derby and Shelton. However, the rates are high, and the company does not serve any of the outlying areas. Neither the taxi service nor the bus companies provide specific service to health and social agencies.

Initiation of the Valley Transit Project dates back approximately seven years when several agencies under the United Fund of the Lower Naugatuck Valley submitted a proposal for the funding of a transport program for the disabled and disadvantaged. In 1971 UMTA agreed to fund Valley Transit District who contracted with Rensselaer Research Corporation for program development.

Valley Transit District

To

EDWARDS LOGEN
APARTMENT 45
HANOVER LAKE GARDENS
DERBY CONNECTICUT 08923

Customer ID: 10005

$9.71
Pay this amount

If you have any questions about your bill, please call 735 6824

For Rent-a-Bus and Door-to-Door service, please call 735 6408.

Thank you

Detach here — To insure proper credit, please return above portion with your remittance — Detach here

Date	Start Time	Origin	Destination	Total Cost	Cost to Customer
DOOR-TO-DOOR TRIPS (TYPE C)					
05/30	10:45AM	G2	B2	2.62	1.31
05/30	11:26AM	D3	G2	1.59	.80
05/30	12:01AM	C3	J0	7.41	7.41
1 SCHED ROUTE TRIPS				.38	.19

Previous Balance		Scheduled Route		Rent-a-bus		Door-to-Door		Deposits		Pay this amount
.00	+	.19	+	.00	+	9.52	-	.00	=	9.71

Valley Transit District

DAILY EDIT MESSAGES FOR BUS 02 ON 740827 PAGE

ID	ZONES		MODES		TIMES		ROP		OCC	GP	CHARGE	FS	MESSAGE
10023	G2	F2	3	3	0745	0802	02	02	02	1	$.49		KEPT
10159	F2	F3	3	3	0912	0914	02	02	03	1	$.33		KEPT
10187	F2	E3	3	3	0904	0918	02	02	02	1	$.40	1	KEPT
10346	H4	G2	3	3	0829	0837	01	02	03	1	$1.06	1	KEPT
11074	G2	F1	3	3	0729	0750	02	02	03	1	$.48	1	KEPT
11215	F5	F2	3	3	1520	1541	01	02	02	1	$.50	1	KEPT
11254	F2	F3	3	3	0903	0915	02	04	02	1	$.36		KEPT
11298	F2	F2	3	3	1002	1010	01	01	01	1	$.66		KEPT
12106	F3	03	3	3	1503	1507	01	01	01	1	$.88		KEPT
12301	F2	F3	3	3	1025	1032	01	01	01	1	$.99		KEPT
12301	F3	F2	3	3	1314	1324	02	02	02	1	$.61		KEPT
12305	E5	F2	3	3	1422	1429	01	01	01	1	$.77		KEPT

Figure M-1. Typical Customer Bill and a Portion of a Daily Log, Valley Transit District, Lower Naugatuck Valley, Connecticut

The project is characterized by three phases: Phase 1 (December, 1972-March 23, 1973), Phase 2 (March 23, 1973-July, 1974) and Phase 3 (July, 1974-June, 1974).

Phase 1 – December, 1972-March 23, 1973

Initiation of service slipped from June 1972 to December 1972 due to late delivery of the modified vehicles. Service was inaugurated in December 1972 upon the arrival of the first four 21 passenger buses (equipped with a special front step). The inaugural service consisted of a free Christmas shopping shuttle under the sponsorship of the Valley Chamber of Commerce. This service carried about 2500 riders. Starting in January, VTD operated a fixed route service thereby filling a gap in service created by a strike of the two private bus companies which extended through the duration of Phase 1. This service was made available to all Valley citizens. Since it followed the pre-existing routes, this service was utilized mainly by the general public who had formerly been riders on those routes before the transit strike. Throughout its short existence (11 weeks) approximately 13,000 passengers used the fixed route service. January 9, 1973 was the initiation date for the contract services. The average weekly ridership during Phase 1 on the contract services was approximately 1800 riders.

It became apparent to VTD that it was infeasible to offer both fixed route and contract services with its limited vehicle fleet size (which had expanded to 6 by the end of Phase 1). The fixed route service was subsequently dropped by VTD at the end of Phase 1.

Although FAIRTRAN was not yet in operation, registration for FAIRTRAN service and the issuance of V-cards began during Phase 1. Registration for the FAIRTRAN service was open to all Valley citizens.

Phase 2 – March 23, 1973-July, 1974

Phase 2 marked the beginning of the FAIRTRAN operation and the flexible route many-to-many demand services. It became evident in Phase 2 that VTD could not provide call in service to the entire four town region on a daily basis. The effort to serve the large area with so few vehicles led to long wait times, on the average of 2–3 hours for the call in service. Consequently, the call in door-to-door service policy was altered by serving only one of the five subareas daily. Figure M-2 shows a map of the Valley District with the five service subareas. The residents in each subarea, however, could travel throughout the Valley on the days that they used the service. The subscription and the contract services and emergency medical trips were not limited by the subarea policy.

By July 1973 approximately 1800 V-cards had been issued. Due to the rapid growth in demand for the demand services, the VTD decided to limit further issued V-cards to only the handicapped and elderly citizens.

By mid February 1974, the demand services were saturated. Approximately 3000 V-cards had been issued and weekly ridership for the demand services had reached 930. At this point, VTD leased two additional vans for use in the prescheduled contract service which had grown to over 2,000 weekly trips. VTD also decided to discontinue further issuance of V-cards.

One of the reasons for the quick saturation of the demand service capacity was the extensive use of the buses for contract services. Contract service consumed 50 percent of the total

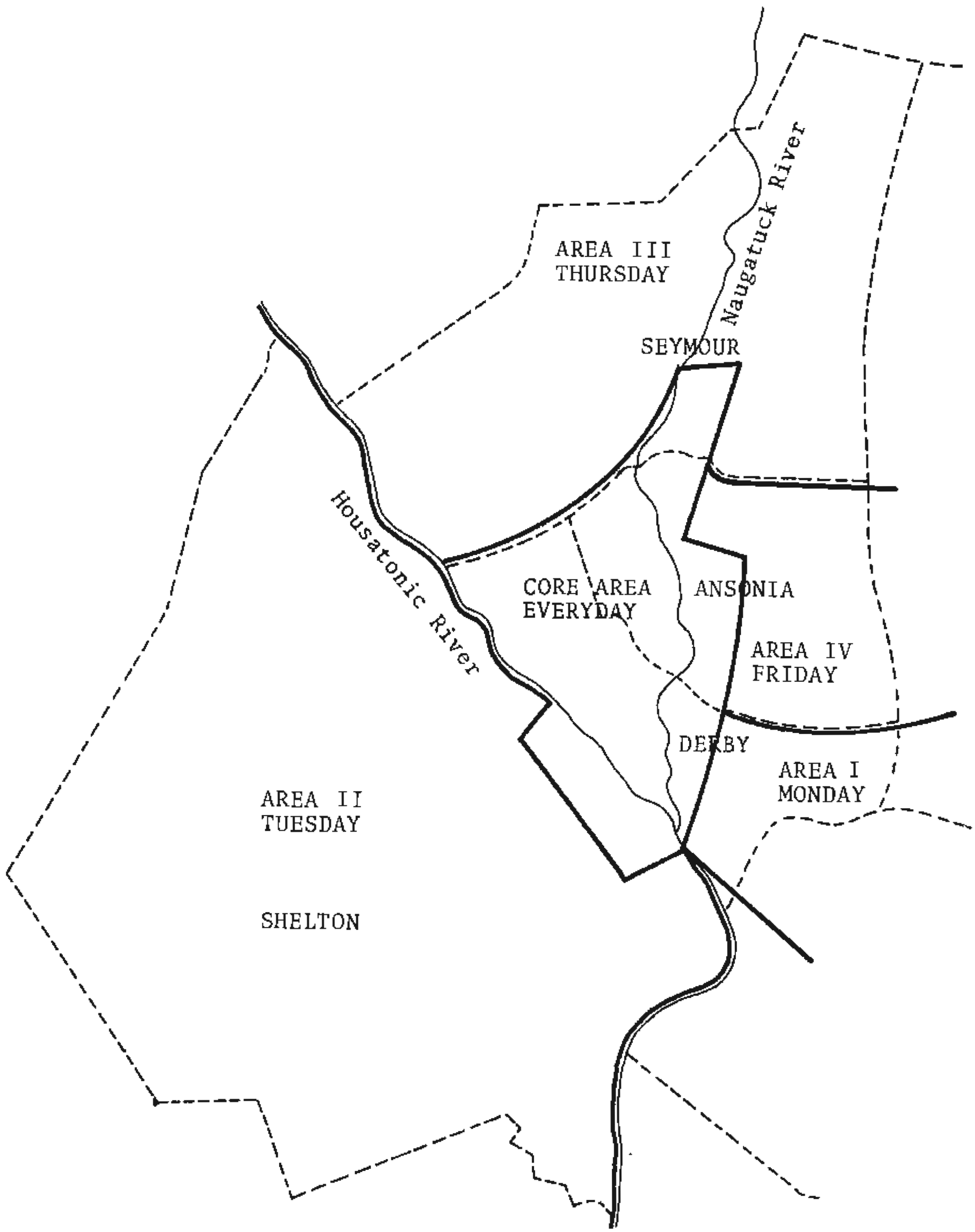

Figure M-2. Service Areas, Valley Transit District, Lower Naugatuck Valley, Connecticut vehicle hours and generated two thirds of the system revenue by March 1974. Equipment failures also limited the overall capacity of the system.

Phase 3 – July, 1974-June, 1977

At the end of Phase 2, VTD received a 36 month continuation grant from UMTA. It also received approval from UMTA for a capital grant which will go towards the purchase of nine additional vehicles. Specifications for these vehicles are being based on the operating experience with the original fleet.

The objective of the demonstration extension is to develop VTD into a transit system for the general public while simultaneously improving the service provided to the handicapped and elderly population. The development of a fare collection system that will accept both credit cards (and perform associated monthly billings) and coin is intended to meet the requirements of a general public transit system. New fixed routes are intended to increase the use of VTD services by the general public. The computerization of the call in dispatch system is intended to reduce the lead time required on calls for service and increase the capacity of the dispatching operation.

Results

Table M-1 summarizes the major results of the Naugatuck demonstration. Weekly ridership exceeds 3,000 and productivity averages above 8 passengers per vehicle hour. Over 3,000 V-cards have been distributed to date, but there were applicants denied registration because of the limited system capacity. For the six month period ending in June 1974, 71 percent of the trips provided by VTD were prescheduled contract services and 29 percent were demand services. More than 75 percent of the demand trips were subscription trips. Figure M-3 shows weekly ridership figures from the demand services from July 1973 to March 1974. The weekly ridership shows a leveling off due to system saturation.

Trips to social service agencies and work are the two main trip purposes for users of this system. Together they account for nearly 80 percent of the total trips taken. The general public; that is, persons who are not elderly, handicapped, or mentally retarded, is the dominant user of the system, accounting for more than half of the trips made. The elderly account for only 25 percent of the trips taken, even though over two thirds of the registrants are elderly. Mentally retarded persons account for 17 percent of the trips, and handicapped for the remaining 4 percent.

The demonstration has been hampered by mechanical problems with the vehicle transmissions, brakes, and drive trains. Several major fires have occurred. The vehicle supplier has not remedied these problems and spare parts have been extremely difficult to obtain. These vehicle problems have forced VTD to substitute rental cars, on occasion, for out of service buses.

