Technology Sharing

U.S. DEPARTMENT OF TRANSPORTATION

OFFICE OF THE SECRETARY
AND
URBAN MASS TRANSPORTATION ADMINISTRATION

STATE-OF-THE-ART OVERVIEW AUGUST 1974

demand-responsive TRANSPORTATION

This document has been prepared by the Transportation Systems Center and is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange.

FOREWORD

On March 16, 1972, the President sent a special message to Congress wherein he called "for a strong new effort to marshall science and technology in the work of strengthening our economy and improving the quality of our life." In this message he stated that in the final analysis, " the progress we seek requires a new partnership in science and technology--one which brings together the Federal Government, private enterprise, State and local governments, and our universities and research centers in a coordinated, cooperative effort to serve the national interest."

As part of its ongoing commitment to this principle of technology-sharing, the U.S. Department of Transportation has initiated a series of publications based on research and development efforts sponsored by the Department. The series comprises technical reports, state-of-the-art documents, newsletters and bulletins, manuals and handbooks, bibliographies, and other special publications. All share a primary objective: to contribute to a better base of knowledge and understanding throughout the transportation community, and, thereby, to an improvement in the basis for decision-making within the community.

This title in the series presents an overview of demand responsive transportation, an innovative approach that may help fill the need for flexibility in public transportation. The report is designed to make more accessible the body of knowledge that now constitutes the state-of-the-art in demand responsive transportation. A special feature is the inclusion of supplementary material to serve as a sourcebook for further information.

ACKNOWLEDGMENTS

In developing this report the Technology Sharing Program Office of the Transportation Systems Center, Cambridge, Massachusetts, received extensive support, cooperation and information from the Office of the Secretary and the Urban Mass Transportation Administration. A special acknowledgment is made to the many State and local government transportation officials who participated in the process and made this document the product of a true Federal, State and local government partnership.

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FIGURES

Given today's transportation technology and facilities, there are countless techniques and combinations of techniques that could improve the efficiency of existing facilities and equipment. They can reduce congestion with accompanying alleviation of environmental problems, improve transportation service, and reduce the need for capital expenditures on fixed transportation facilities. Many of these techniques require a reorientation in the manner in which transportation problems are approached and resolved. Problems need to be viewed first in terms of better service rather than increased capacity. This is not to imply that additional capacity will not be required. In many instances it will; but the requirements could be reduced. The current institutional setting prevents or makes extremely difficult, the implementation of many of these techniques, but the cost and social and environmental impacts of constructing additional transportation facilities make it imperative that greater consideration be given to approaches that more efficiently use the existing transportation facilities. Moreover, a number of these techniques increase the number and types of transportation services available to the public. This broadens the range of options available to individuals and increases the chance that the transportation services will better serve travel needs and requirements.