Evaluation and Conclusions

In this demonstration, there have been more demands for service than the system has been able to accommodate. Several adjustments were made during the demonstration to constrain demand and maintain an adequate level of service: first, by discontinuing fixed route service; second, by dividing the Valley into subareas which could use the call-in service one day a week; third, by restricting the issuance of V-cards to handicapped and elderly citizens; and fourth, by discontinuing further issuance of V-cards. The VTD also added vehicles during the demonstration in an attempt to keep up with demands for service. Due to the increasing demands and limited

TABLE M-1. SELECTED RESULTS: TRANSIT SERVICE FOR HANDICAPPED AND ELDERLY, LOWER NAUGATUCK VALLEY, CONNECTICUT

Category	
COSTS:	
Total Capital and System Development June 1973-June 1974	$585,000
Annual Operating Costs	$239,000
RIDERSHIP AVERAGES:	
March 1974	
Average Weekly Ridership	
a. Contract	2,270
b. Demand	
1. Subscription	700
2. Call-in	230
Total Average Weekly Ridership	3,200
Demand Density (Trip Demands/Sq.Mi./Hr.)	0.15
FARE STRUCTURE/REVENUE:	
March 1974	
Contract Round Trip Fare	Approx. $1.00
Demand Round Trip Fare	Approx. $1.00
Operating Ratio (Oper. Cost/Rev.)	1.5
PRODUCTIVITY:	
March 1974	
Passengers/Vehicle-hour	8.2
UNIT COSTS:	
March 1974	
Operating Cost/Passenger Trip	$1.31
Operating Cost/Vehicle-mile	$10.74
TRIP PURPOSE:	
March 1974	
Social Agency Services	35.8%
Work	32.8%
Retarded Workshop	20.7%
Personal Business	6.8%
Church	1.6%
Day Care	1.4%
Shopping	0.9%

TABLE M-1. SELECTED RESULTS: TRANSIT SERVICE FOR HANDICAPPED AND ELDERLY, LOWER NAUGATUCK VALLEY, CONNECTICUT (CONT'D)

Category	
USER CHARACTERISTICS:	
March 1974	
Elderly	25%
Handicapped	4%
Mentally Retarded	17%
General Public	54%

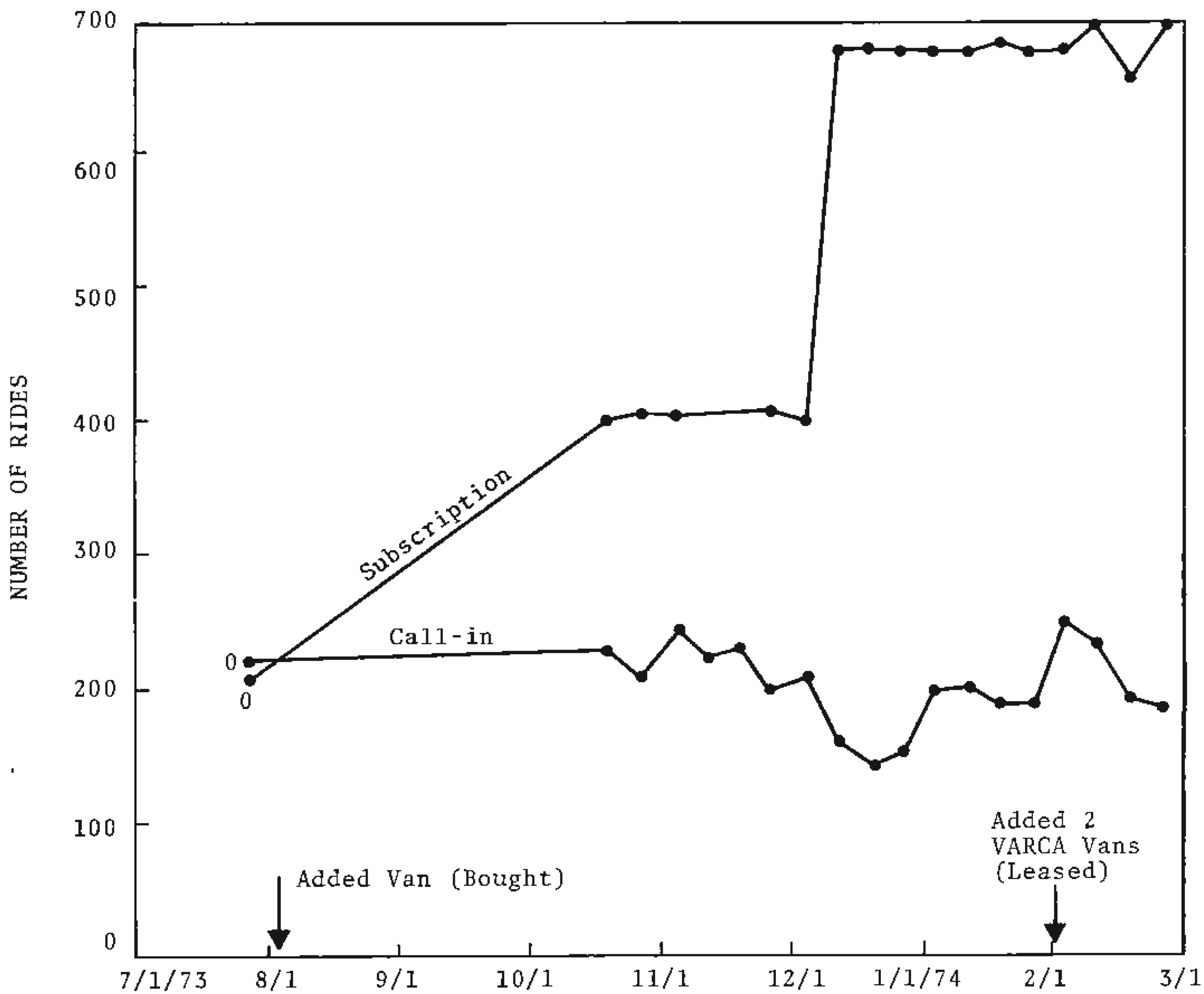

Figure M-3. Weekly Demand Ridership, Valley Transit District, Lower Naugatuck Valley, Connecticut, July 1973 - March 1974 number of vehicles, it was not necessary to mount a marketing campaign to increase the ridership base.

The ridership trends strongly suggest that there is latent demand so that additional vehicles would immediately increase total ridership. When additional vehicles are purchased, the credit card distribution could again be opened to the general public, allowing more effective service. Also, service could be expanded into evening hours and weekends. The contract services could be expanded to serve more than the 20–25 agencies presently served by VTD operations.

VTD's vehicle design modifications to accommodate the elderly and handicapped provide a high comfort level and have helped to set national standards for barrier free equipment.

The public reaction to the FAIRTRAN billing system has been mixed. There has been some confusion on the part of passengers regarding the mechanics of the farebox operation, and how billing for the ride is determined, especially when others on the bus are taken to their destinations first with a resultant route deviation. The Valley area has proved a good testing ground for the FAIRTRAN system and its innovations, and has demonstrated the applicability of a third party billing system.

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APPENDIX N

TRANSVAN, TRANSPORTATION FOR THE HANDICAPPED AND ELDERLY: CRANSTON, RHODE ISLAND

Project Overview

In June 1972, the City of Cranston, R.I. obtained an UMTA Demonstration Grant for a low cost, door-to-door transportation system for handicapped and elderly citizens. The Transvan system began service in April 1973.

The operation of the program is supported by the following: a steering committee of many city department heads to set policy and assure sensitivity and responsiveness; an advisory group from the commercial, professional and general public sectors; an executive director from the City Planning Department to develop and direct the services; a vigorous information program; and an ongoing evaluation of program operation and utilization designed to adjust and improve service.

The total cost to date and funding sources are shown below. A one year extension of the federal funding to December 1974 provided an additional $82,000 from UMTA (included in the table). Operating costs for the one year extension was shared on a 50 percent local and 50 percent federal basis. UMTA funding ceased December 21, 1974.

Funding through 1974

Source	Amount	Percentage
UMTA	$309,000	81%
Local	$73,000	19%
Total	$382,000	100%

Objectives

The Cranston, Rhode Island Transvan demonstration project encompassed the Service and Methods Demonstration Program objective of improving transit service for the elderly and handicapped. Transvan was designed to meet the travel needs of persons who by reasons of trip orientation or personal handicap cannot make effective use of existing public transit services. It met the stated objectives by providing daily door-to-door service within Cranston for all trip purposes as well as a subscription service on a more limited basis to major shopping centers and medical facilities outside Cranston.

A comprehensive experimental design was developed prior to the inception of the service in order to measure the effectiveness and benefits of the operation. The major features of the demonstration to be evaluated are: (1) the effectiveness of a door-to-door transportation system which feeds to major medical facilities, major suburban shopping centers, and a training and work center for the mentally retarded; and (2) the impact on the elderly and handicapped due to increased mobility.

Project Description

Transvan service is provided in the following manner:

- Weekday service for almost any purpose within City boundaries.
- Scheduled trips (twice weekly) to health services in most areas of nearby Providence.
- Scheduled, once a week health service trips to Kent County hospital areas in Warwick.
- Scheduled trips to the nearest (Warwick) enclosed shopping malls (Cranston has none).
- Scheduled group recreational trips on Saturdays.
- Scheduled trips to attend Sunday morning religious services.
- Special shuttle service from the Cranston Center for the Retarded to job training workshops.

The following regulations govern trip requests:

- Reservations should be made 2 days in advance for medical related trips.
- Ridership dependent on the lift vehicle should be arranged 2 days in advance.
- Other reservations must be called in before 3 PM on the day prior to the requested ride.
- Emergency trip requests will be given same day service if possible.

In order to qualify for Transvan service, a person must be a resident of Cranston and more than 62 years of age or physically handicapped. Prepaid passes are sold to qualified subscribers at the token cost of $1.25 per month or $3.00 per calendar quarter.

The Transvan fleet consists of two 19 passenger flxettes and one 1958 GM coach retrofit to accommodate wheel chairs. These vehicles serve the 28 square mile area of Cranston plus out of the area trips to Warwick and Providence. A map of the area served by Transvan is shown in Figure N-1. Approximately 12,000 handicapped and elderly citizens live within this area.

Daily service is provided from 9:00 AM to 5:00 PM Monday through Friday. Arrival of Transvan vehicles at a rider's residence is assured to within 15 minutes of the designated time. Vehicles will wait up to five minutes before departing from a rider's residence.

The Transvan vehicle operators and maintenance are provided by the Rhode Island Public Transit Authority under a contract arrangement.

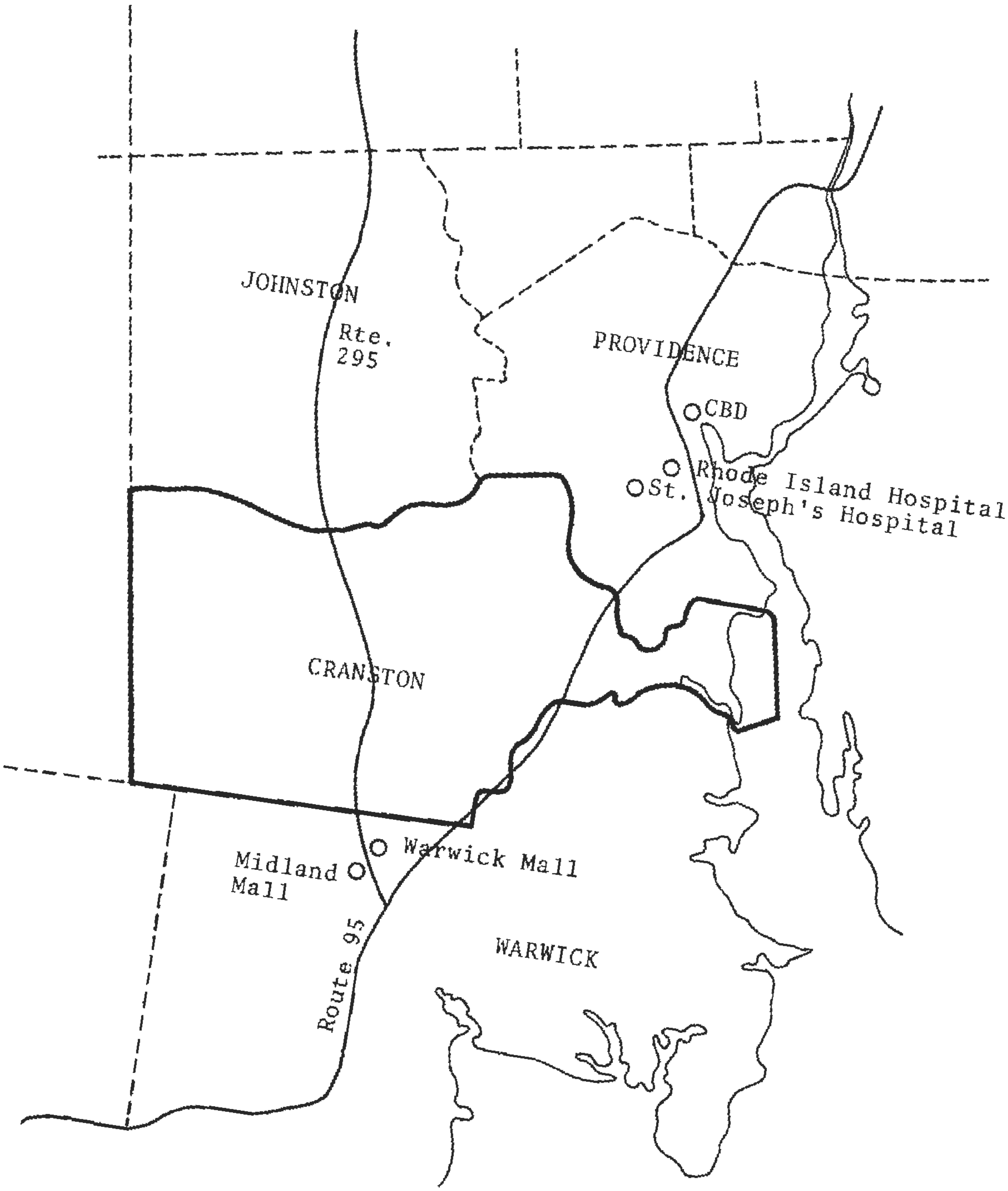

Figure N-1. TRANSVAN Service Area, Cranston, Rhode Island

Project History and Status

Intra-city public transportation in Cranston is not particularly good. The elderly are often unable to provide their own means of transportation and are increasingly left in isolation. In 1971, the city arranged for limited transportation for senior citizens living in housing for the elderly. In the desire to extend this transportation, Cranston applied for and obtained an UMTA grant to determine the feasibility of starting a low cost transportation system for elderly and handicapped.

The demonstration grant was approved for 18 months of operation beginning in June 1972 under UMTA funding with local resources used for planning and the operating staff. Actual service was initiated in April 1973 with three vehicles leased from the Rhode Island Public Transit Authority. The three vehicles purchased especially for Transvan were not in service until September 1973. A one year extension of federal funding, to December 1974, was subsequently requested and approved.

Subscriber registration began in September 1972. Up until that time no major communication or information programs had been initiated to advertise the Transvan System. An extensive public relation program was then launched by a professional firm and included brochures, mailgrams, a speaker's bureau, poster campaigns and the Transvaner newsletter. In addition, press releases were given to three weekly and two daily newspapers and service spots were run on several radio stations.

Results

Results to date are shown in Table N-1. Figure N-2 shows Transvan subscribership levels for successive quarters for the October 1972 – March 1974 period. The effectiveness of the marketing effort for the Transvan service is indicated by the steady increase in quarterly subscribership levels from December, 1972, to December, 1973; almost a twofold increase in a year. The decline in the March 1974 subscribership level is due to the system's saturation resulting from expanded service programs. Over the demonstration period about 850 different persons have become users of Transvan service.

The two 19 passenger Flxettes and the GM coach travelled over 70,000 miles and carried 40,000 riders during the 18 month period from September 1973 to March 1974.

The average monthly ridership has risen steadily. The cumulative ridership for 1974 is well over 2800 rides a month, effectively saturating the Transvan three bus system. Transvan has reached the point where there are more requests for rides than can be scheduled in an 8 hour day on the three vehicles.

Figure N-3 shows that the average riders per bus trip has climbed steadily during the period from June 1973 to March 1974 and that the cumulative average for 1974 is nearly one and a half times greater than the 1973 figures.

For the period March 1973 to April 1974, 62 percent of the riders were 62 years of age or over, 35 percent were retarded and 3 percent were physically handicapped. Surveys indicate that for the rides taken by the elderly, 40 percent are for personel affairs, 25 percent for health services, and only 20 percent for grocery shopping.

TABLE N-1. SELECTED RESULTS: TRANSVAN, TRANSPORTATION FOR THE HANDICAPPED AND ELDERLY, CRANSTON, RHODE ISLAND

Category	
COSTS:	
June 1972-Dec. 1973	
Planning and Implementation Costs	$63,024
Capital Costs	$43,285
Operating Costs	$120,877
Total Costs	$227,186
Jan. 1974-Dec. 1974	
Annual Operating Costs (Extended Services)	$130,000/Yr.
RIDERSHIP AVERAGES:	
April 1973-March 1974	
Average Total Daily Ridership	138
Average Peak Day Ridership	160
Trip Demands/Sq. Mi./Day	5
Average Vehicle Occupancy Rate	9
Subscription (as of March 1974)	500
FARE STRUCTURE:	
Regular Fare	$1.25/month or $3.00/calendar quarter
Monthly Revenue Passengers	2,800
Monthly Passenger Revenue	$500
Revenue/Passenger	$.18
Operating Ratio (Oper. Cost/Rev.)	15
PRODUCTIVITY:	
March 1974	
Passengers/Vehicle-hour	6.1
Average Riders/Bus Trip	9.25
UNIT COSTS:	
February 1973	
Operating Costs	
a. Dollars/Passenger Trip	$2.47
b. Dollars/Vehicle-hour	$13.30
Capital Costs	
a. Dollars/Passenger Trip	$0.13
b. Dollars/Vehicle-hour	$0.69

TABLE N-1. SELECTED RESULTS: TRANSVAN, TRANSPORTATION FOR THE HANDICAPPED AND ELDERLY, CRANSTON, RHODE ISLAND (CONT'D)

Category	
Promotional Costs	
a. Dollars/Passenger Trip	$0.12
b. Dollars/Vehicle hour	$0.64
Total Costs	
a. Dollars/Passenger Trip	$2.73
b. Dollars/Vehicle hour	$14.63
USER CHARACTERISTICS[1]:	
Over 62 Yrs. of Age	62%
Mentally Retarded	35
Physically Handicapped	3
	100%
TRIP PURPOSE:	
Retarded Center	35%
Personal Business	25
Health Services	15
Grocery Shopping	14
Recreation	7
Meals	4
	100%
FREQUENCY OF USE:	
Average Frequency of Use	1.7 Trips/Rider

[1]Approximately 7% of the eligible handicapped and elderly population in the Cranston area have used this service.

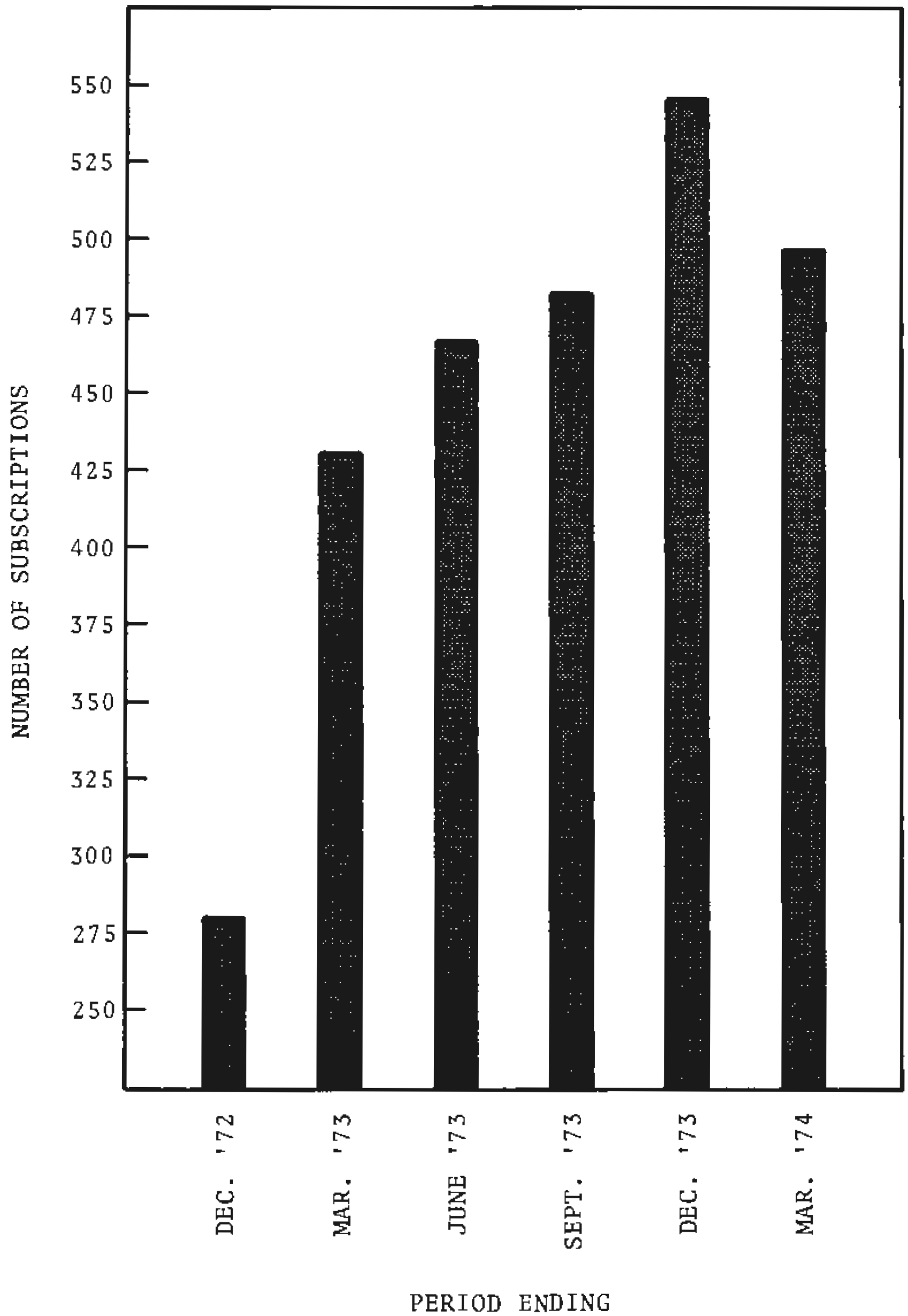

Figure N-2. TRANSVAN Subscriberships, Cranston, Rhode Island
October 1972 - March 1974

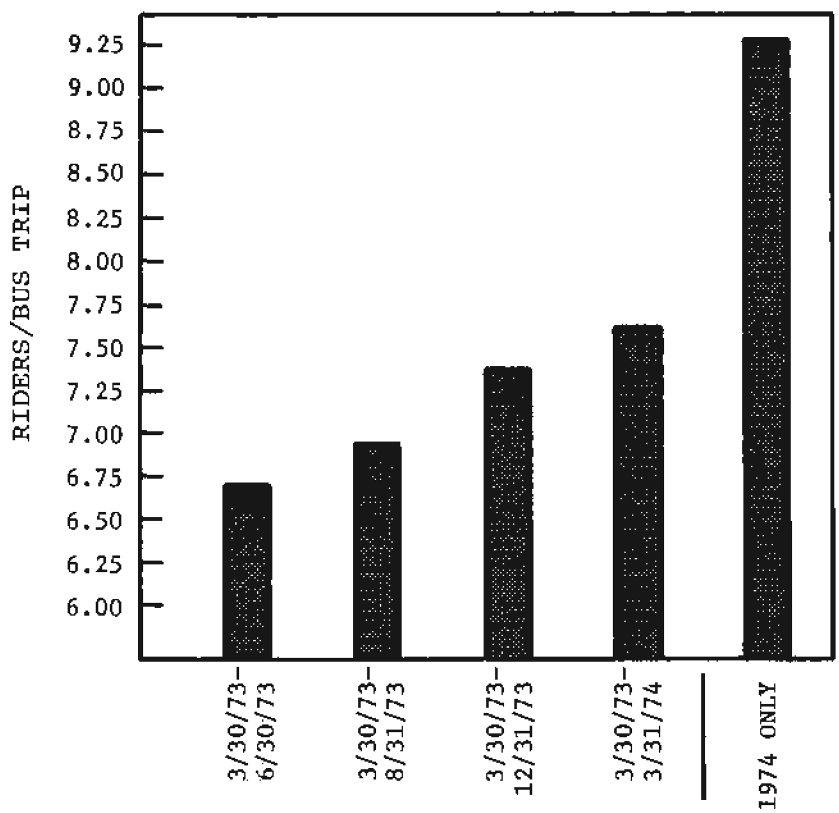

Figure N-3. Average Riders Per Bus Trip, TRANSVAN, Cranston, Rhode Island, April 1973 - March 1974

Transvan's operating costs are high ($2.47 per passenger trip) because it uses drivers from the Rhode Island Public Transit Authority (RIPTA), assigned by the union. Transvan pays a straight rate to RIPTA both for drivers and for vehicle maintenance. Productivity is low (6.1 passenger trips per vehicle hour) because of the little group riding and a low demand density due to being an elderly and handicapped only system. Additionally, Cranston is served by nine RIPTA fixed routes.

Evaluation and Conclusions

The benefits that accrued from the Transvan service were immediate. Attitudinal surveys showed that the citizenry who were physically unable to use other types of vehicles, who were not able to use private autos, who found taxis too expensive and who had no other transportation to essential services felt that the service has increased their economic power and expanded their educational and employment opportunities.

Some of the more interesting information obtained from the attitudinal surveys were the subscriber's reasons for riding. Pre-operational estimates envisioned shopping as one of the main components of travel demand. However it has turned out that, personal business and health service trips have been more frequent than shopping trips.

Reservation service (as opposed to fully demand responsive) has had two major advantages: it has reduced mileage costs and times by more efficient routing, thereby saving on vehicle operating costs and maintenance, and giving the rider some assurance of being served at the time requested.

Because the cost of Transvan service is high and the revenue generated is low, a substantial operating subsidy is needed. Revenues cover only 5 percent of total operating costs, since fares were purposely set at token levels. However, the intent of the project was to provide service to the handicapped and elderly and not to pay for any significant part of the program from user charges. It was recognized by the city from the outset that a substantial subsidy would be required to continue the service.

The ability of Transvan to serve the handicapped and elderly is restricted by the use of only three vehicles. This accounts for the limited ridership of 2800 per month which essentially saturates the system. Only 850 out of a total market of 12,000 persons have used the system. The latest figures reveal that fewer than 500 persons subscribe to the system, down from a high of 545 during the last quarter of 1973. Due to the capacity limitation, which sometimes makes obtaining service difficult, Transvan has evolved a system used primarily by those handicapped and elderly most in need of transportation.

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APPENDIX O

TOTE, TRANSPORTATION FOR THE ELDERLY, ST. PETERSBURG, FLORIDA

Project Overview

The city of St. Petersburg initiated TOTE service on September 20, 1973. TOTE was the acronym applied to Transportation of the Elderly, a door-to-door demonstration transportation system funded under Section 6 of the Urban Mass Transportation Act of 1964.