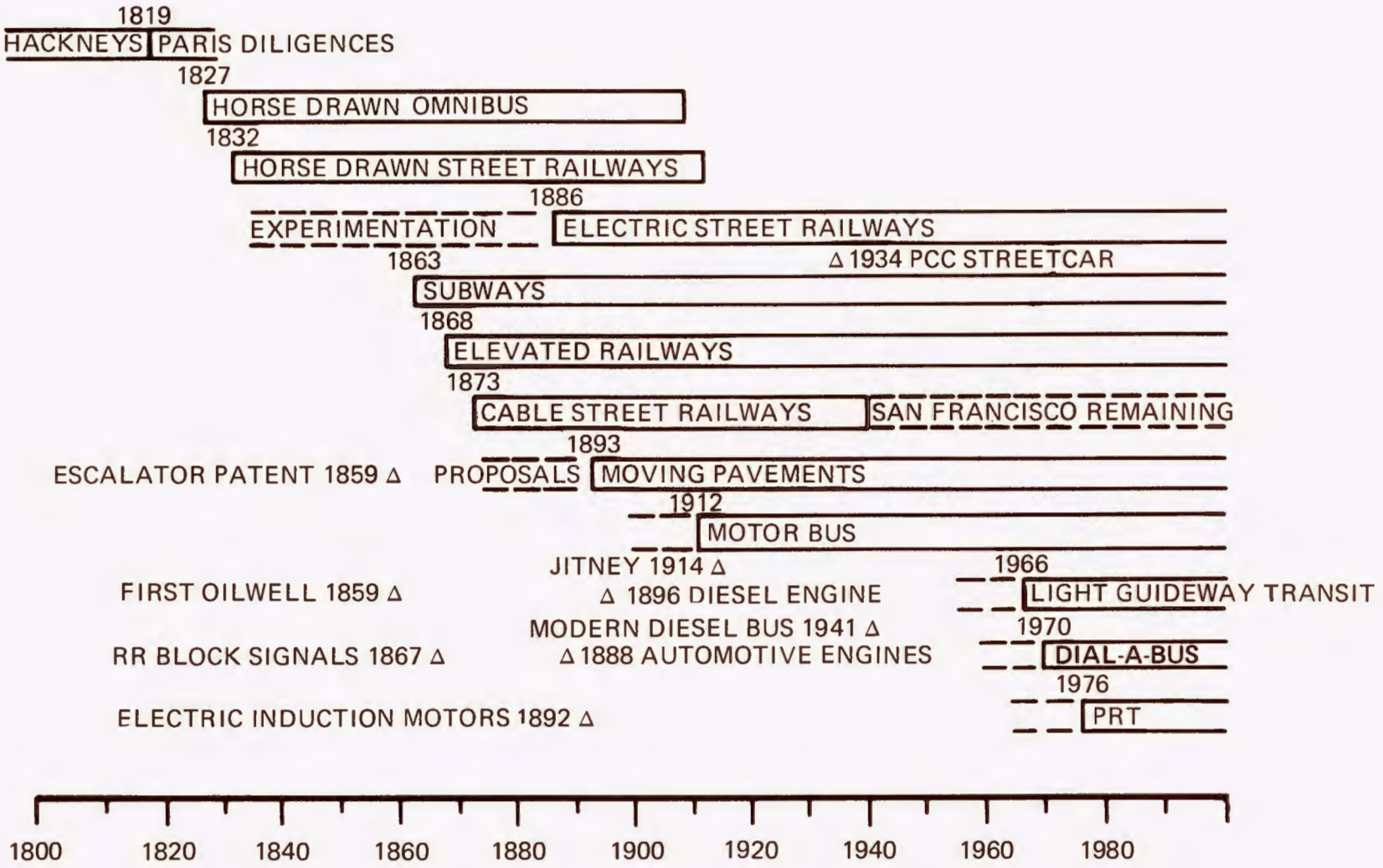
Most of the alternatives...have the attractive feature of flexibility. Transportation improvements can be made at minimum cost and the results need not be permanent. This is in contrast to construction facilities that are extremely costly, especially in built up urban areas, and that become essentially permanent features on the landscape. This quality of flexibility reduces the cost of mistakes and can encourage continuous experimentation and tailoring of transportation services to changing travel requirements.

The difficulties of implementing these alternatives should not be minimized. Institutional rigidity, established public attitudes and habits, and the interest of special groups must all be dealt with. Demonstrations must be tried to determine the full extent of the problems and effects of the various approaches, and to show whether they can work.

The potential payoffs in such approaches as well as the real possibility that soon these alternatives may be the only ones available to improve travel service require a major effort to encourage, promote, and implement them.

1972 NATIONAL TRANSPORTATION REPORT,
U.S. Department of Transportation

Chronology of Urban Transit



Source: N.D. Lea Transportation Research, Lea Transit Compendium, Vol 1 No. 1, 1974

I A PERSPECTIVE ON DEMAND RESPONSIVE TRANSPORTATION

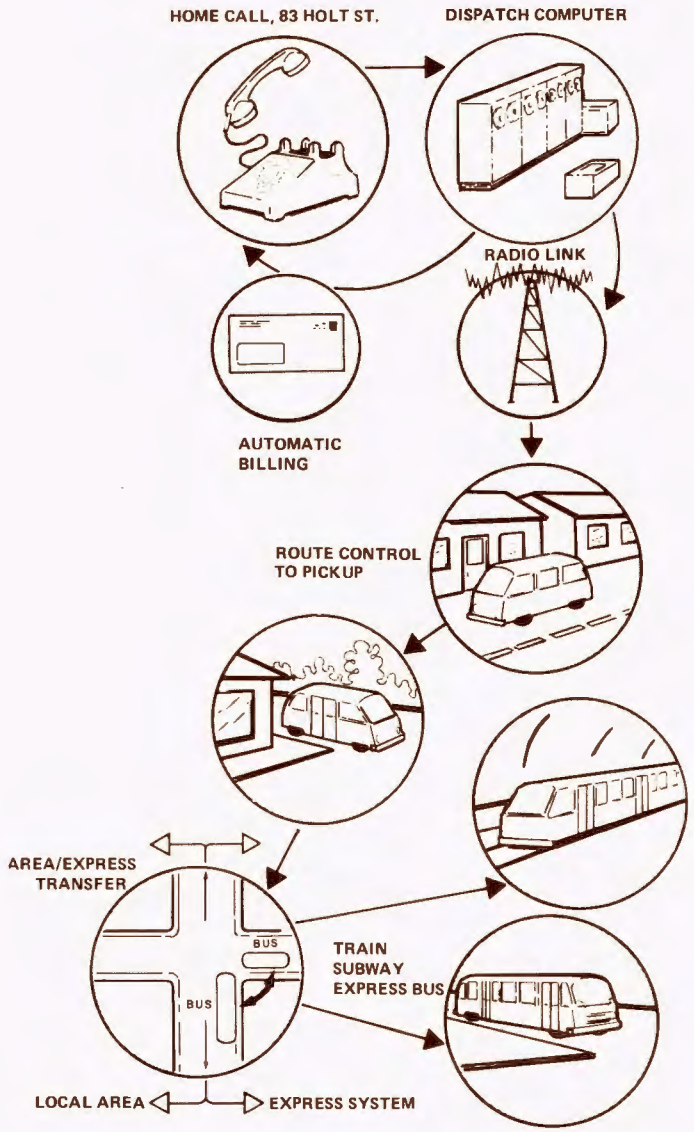
the market context of demand responsive transportation

IN RECENT YEARS attention has been focused on the need for adequate public transportation in a society increasingly dispersed and increasingly dependent on the private automobile. In an age of unparalleled personal mobility, large segments of the population are "transportation poor," including the elderly, the very young, the impoverished, the handicapped, and in some circumstances even the one-car family. At the same time pressures are increasing to constrain automobile traffic, reflecting growing environmental awareness and concern for the quality of urbanized life. The recent energy crisis and inflationary pressure on disposable income have given added impetus to a general movement among transportation planners and concerned citizens to provide an acceptable alternative to the automobile.

However, it is generally recognized that conventional public transportation suffers from major limitations. One form of public transportation, the private taxi,* does supply a high quality of service in terms of personalized, door-to-door transportation on demand,

*The taxicab is not regarded as a form of urban *mass* transit. It is, however, a public transit vehicle that plays an important role in moving people within urbanized areas. (Institute for Defense Analyses, Economics Characteristics of the Urban Public Transportation Industry, U.S. Department of Transportation, February 1972.)

Demand Responsive Service



Source: Reference 69

but the fare is prohibitively high for many potential users. The alternative, mass transit -- scheduled rail or bus services--is constrained by the economics of line-haul operations and cannot adequately serve the lower-density areas that now represent the bulk of the U.S. population. Service levels even in center-city areas have deteriorated as patronage has declined. Moreover, traditional transit systems were not designed to accommodate the aged, infirm or handicapped patron. Although some improvements may be implemented in this area, conventional transit cannot be expected to respond fully to specialized needs.