The TOTE demonstration was initiated for the purpose of improving the mobility of the elderly, (60 or over) and the handicapped. It provided reservation, subscription, demand responsive and rent a bus service in a thirteen square mile area in the eastern heart of the city (Figure O-1).

The TOTE service was funded as a joint venture between UMTA and the Florida Interlocal Corporation which comprises the City of St. Petersburg and the Florida Department of Transportation. UMTA funding of TOTE service ended on March 31, 1975.

Demonstration funding was shared as follows:

Federal - UMTA (2/3)	$300,000
State - Florida DOT (1/6)	75,000
Local - St. Petersburg (1/6)	75,000
Total	$450,000

Objectives

The TOTE demonstration encompassed the SMD objective of improving transit service for the handicapped and elderly. The local objectives included increasing the mobility of this target group through the development of an efficient, call in door-to-door transportation service that would complement the existing Municipal Transit System and that could be incorporated into it at the completion of the demonstration.

Project Description

The TOTE demonstration service provided personalized reservation, subscription and demand response door-to-door transportation for all the handicapped and all persons over 60 years of age within the designated coverage area. In addition, buses could be chartered for group travel in or out of the service area.

Reservation and subscription service runs were made every half hour within the original 10 square mile service area and every hour to the expansion (3 square mile) area. This service was offered from 7:30 AM to 7:00 PM Monday through Friday. Sunday service was provided from 9:00 AM to 2:00 PM. An average of slightly over seven vehicles was needed for average weekday

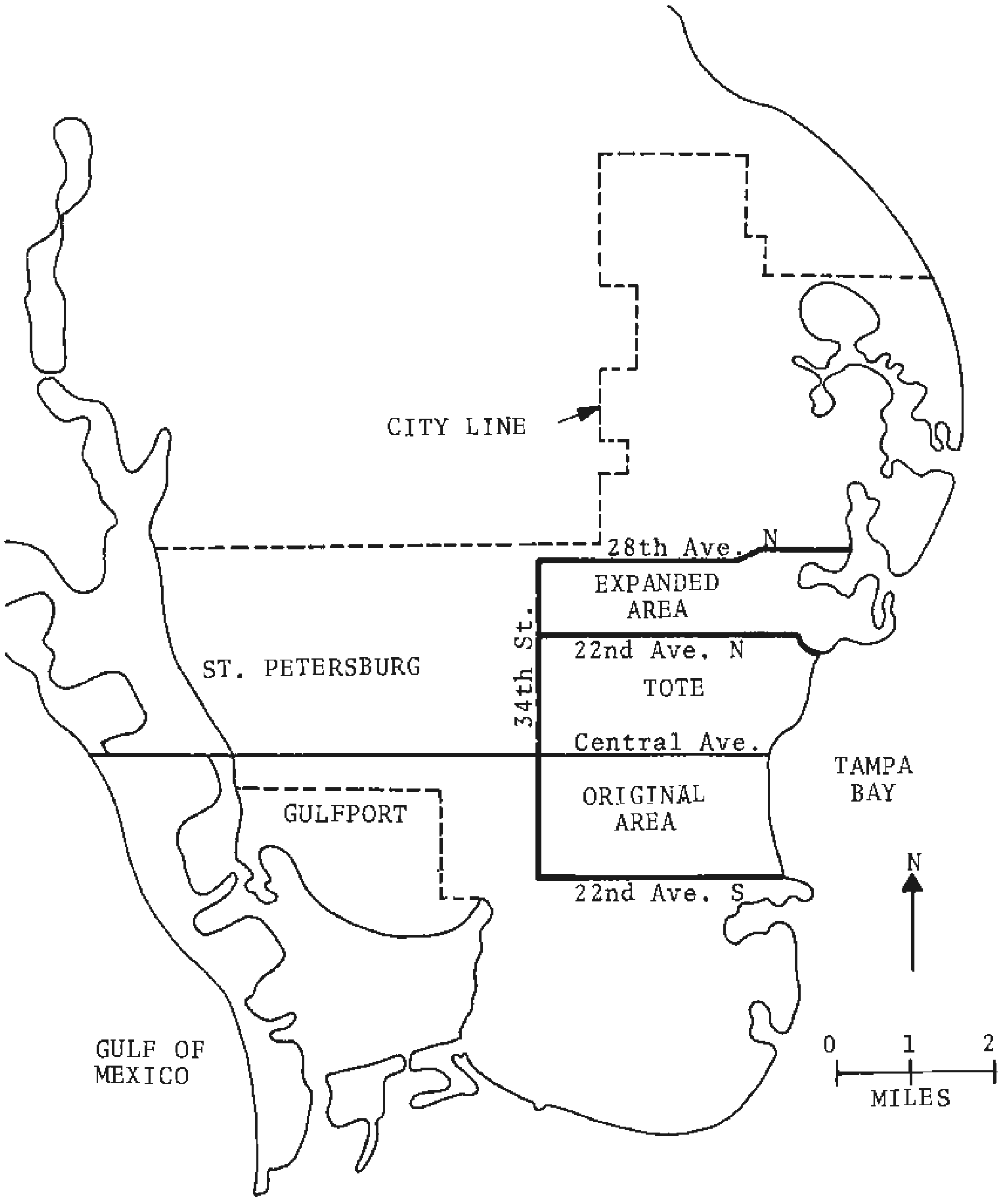

Figure O-1. TOTE Service Area, St. Petersburg, Florida advanced reservation and subscription service. Normally two vehicles were on standby to service demand responsive requests which could not be accommodated by vehicles in advanced reservation service. During the month of December, 1974, the buses averaged over 54 hours of service per day. The fare for advanced reservation service was 35 cents per one way trip. The fare for demand responsive service was 60 cents per one way trip. In addition to the reservation, subscription, and demand responsive services, buses would be chartered for group travel in or out of the service area.

The TOTE fleet comprised 13 Dodge Maxivans (Figure O-2). Two of the vehicles were equipped with hydraulic lifts to accommodate one wheelchair person in addition to seating 10 other passengers. The other 11 vehicles seated 13 passengers each.

The service area had almost all the necessities and amenities required by the target group. It includes downtown St. Petersburg, shopping centers, several hospitals and surrounding clinics, the more significant social service and government offices, rail and bus terminals and several restauraunts, clubs, theatres, parks and other recreational attractions. Trips to activities outside the werea are made on a twice weekly basis.

A major activity connected with the demonstration was registration of eligible riders. In order to obtain TOTE service the rider must have had a registration form on file. According to the 1970 census, approximately 37,000 residents were eligible. In addition, all handicapped or elderly tourists and part-time residents could register.

History and Status

In 1971 a transit planning consortium met to discuss the lack of mobility inherent within the Senior Citizen group. This effort eventually culminated in the development of a grant application to UMTA for a demonstration of handicapped and elderly service.

A four month planning phase began in April 1972. The results of the analysis revealed that a fixed transit network would not give the desired service, and door-to-door service was called for. The grant application for the demonstration was approved by UMTA in December 1972 and in January 1973 work started on plans for an operating system.

TOTE registration began on May 15, 1973, approximately four months prior to service operation. Almost seven thousand persons were registered during this period. On Sept. 20, 1973 TOTE service began. By March 31, 1974, almost 12,600 persons had registered. Initially service operated from 9:00 a.m. to 5:00 p.m. Monday through Friday with a rent-a-bus service available on Saturday and evenings. In December, 1973, TOTE instituted a Sunday service from 9:00 a.m. to 2:00 p.m., introduced daily service from 7:30 a.m. to 7:00 p.m. and developed two special destination services outside the demonstration area.

In February, 1974, TOTE initiated a ticket program in conjunction with the Red Cross to increase mobility and access of services for indigent elderly persons.

On October 25, 1974, the service area was expanded from 10 to 13 square miles. The significant effects of this expansion can be seen in the ridership growth presented in the project results.

Figure O-2. TOTE Vehicle (Dodge Maxivan), St. Petersburg, Florida

On March 31, 1975, the TOTE demonstration was completed. At that time the City of St. Petersburg has continued operation of the TOTE system with its other transit services. However, TOTE service as presently offered will end in September, 1975. A more limited service is expected to replace it in November, 1975.

Just prior to the inauguration of TOTE, the City of St. Petersburg introduced a $2 per week unlimited pass for its fixed route bus system which also services the TOTE area. This, of course, made the city transit system potentially much cheaper than TOTE. The combination of many routes and low fares on the city buses has unquestionably limited the TOTE ridership potential.

Project Results

Some results of the first 15 months of TOTE service are given in Table O-1. While ridership is a key indicator of the acceptance of a transit service, the percentage of registrants is an important indicator of the degree of interest and awareness among eligible users. As a result of the extensive marketing efforts, registration has climbed to 42 percent of the target group, or 16,000 persons out of 37,000 eligible. There are no data indicating the percent of registrants who used the service. The age breakdown of registrants is shown in Figure O-3.

Several factors affected the ridership on the system (Figure O-4). The first was a service change in December 1973 which expanded weekday service from eight to eleven and one half hours, and added Sunday service. These added services accounted for about 15 percent of TOTE ridership. The Red Cross Ticket Program paid for 15,000 rides on TOTE in the ten and one half month period or a little over 14 percent of all TOTE ridership to December 1974. The other service change with a significant impact was the addition of three square miles to the service area. Ridership certainly increased following this change but the amount of the increase is not readily discernible. The seasonal effect on ridership of the influx of winter tourists is also difficult to gauge.

The hours of highest TOTE ridership have been from 9:00 AM to 3:00 PM with the highest single hour being 10:00 AM to 11:00 AM (Figure O-5). The fact that handicapped and elderly transportation is an off peak service is clearly evidenced.

The trip purpose (other than returning home) for which the handicapped and elderly most used TOT was personal business (46%). The next highest trip purpose was medical/dental(20%); shopping was a close third ((17%). Recreation (11%), employment or volunteer work (5%), and social services (29%) made up the remaining trip purpose. The percentage of trips in most trip purposes varied considerably over the duration of the project (Figure O-6). For the first few months of the demonstration medical/dental was the most frequent purpose stated, with personal business a close second. Recreation did not turn out to be as large a percentage of outgoing trips as might have been anticipated.

Service to the non-ambulatory handicapped was a very small portion of the total. Requests for the wheelchair lift vehicles averaged about 10–12 per day.

After some sharp early increases in passengers and revenues per vehicle mile of operation (Figure O-7) both became more or less stable even though ridership continued to grow. Mileage has increased as trips became more dispersed throughout the demonstration area. Also the early morning and late afternoon hours added considerable mileage for very few passengers. However, the intent of the demonstration was to emphasize service rather than productivity. If some of this

TABLE O-1. SELECTED RESULTS: TOTE, TRANSPORTATION OF THE ELDERLY, ST. PETERSBURG, FLORIDA

COSTS:	
Planning	$ 49,800.00
Capital	$ 130,175.00
Operating	$ 319,825.00
Total	$ 499,800.00
RIDERSHIP:	
Daily	360
Peak Hr.	52
Demand Density, Trip/Sq.mi/Hr.	2.4
TRAVEL TIME:	
In Vehicle Time	10 minutes
Trip Length	2.5 miles
Vehicle Speed	14.8 mph
FARE/REVENUE:	
Reservation/Subscription	$ .35 each way
Demand Response	$ .60 each way
Annual Passengers	102,670
Annual Revenue	$ 42,815
Revenue/Passenger	$ .41
Operating Ratio	$ 4.25
Operating Deficit	$ I.33/passenger
PRODUCTIVITY:	
Passengers/Vehicle Hour	6.4
Passengers/Vehicle Mile	0.43
UNIT COSTS:	
Operating Cost/Passenger Trip	$ 1.74
Operating Cost/Vehicle Mile	$ .70
Operating Cost/Vehicle Hour	$ 10.41
Capital Cost/Passenger	$ 1.27
Capital Cost/Vehicle	$ 10,014.00
SAFETY:	
Accidents	1/month

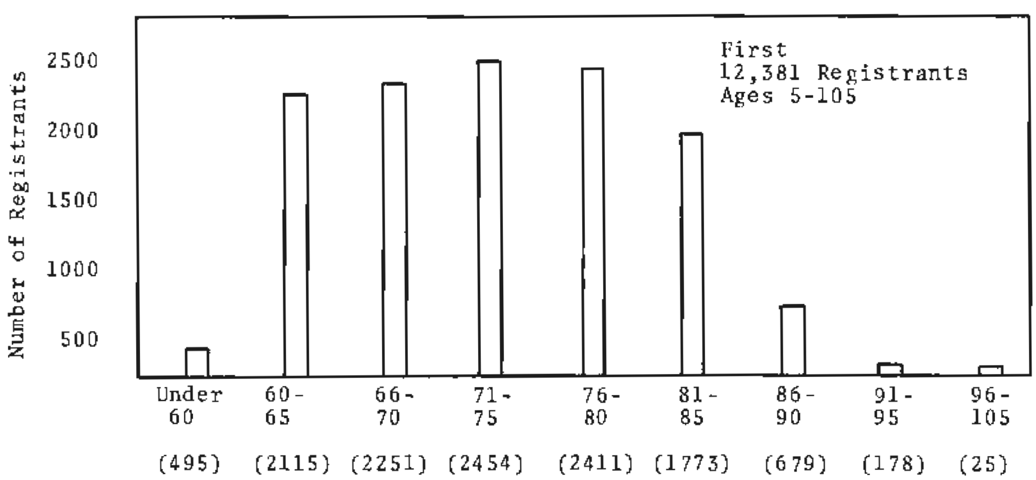

Figure 0-3. Registrants by Age Group, TOTE, St. Petersburg, Florida

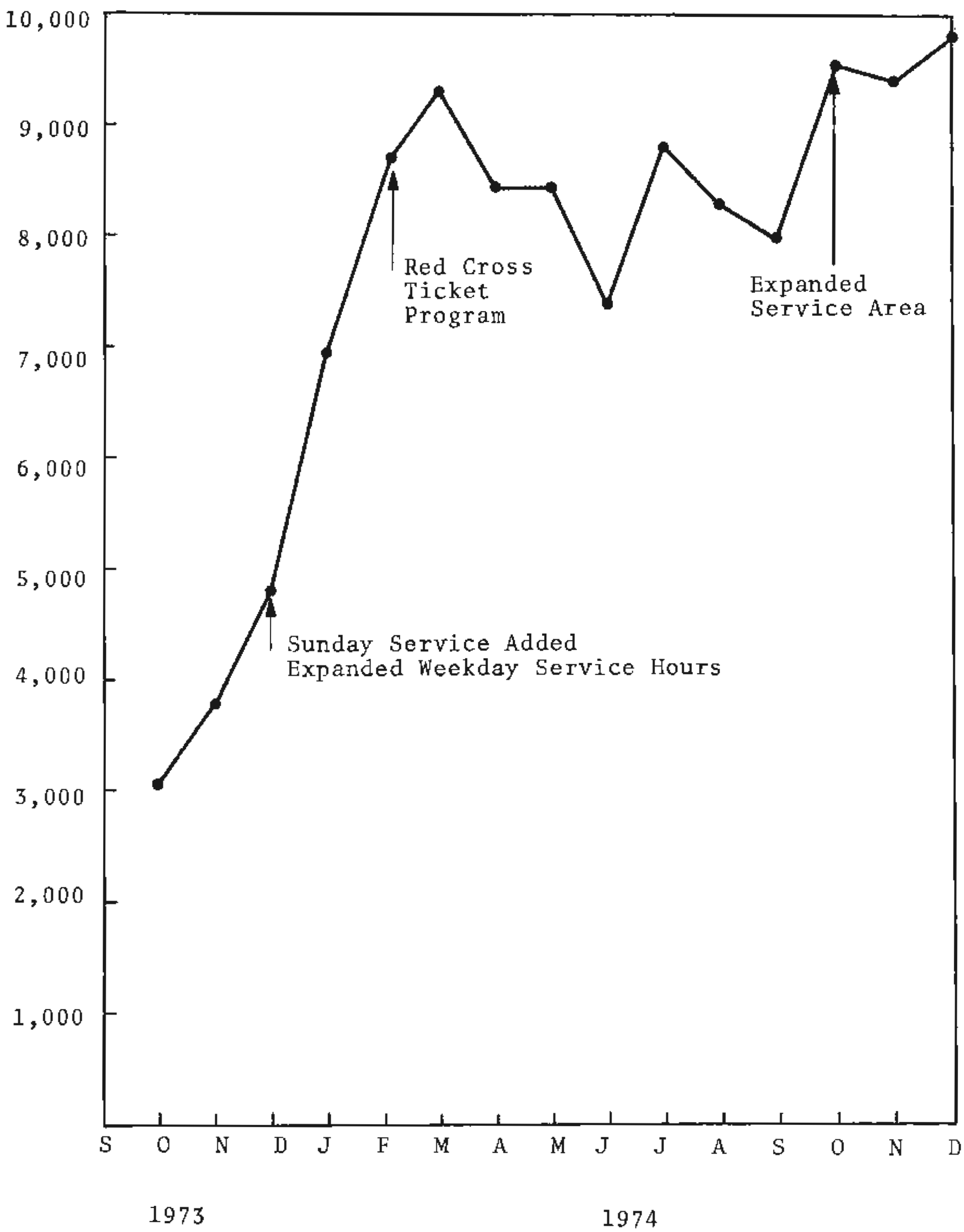

Figure 0-4. Monthly Ridership, TOTE, St. Petersburg, Florida

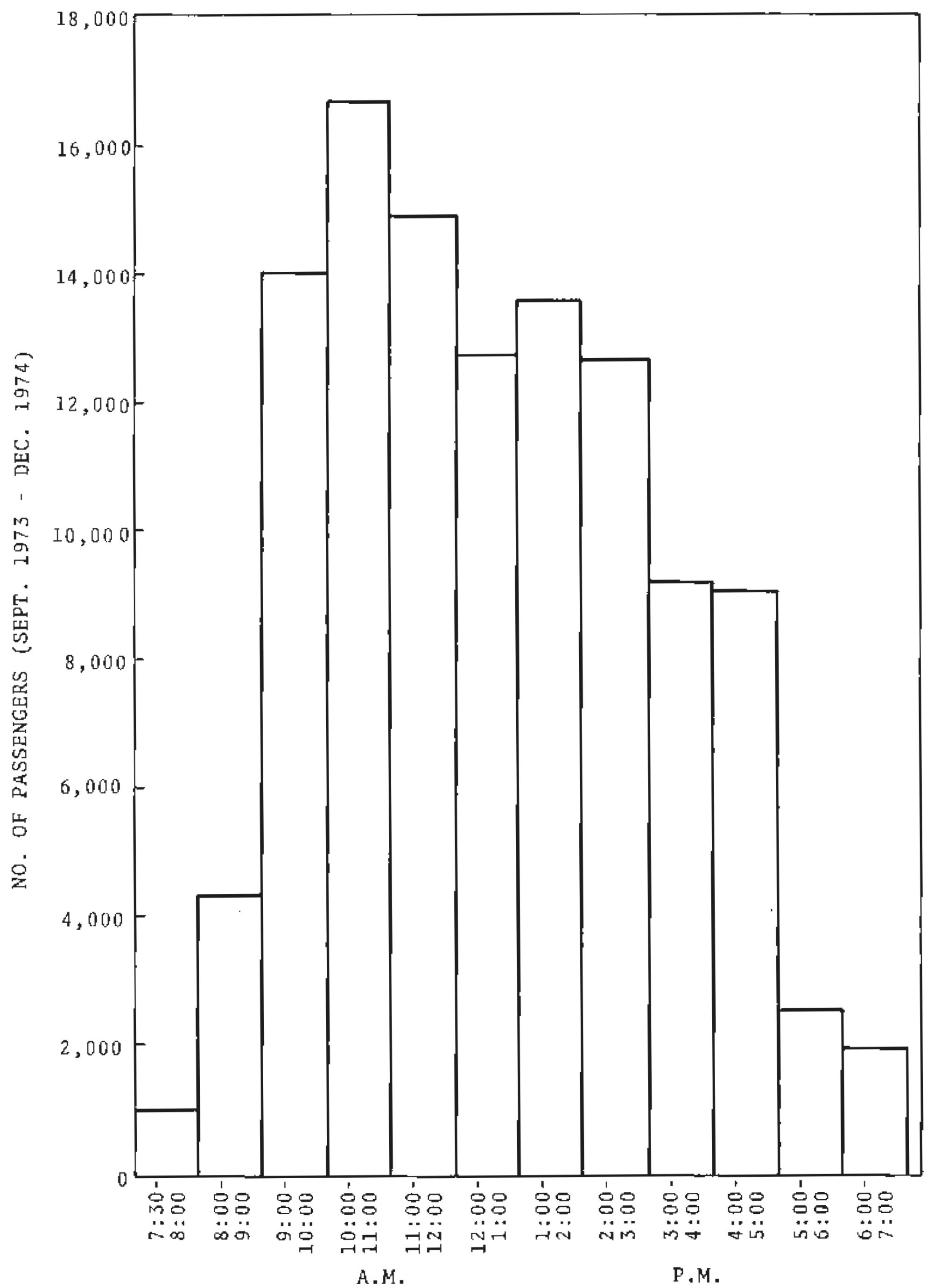

Figure O-5. Passengers by Time of Day, TOTE, St. Petersburg, Florida

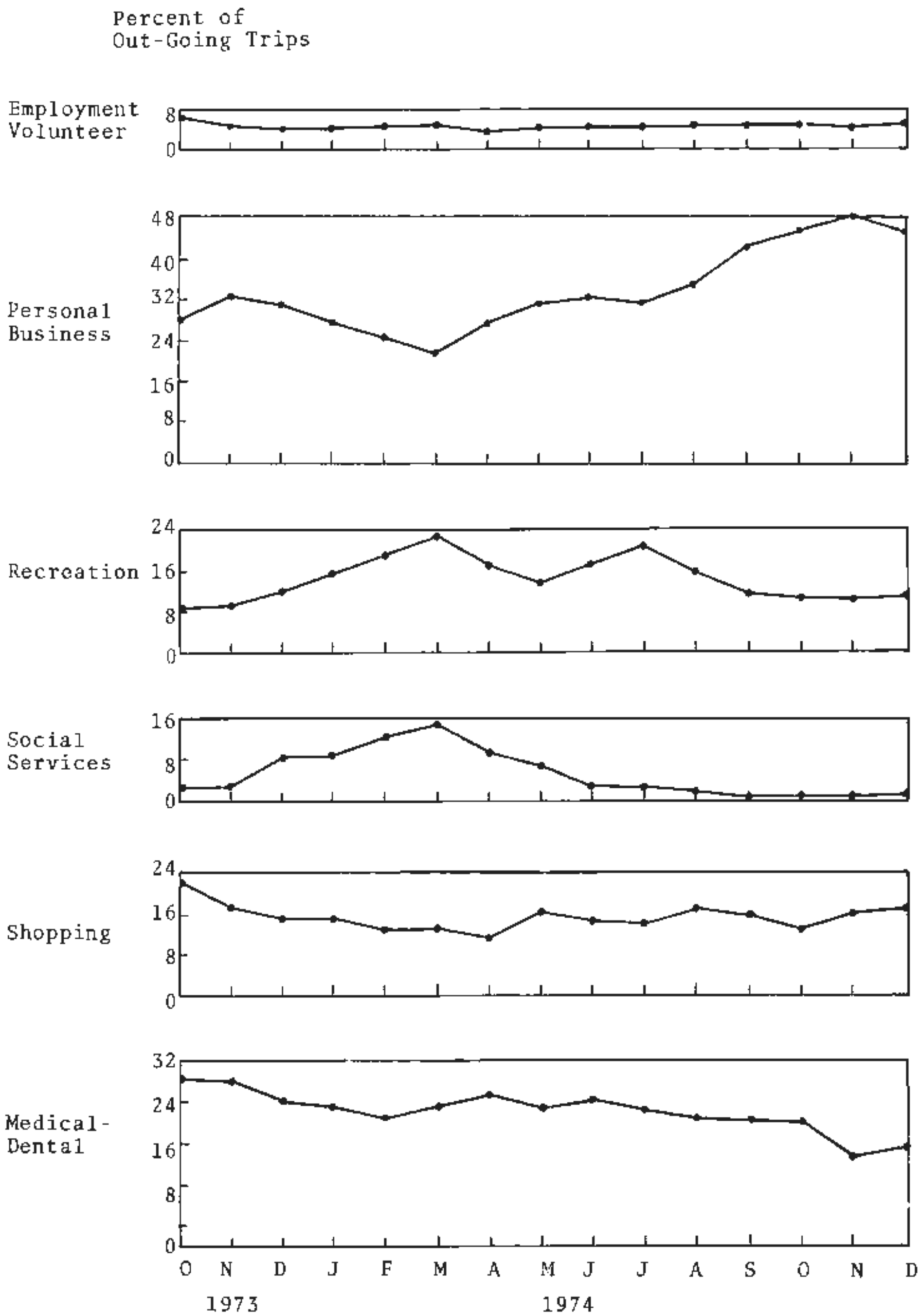

Figure O-6. Trip Purpose, TOTE, St. Petersburg, Florida

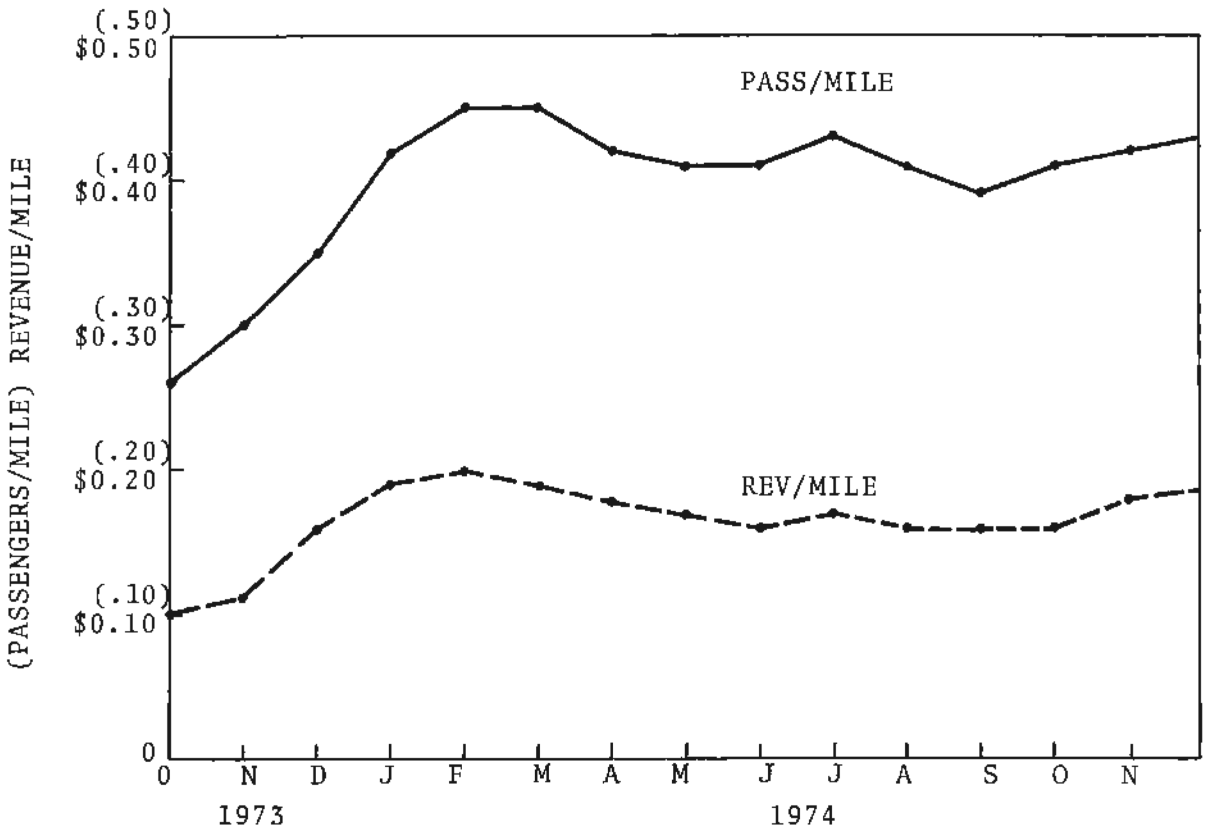

Figure O-7. Passengers and Revenue Per Mile, TOTE, St. Petersburg, Florida low volume service was eliminated other passengers would have been lost due to the uncertainty of being able to make a return trip during the latter part of the day.

The vehicles used in the service performed well. Maintenance was not a major problem. The nonavailability of vehicles averaged less than one per week. The vans provided good flexibility and operating efficiency.

Evaluation and Conclusions

The main purpose of the demonstration to increase the mobility of the handicapped and elderly has been achieved. A total of nearly 115,000 trips were made on TOTE between September, 1973, and December, 1974. The ridership indicates that this type of service is desirable to a substantial number of elderly people.

The vehicles chosen did, in fact, prove to be of the right size and type for the service provided. The vehicle availability was high with less than one per week out of service for maintenance work.

The original service hours of 9:00 a.m. to 5:00 p.m. encompassed over 91 percent of the weekday service requests. The added hours reduced the uncertainty of being able to make a return trip in the late afternoon. Without the added hours the number of trips made during the 9:00 a.m. to 5:00 p.m. period would undoubtedly have been lower.

Despite TOTE's success, there has been some disappointment in the ridership totals which did not reach expected levels. There appeared to be a substantial number of elderly who either do not know about, do not need, or were reluctant to ride the TOTE service as evidenced by the fact that only 16,000 out of a potential market of 37,000 residents (plus an unknown number of visitors) registered for use of the system. In December, 1974, average daily ridership of 360 was a small fraction of the potential market. It would seem that a similar handicapped and elderly transportation system would attract a higher patronage level where there is not such strong competition from an existing transit system offering a substantial number of routing alternatives at a lower fare. In the case of TOTE, the system was meant to complement the existing transit system in accommodating those who for a variety of reasons would not use the fixed route system or found the TOTE service more desirable. Nevertheless, it must be recognized that since both serve the same area they were competing for the same trips.

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APPENDIX P

CLEVELAND, OHIO, COORDINATED NEIGHBORHOOD TRANSPORTATION FOR THE ELDERLY

Project Overview

In March 1975, the city of Cleveland inaugurated the N.E.T. (Neighborhood Elderly Transportation) demonstration project intended to coordinate transportation services to meet the needs of the elderly, those 60 years of age and over. within three demonstration neighborhoods, small buses provide advanced reservation and demand responsive service that is coordinated with regular public transit.

The 18 month demonstration began operation on March 16, 1975. It is being funded jointly by UMTA and the HEW Social and Rehabilitation Service with local assistance from the City of Cleveland, Greater Cleveland Associated Foundation, Cleveland Transit System and Buckeye Development Corporation. Project funding is shared as follows:

UMTA(OH-06-0018)	450,000
HEW(SRS)	250,000
Local	304,675
Total	$1,004,675

Objectives

The concepts established in this project demonstrate another technique for achieving increased mobility and access to services for the aged population. Besides increasing the general mobility of the elderly, the project should improve mobility to and from social services on a reduced fare basis, increase scheduling reliability, and expand weekly service hours. The most significant benefit of this program should be improvement of reliability of service through effective management of the project.

The primary local objective is the improvement of neighborhood health and social service delivery through the cooperation and coordination of client agencies, and through demand responsive and reservation service for the elderly.

Project Description