More specific deficiencies with respect to public transit service in lower-density areas reflect the lower volumes of traffic and the increased dispersion of origins and and destinations. Thus the transit environment in many suburban areas has been characterized by:

--lack of any transit service at all in some areas
--infrequent and unreliable service
--inefficient utilization of vehicles
--inflexible routing
--poor connecting service
--slow speed and delays
--crowding and lack of comfort
--noise
--lack of scheduling information
--exposure to crime
--exposure to inclement weather

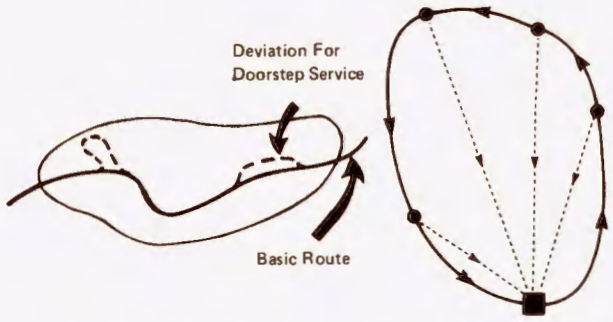
Efforts to supplant the automobile or to generally upgrade existing public transportation have produced a variety of transit innovations and service improvements ranging from aggressive marketing techniques to para-transit approaches such as carpooling, subscription bus services and jitneys. One of the most promising innovations is demand responsive transportation, the concept of flexibly-routed, personalized transportation available to serve individual demands.

the concept of demand responsive transportation

Demand responsive transportation denotes a range of public transportation services characterized by the flexible routing and scheduling of relatively small vehicles to provide shared-occupancy, door-to-door personalized transportation on demand and at modest fares. Demand responsive transportation thus represents a hybrid form of traditional bus and taxi service, combining the economic efficiencies of line-haul mass transportation with with the point-to-point flexibility, convenience, and security of private taxis.

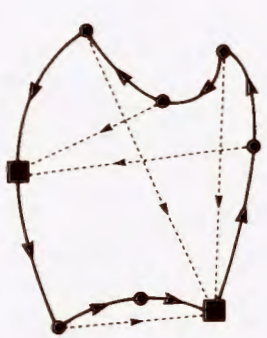
Shared-taxi services operating door-to-door qualify as demand responsive transportation. Indeed, at least two successful taxi-based demand responsive transportation

Service Patterns

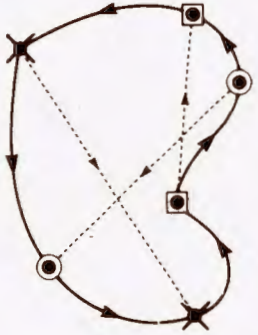


(1) ROUTE DEVIATION

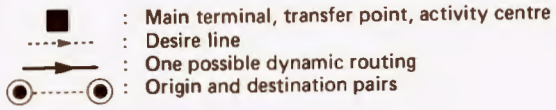
(2) MANY-TO-ONE



(3) MANY-TO-FEW



(4) MANY-TO-MANY



Source: (1) Reference 1
(2), (3), (4) Reference 77

services presently operate in the United States, and the taxi industry has recently indicated strong interest in participating in the development of demand responsive transportation. However, most demand responsive transportation services to date have been implemented by public transit organizations to supplement or replace existing transit services.

The basic operation of a demand responsive transportation service involves dispatching a vehicle in response to a telephoned request for service to carry the patron to his destination, while simultaneously accommodating in the vehicle other patrons whose requests for service are compatible in terms of both time and geography. The actual number of intermediate stops made between the origin and destination of a particular passenger will vary with the pattern of demand responsive transportation service offered, the time of day, the capacity of the vehicle, the level of service offered, as measured in terms of waiting time and travel time for passengers, and other parameters of a particular service.

The patron's request for service may be made just before the trip is to be made, or in advance. A particularly important case of advance request is subscription service provided to patrons who wish to utilize the service on a daily or other regular basis.

The basic elements of a demand responsive transportation service are thus: a fleet of vehicles, a means of communication between the patron and the service, a means of communication between the service and the vehicle drivers, and a control center to receive requests for service and schedule and dispatch vehicles. Around these basic elements, the concept of demand responsive transportation service lends itself to a variety of configurations in terms of organizational character, degree of automation, equipment, work force, service patterns, size of service area, and market role.