All elderly citizens 60 years of age or older who are registered with the service and eligible for medicare are provided personalized door-to-door transportation on a demand responsive or an advanced reservation basis to and from desired destinations within their neighborhood. The service is provided by three 15 passenger 2-way radio equipped buses in each of the three neighborhoods. Three additional vehicles serve as back up equipment. These buses operate on a non-fixed route concept, combining demand responsive and advanced reservation service to both elderly clients and their assistants for a fixed fare of 10 cents each. Service is offered 12 hours a day, from 7:00 AM to 7:00 PM five days per week and from 7:30 AM to 3:30 PM on Saturday and Sunday.

Twelve small buses and two Dodge Systems Maxivans equipped with lifts were purchased. The Cleveland Transit System is under contract from the city to supply and manage day-to-day operations and maintenance. The three neighborhood operations are coordinated from one centralized dispatching unit.

The service does not conflict with nor duplicate existing transit services but in some cases provides access for elderly residents to and from regular transit services operating in these neighborhoods.

The service area consists of three distinct low income neighborhoods; Buckeye, Model Cities, and Tremont, covering a total of 7.6 square miles. Each has differing ethnic characteristics, and is socially and geographically identifiable, with a relatively high concentration of residents 65 years of age and older. The three neighborhoods, of comparatively similar size, have elderly populations of 12,000, 8,000, and 7,000 respectively. They also contain sufficient activity centers and services to satisfy most of the basic daily needs of elderly residents. The neighborhoods are located within the service area of the new Areawide Model Project on Aging, which was established to improve the existing service delivery system in order to prevent life crises among older persons. Efforts have been made to establish lines of communication with elderly residents of each neighborhood. The analysis of transportation requirements estimated that over 75 percent of the basic trip needs of the elderly in these urban areas can be satisfied within the neighborhood through use of a special transportation service.

The demonstration is the coordinated effort of over 12 agencies and organizations, including the Cleveland Transit System, the Mayor's Commission on Aging, Model Cities, and the Areawide Model Project on Aging. The city of Cleveland and the Mayor's Commission on Aging have implemented the program and the Cleveland Transit System operates the service, permitting utilization of maintenance and storage facilities, marketing skills, communication systems, personnel and other services of the existing transit system.

References

None

APPENDIX Q

BLUE STREAK TRANSIT DEMONSTRATION PROJECT, SEATTLE, WASHINGTON

Project Overview

The "Blue Streak" demonstration was conceived by the Seattle Transit System as an express bus system that would provide service competitive with the private automobile.

The Blue Streak provided service between the northeast section of the City and the Seattle CBD. Blue Streak buses used the I-5 freeway reversible roadway and had exclusive use of an on-off ramp in the southern part of the Seattle central business district. Direct service was provided to and from a free park-and-ride lot eight miles north of downtown. The Blue Streak system included seven other routes in the north part of Seattle with at least a portion of the route on the I-5 reversible roadway. The Blue Streak demonstration routes are diagrammed in Figure Q-1.

Transportation Administration, the Washington State Highway Commission, the Seattle Transit System, and the City of Seattle Traffic Engineering Division. The Federal Highway Administration gave approval of the closing of the Cherry Street ramp. Federal funds were provided as follows:

UMTA	$1,293,000
Local	646,000
Total	$1,939,000

In addition, a program was set up by UMTA for development of planning and evaluation of Blue Streak. The work was done by Northwestern University for $94,000.

Objectives

The service and Methods Demonstration Program objective addressed in this project was reduced travel time for transit riders. At the local level the project was initiated to address eight specific questions:

- Could patrons be attracted to a normally configured arterial bus system, but with freeway express service replacing local travel between their neighborhood and downtown?
- Could auto drivers and passengers be diverted to an express bus, park-and-ride system?
- Is bus preferential treatment important for the freeway part of the system?
- What will happen to traffic flow when a CBD ramp is changed to exclusive bus use?
- Will Blue Streak cost more?

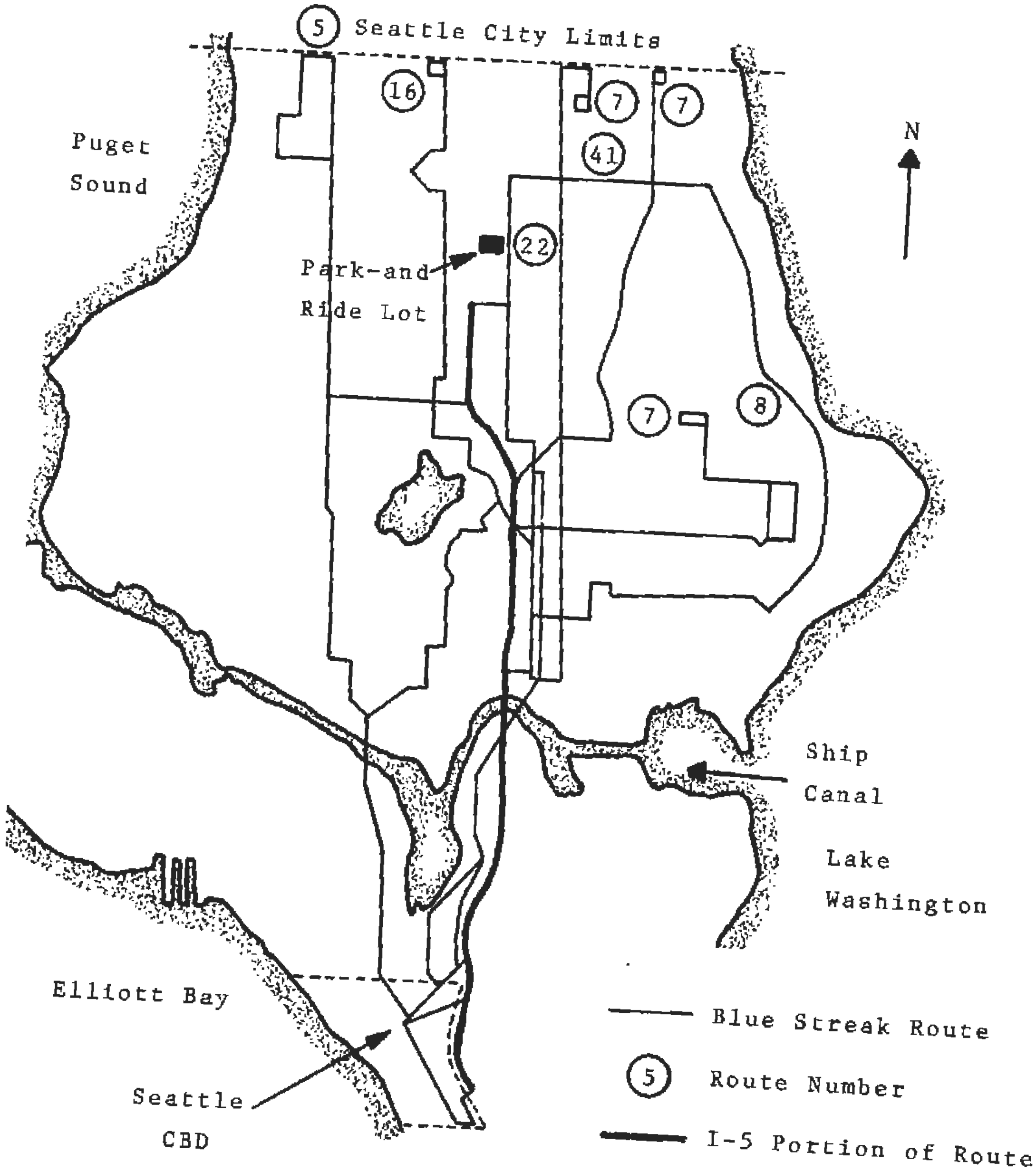


Figure Q-1. Blue Streak Bus Routes, Seattle, Washington

- What will be the impact on the I-5 freeway?
- What can be learned about mode shift sensitivity and park-and-ride characteristics?
- Will benefits occur to various transportation system users?

Project Description

The Blue Streak express bus routes covered about 22 square miles in the northeast section of Seattle. This area had a relatively stable population of about 230,000 people, as determined by the 1960 and 1970 census. The area is primarily residential and the population density is higher than most of the rest of the metropolitan area. This section of Seattle has for many years used public transit more heavily than other sections. The transit use is principally oriented toward the Seattle CBD. The project area is located north and somewhat east of The CBD, and lies from 3 to 10 straight line miles from the heart of the CBD.

In the study corridor, I-5 is a six and eight lane freeway with an additional two to four lane reversible roadway with separate entrance and exit ramps. The direction of travel on the reversible roadway is southbound in the morning and northbound in the evening. The change over in travel direction is done manually, although the reversible portion of the freeway is under partial television surveillance. Daily volume on the freeway in 1971 and 1972 was over 130,000 vehicles.

The Blue Streak demonstration service consisted of seven routes in which buses picked up riders in a residential collection area and then proceeded non-stop on the I-5 freeway to the CBD. On the eighth route, buses picked up riders at a large parking lot and similarly proceeded to the CBD non-stop. The express routes overlapped local routes to some extent.

Coverage of the Blue Streak routes, using the quarter mile service standard, is shown in Figure Q-2. Using 1970 census data, the following portions of the area population were within the coverage area:

Population of Project Area Within
One-Fourth Mile of Bus Routes

Item	Population	Percent
Total Population	230,000	100
Total Covered	118,000	51
Blue Streak Only	50,000	22
Local Only	23,000	10
Both	45,000	19

The buses in the Blue Streak demonstration used the reversible roadway to downtown in the morning, returning via the outer roadway of I-5. The direction of the reversible lanes shifted at noon each weekday to northbound for the afternoon and evening. The reversible lanes were changed to the southbound direction between 4:00 and 5:00 A.M. In downtown, the buses ran a clockwise loop in the morning, reversing at noon.

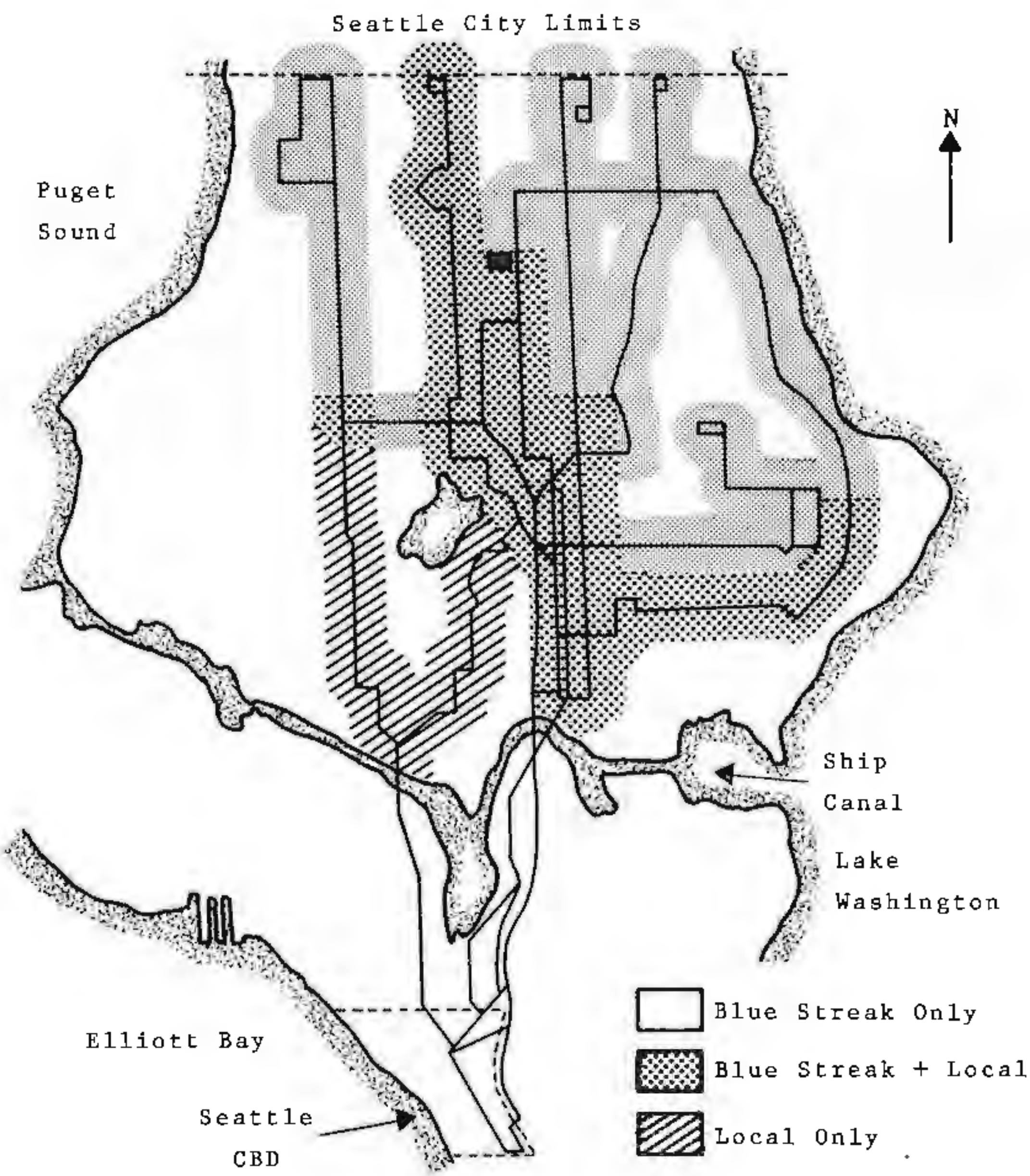


Figure Q-2. Blue Streak Route Coverage, Seattle, Washington

Demonstration service was provided from 7:00 a.m. to 7:00 p.m. Peak period headways were 20 minutes or less; midday headways were about 30 minutes. Peak hour headway was four minutes for the park-and-ride express route. Two fare zones were covered, so the one way trip cost to downtown was either 30 cents or 35 cents.

The park-and-ride lot is located eight miles north of the CBD; it originally contained 475 spaces but was promptly enlarged to 525 spaces because of heavy demand. Even with the expanded capacity, the lot was full by 8:15 A.M. The lot has separate entrance and exit driveways, with the exit signal controlled. It is fenced, lighted, and landscaped. An attractive passenger shelter is provided, but with no special amenities.

The Blue Streak demonstration project had four distinguishing features:

- The buses used the reversible lanes on the I-5 freeway for the express segment of their peak direction runs. The return was on the regular lanes of the freeway.
- No bus priority treatment was provided on the freeway. Buses mingled with the general traffic.
- Buses had exclusive use of one ramp in the CBD.
- The flow on the reversible freeway lanes, the direction of use of the exclusive ramp, and the circulation pattern in the CBD were all reversed at noon each weekday. The CBD bus stops were moved from one side of the street to the other, and their status ("In Use" or "Not In Use") was indicated by manually changed signs.

The Blue Streak project employed a major, multi-media promotional campaign to inform and attract potential riders. Five months of preparation led to a saturation campaign starting ten days before the beginning of the express service. Heavy emphasis was placed on morning radio, prime time evening television, and newspaper coverage with full route maps. No direct mailings were used. The campaign intensity decreased slowly through the end of March 1971; TV advertising ended early but radio spots continued until March. After March the project depended entirely on news coverage.

The total promotional cost was $149,650. It was spent as follows: April, 1970, through August, $11,150; September through December, $108,050 and January, 1971, through August, $30,450. Radio advertising accounted for the largest amount, $69,350.

Project Status and History

Seattle was a place of vigorous growth in the 1960's, and witnessed steadily increasing congestion on Interstate 5, the Seattle Freeway. In an attempt to ease this congestion, Blue Streak was conceived in mid 1966. It was ultimately implemented in 1970 as a Federal transit demonstration project. The Cherry Street ramp was closed to non-bus traffic in September 1970, and the Blue Streak express bus service started on 1 October. The demonstration ended in December 1971.

The analysis of the demonstration was divided into two functional phases. Phase I (Before) consisted of a study of traffic characteristics and travel patterns prior to the inauguration of Blue Streak service. The Phase I surveys were conducted in June, July, and August of 1970. Phase II) was the survey and analysis of traffic and travel after Blue Streak had been in operation for about one year. Phase II surveys were conducted in June, July, and August of 1971.

A Phase III had been proposed, in which the exclusive bus ramp in the CBD would be opened to general traffic, and the results analyzed. This phase was never implemented.

Blue Streak service has been continued by the Seattle Transit System. It has been slightly modified as the result of operating experience.

The results of the Phase I and Phase II comparisons have been distorted by one major circumstance; the serious drop in employment in the Seattle metropolitan area which occurred between the survey periods. This drop in employment greatly reduced the amount of work directed travel and thus reduced the number of riders on the Seattle Transit buses. Selected data showing the effects of unemployment are shown below.

Employment Changes and Impacts on Travel

Item	Phase I	Phase II
Labor Forces Employed (percent)	90	85
Employed Labor Force (x1000)	587	550
Employed in Aircraft Mfg (x1000)	59	38
Canal Bridges Vehicle Count (x1000)	299	292
Canal Bridges Persons Count (x1000)	457	440
I - 5 Bridge Vehicle Count (x1000)	136	134

Results

The Blue Streak demonstration was successful in attracting additional riders to transit service, countering a general long term decline in bus ridership. More specifically, the approximate average daily ridership of Blue Streak increased from 7,500 to 10,300 as shown in Figure Q-3. Before Blue Streak, the system wide ridership was declining by more than 9 percent per year; approximately coincident with Blue Streak, the rate of decline in the STS (Seattle Transit System) changed to about 6 and a half percent. This change is shown in Figure Q-4.

Blue Streak was also successful in reducing the travel time in the direction of peak traffic flow by using the I-5 freeway and the exclusive bus ramp for the express portion of the bus routes. The average travel time was reduced from 50 to 40 minutes, a 20 percent saving.

Blue Streak was successful in diverting some patrons from their autos. Overall, more than 20 percent of the riders (about 2000) were diverted from autos. The park-and-ride service diverted over 50 percent of its users from their cars. The Phase II passenger survey indicated that patrons who previously had not used the bus were about equally divided between those diverted from automobiles and those who did not make the trip prior to Blue Streak.

The park-and-ride lot service was highly successful. The 525 spaces were completely filled by 8:15 AM. More parking space was sought but was not available because the area was built-up. The origin of park-and-ride users extended well beyond the demonstration project area. More than 30 percent of the trips originated in King County outside the Seattle city limits, and about 18 percent originate in Snohomish County, at least three miles north of the city limits.