There are two kinds of demand responsive transportation service. The first, route deviation, is a limited form, in which a vehicle will deviate from a regular fixed route to pick up or discharge a passenger at a requested location, typically within several blocks of the main route. The more common kind is known as "pure" demand-responsive service, wherein the routing and scheduling of vehicles depends entirely on the particular requests of patrons. Three variants of the pure form may be employed as a basic service pattern:

- Many-to-one--providing transport from several origins to a common destination, such as a shopping center or bus terminal.
- Many-to-few--providing transport from multiple origins to a few destinations, such as major activity centers or points on a downtown loop.
- Many-to-many--providing transport between any origin-destination pair in the service area without limitation.

These service patterns may be used alone, in reverse, or in combination throughout a

Demand Responsive Vehicle Equipped for Wheelchair Patrons

service area or on a zonal basis, depending on the characteristics of the service area.

Demand responsive transportation is too new a transportation concept to have been institutionalized. Although it is easy to identify the market roles it serves on the spectrum between fixed-route and taxi services, it is not so easy to characterize its institutional role. As a hybrid, demand responsive transportation partakes of both transit and taxi features, in terms of operations, technology, and economics. As a member of a regulated industry, it is subject to constraints on innovation generally that may strongly influence the implementation and integration of demand responsive transportation services in particular jurisdictions. Some of the considerations and developments with respect to institutional issues are discussed in Chapter III. At this point it seems fair to observe that the outlook for achieving the full potential of demand responsive transportation services is most favorable when undertaken by a public authority or agency.

the role of demand responsive transportation

Demand responsive transportation services can perform a variety of important roles with respect to improving the level of existing transportation services available to a community, such as:

- Feeder service to line-haul transit--the collection and distribution functions to provide door-to-door service for commuters and other transit patrons cannot be performed efficiently in traditional transit operations. By using demand responsive transportation to improve the overall level of service available to transit patrons, additional demand is generated for the line-haul operations.
- Replacement service for conventional buses in low-density areas or at periods of low demand--demand responsive transportation provides a higher-quality service for areas or times, such as weekends and evenings, that cannot economically support traditional bus service.
- Route rationalization--demand responsive transportation is used to identify appropriate placement and revisions of fixed route service.
- Specialized service for the handicapped and elderly--demand responsive transportation vehicles can be designed to accommodate wheelchairs or other special equipment for the infirm or handicapped. Many elderly persons cannot negotiate the steps or long walking distances involved in using traditional transit, cannot afford the expense of taxi fares, and do not have an automobile available. Demand responsive transportation can be tailored to their needs.
- Substitute for or alternative to private automobile--even for the relatively affluent, demand responsive transportation can provide an appealing alternative to driving or riding in a private auto for such trip purposes as shopping, chauffeuring children, attending meetings, and commuting to work. Demand

responsive transportation adapts well to non-radial and offpeak suburban trips that are not served adequately by traditional transit, and can offer the convenience of subscription service.

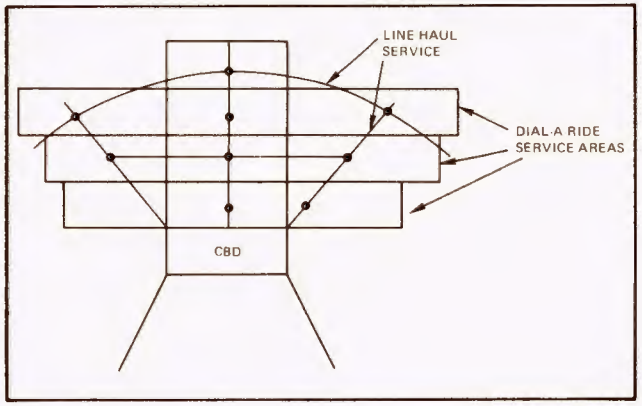
Other specialized segments of the transportation market that have been served by demand responsive transportation include:

--parcel delivery
--airport shuttle service
--delivery of mail from post office boxes to business firms and local institutions
--transfer of business data among branch banks
--transportation of blood and other hospital supplies
--shopping services sponsored by retailers
--transportation of children to school
--transportation of tavern patrons home.