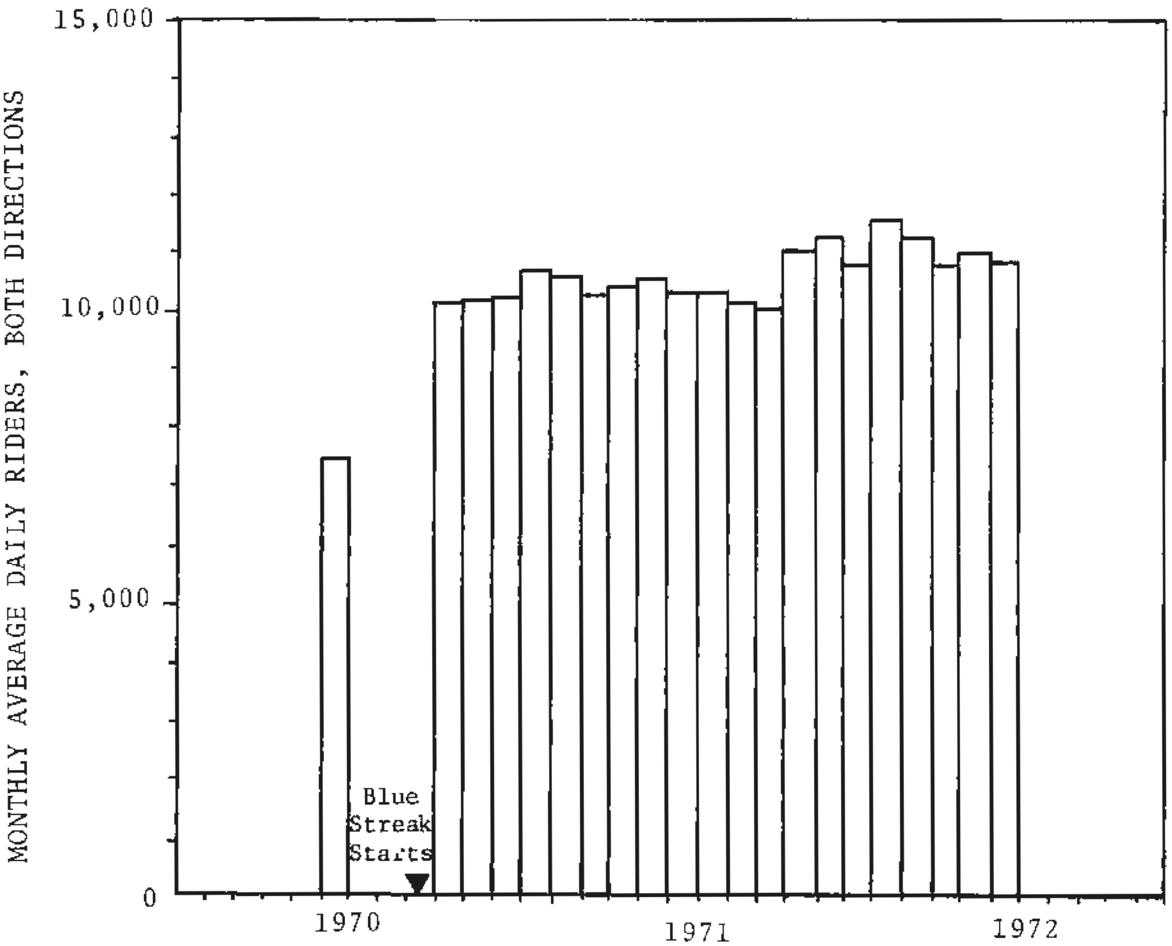
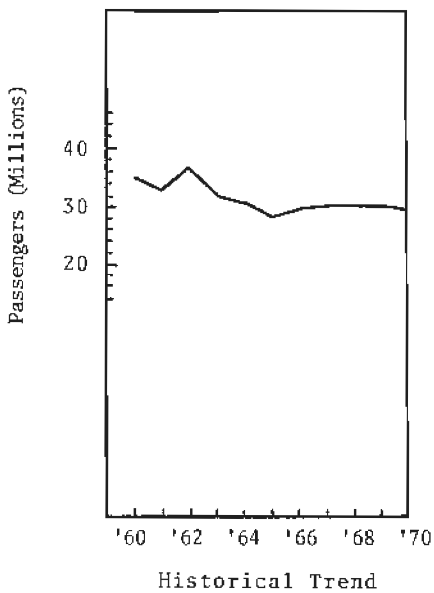
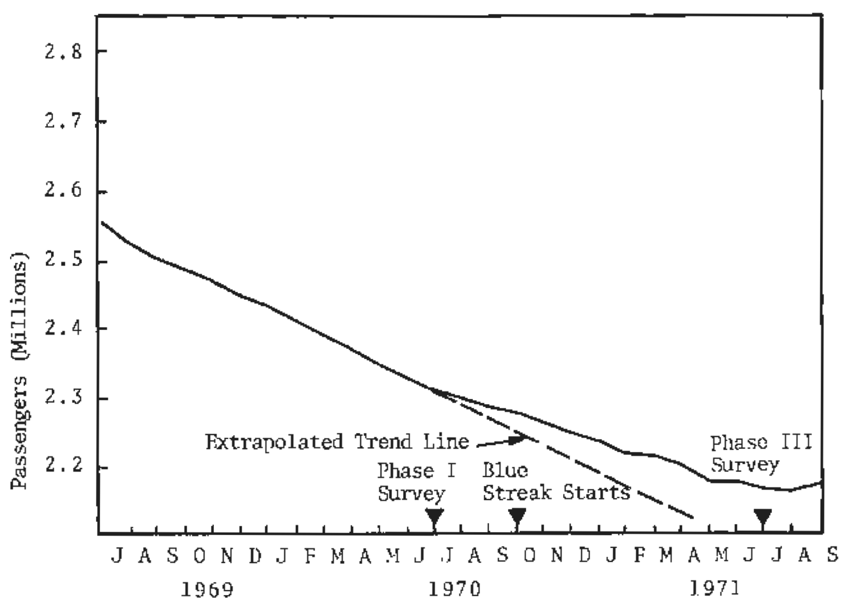


Figure Q-3. Blue Streak Patronage Trends, Seattle, Washington



Historical Trend



Seasonally Adjusted Recent Trend

Figure Q-4. Seattle Transit System Patronage Trends, Seattle, Washington

For most patrons, the 70 cents round trip bus fare was definitely lower than the all day parking cost in the Seattle CBD.

The closing to autos of the Cherry Street ramp in the CBD produced a complex reaction. The closing initially produced a great increase in congestion and confusion at all nearby ramps. For example, inbound AM speeds fell from 53 to 43 MPH on the outer roadway, and from 61 to 57 MPH on the reversible lanes. As motorists reorganized their travel patterns the confusion subsided, and the speeds ultimately increased to 55 and 63 MPH respectively. However, one year after the closing, volumes on the nearest auto ramps during peak periods remained sharply higher; up as much as 38 percent.

The person count on the Cherry Street ramp increased about 25 percent when the ramp was changed to exclusive bus use. Thus the bus ramp was serving more people despite the decrease in vehicle numbers.

The impact of the Blue Streak demonstration on highway traffic was difficult to determine because of the decrease in employment (down 5 percent) and the corresponding decrease in work directed travel (down 4 percent on I-5). Between Phase I and II, the number of vehicles and the number of persons crossing the Ship Canal screenline (6 bridges) decreased by 2.4 percent. Transit ridership crossing this screenline increased an average of 11 percent; there was a decrease of 7 percent on bridges not used by Blue Streak and an increase of 21 percent on bridges used by demonstration project buses.

Blue Streak did not significantly affect the accident record on I-5. Collisions per million vehicle miles remained in the range of 1.8 to 3.8. However, based on a special study, Blue Streak buses appeared to have a lower accident rate than the average for all STS buses.

Comparative data for Phase I and II are given in Table Q-1. The implementation of Blue Streak resulted in a complete overhaul of routes in the project area. Ridership, cost, revenue, and productivity changes were difficult to develop because of this restructuring of routes and service. Simple before and after comparisons are not available, however, estimates have been made for ridership, and certain routes were selected to permit controlled comparisons. The Phase I ridership figure of 7,500 per day is a composite of three estimates. The Phase II figure of 10,300 is derived from actual counts.

Comparisons of Blue Streak express, local, and control route data can be used to obtain insight into the relative performance of the project. Express, local, and control route comparative data are given in Table Q-2.

The operating ratio (cost/revenue) for Blue Streak express routes was 1.33; for the local routes in the project area it was 0.99; for the control routes it was 1.27; and, for all STS buses routes it was 1.72. The Blue Streak service operating ratio was very close to that of the control routes, and was considerably better than that of the overall STS network.

The impact of Blue Streak, coupled with a simultaneous increase in school service, caused about a 10 percent increase in total STS bus miles and bus hours.

Blue Streak was very efficient from the viewpoints of safety and maintenance. Safety records for freeway operation were very good, with an average of 11.1 collisions per million bus

TABLE Q-1. SELECTED RESULTS: BLUE STREAK EXPRESS BUS SERVICE, SEATTLE, WASHINGTON

	PHASE I	PHASE II
1. DAILY TWO WAY RIDERSHIP	7,530	10,370
2. ROUTINE COUNTS (at ship canal bridges)		
Automobiles	287,956	280,981
Vehicles, All	299,270	292,059
Persons in Automobiles	417,388	397,482
Persons in Buses	27,279	30,184
Total Persons	457,161	439,841
3. TRANSIT TRAVEL TIME (typical minutes)		
Southbound, AM Peak Period	49	38
Mid-Day, Base Period	45	40
Northbound, PM Peak Period	50	41
4. VEHICLE SPEEDS (average mph)		
Bus, Peak Period Treminal-to Treminal	11	17
Automobile, on I-5		
Northbound, Outer Roadway		
a. AM	65	63
b. PM (main flow)	49	48
Reversible Roadway		
a. AM	61	63
b. PM	51	48
Southbound, Outer Roadway		
a. AM (main flow)	53	55
b. PM	61	63

TABLE Q-2. COMPARATIVE DATA ON BLUE STREAK, LOCAL AND CONTROL ROUTES, SEATTLE, WASHINGTON

	Blue Streak	Local	Control
1. OPERATING RATIO	1.33	0.99	1.27
2. PRODUCTIVITY MEASURES			
Passengers/Vehicle/Hour	40.5	40.5	29.7
Passengers/Vehicle/Mile	2.44	3.65	2.56
Passengers/Seat Mile	0.054	0.081	0.057
3. OPERATING COSTS			
Dollars Mile	0.99	1.04	1.00
Dollars/Seat Mile	0.0220	0.0231	0.0222
Dollars/Vehicle/Hour	16.43	11.57	11.58
Dollars Passenger	0.41	0.29	0.39
Total Daily Cost, $	6,640	3,261	1,860
4. OPERATING REVENUES			
Dollars/Mile	0.74	1.05	0.79
Dollars/Seat Mile	0.0165	0.0234	0.0176
Dollars/Vehicle/Hour	12.24	11.64	9.13
Dollars/Passenger	0.30	0.29	0.31
Total Daily Revenue, $	4,976	3,280	1,466

5. ACCESS MODE TO BUS (percent)	Phase I	Phase II
Southbound (toward work)		
a. Other Bus	6%	3%
b. Walk	87	82
c. Automobile	6	14
d. Other	1	1
Northbound (toward residence)		
a. Other Bus	28%	24%
b. Walk	70	74
c. Automobile	1	1
d. Other	1	1
6. FARES, TWO ZONE (cents)	30/35	30/35

TABLE Q-2. COMPARATIVE DATA ON BLUE STREAK, LOCAL AND CONTROL ROUTES, SEATTLE, WASHINGTON (CONT'D)

	Phase I	Phase II
7. USER CHARACTERISTICS (percent)		
Age groups, Years		
a. Under 20	10%	10%
b. 20-44	43	50
c. 45-65	33	30
d. Over 65	14	10
Family Income, Dollars per Year		
a. Undre $4,000	26	20
b. $4,000-$10,000	49	47
c. Over $10,000	25	33
Car availability for Trip		
a. Yes	31%	41%
b. No	69	59
Car Ownership		
a. No Car	35%	29%
b. One Car	45	46
c. Two or more Cars	20	25
8. PREVIOUS MODE OF TRAVEL (percent)		
Street Collection		
a. Automobile Driver	20%	16%
b. Automobile Passenger	5	5
c. Bus	65	61
d. No Trip Made	10	18
Park-and Ride Lot Collection		
a. Automobile Driver	65%	43%
b. Automobile Passenger	12	9
c. Bus	23	28
d. No Trip Made	NA	20
9. Safety		
Adjusted Collision Rate, Collisions per million Bus Miles, Blue Streak only in Phase II	55.1	11.1

miles, compared to a system wide rate of over 50. Maintenance cost were very much lower, at $0.079 per mile compared to $0.129 per mile for buses not used in the project.

The promotional campaign was considered essential for project success. Accordingly, an intense and comprehensive campaign was carried out, with saturation coverage during the start up period. Bus patronage increased rapidly at the beginning of the project period, but has remained fairly constant since then at over 10,000 per month. It is felt that the heavy promotion did produce the rapid increase in ridership, but also that more promotion would not have produced significantly increased patronage since there were indications that maximum patronage levels were nearly reached.

Blue Streak attracted a large amount of free news coverage. Newspapers provided the most coverage, with radio and TV tending to cover specific events such as the ceremony for the inauguration of service.

Evaluation and Conclusions

Blus Streak demonstrated that auto users can be diverted to bus transit. The transit service must meet the needs of the travellers, however, and the service must be carefully planned and operated.

The initial rapid increase in project ridership was attributed to the massive promotion publicity campaign, which informed potential users of the new service and of the details of its operation. However, except for the park-and-ride route, the Blue Streak service appeared to meet almost all of the demand. It is questionable whether increased service or increased promotion would have attracted significantly more riders.

The park-and-ride service did not saturate its market, and it was estimated that 500 more parking spaces could easily have been filled. The park-and-ride lot seemed to be ideally situated. It was far enough from the CBD to make the mode change worthwhile; it was close enough to the CBD and to I-5 to intercept a large number of travellers. The fast, frequent Blue Streak service took the rider to the middle of the CBD in about the same time as it would have taken by auto, while relieving the driver of the cost and problem of parking.

The closing of the Cherry Street ramp to autos, the reversing of the bus travel direction through the CBD each noon, and the physical moving of the bus stops produced some initial confusion. The effect was transitory, and by the time of the Phase II surveys the effects were completely gone. The auto volumes at adjacent I-5 ramps did, of course, remain higher throughout the Phase II period.

The Service and Methods Demonstration objective of decreasing travel time was achieved. Typical travel times were reduced from 50 to 40 minutes, a 20 percent decrease.

It is likely that the benefits of Blue Streak would have been more pronounced if employment had remained at its previous level. The trends of increasing auto and personal travel toward the CBD would have continued, and the congestion on I-5 would have increased. This congestion would, in turn, have made the advantages of Blue Streak service more obvious and more important, and ridership levels and time savings would probably have been even greater than those realized.

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