Demand responsive transportation can also contribute to meeting national transportation goals. In his message to Congress in May 1973 on implementing national transportation policy, the Secretary of Transportation emphasized two important goals: first, to exploit low-capital-intensive opportunities to improve the service and capacity of existing resources; and second, to limit the harmful side effects of transportation, such as environmental damage. Demand responsive transportation services can help achieve both these goals.

- Demand responsive transportation is labor-intensive, rather than capital-intensive. The turnkey cost of a small demand responsive transportation service can be kept under $100,000, with opportunities to reduce initial costs by leasing the hardware components and contracting for labor.
- Demand responsive transportation utilizes the existing highway network and therefore requires no investment in expensive rights-of-way.
- Demand responsive transportation can serve to improve the utilization of existing transit services and facilities either directly by providing feeder service, or indirectly by identifying more appropriate routes or markets for fixed-route scheduled services. It can also offer employment to transit labor that would otherwise be underutilized.
- Demand responsive transportation utilizes existing technology. The components of a manual demand responsive transportation service are readily available, and the technology to support advanced automated, integrated operations is being developed.
- Environmental damage can be minimized by deploying aesthetically-appealing vehicles that meet higher standards of quiet, pollution-free operation than are typical of traditional buses or taxis. Conservation of energy resources could also

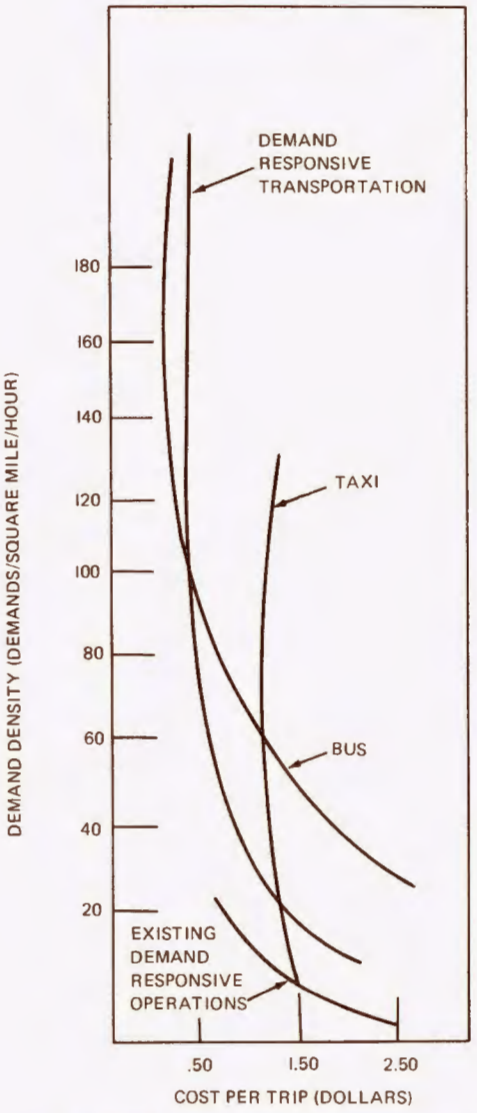
Mass Transit with Demand Responsive Transportation



Coordinated Mass Transit System Components

- DIAL-A-RIDE FEEDER/DISTRIBUTION SERVICE IN SUBURBAN AREAS
- DIAL-A-RIDE LOCAL TRANSIT IN SUBURBAN AREAS AND OFF-PEAK
- FIXED ROUTE FEEDER/DISTRIBUTION/LOCAL SERVICE IN CBD
- EXPRESS BUS IN MEDIUM DEMAND CORRIDORS
- RAPID TRANSIT IN HIGH DEMAND CORRIDORS

Comparative Passenger Costs



Source: Adapted from Arthur Saltzman, "PARA-TRANSIT: TAKING THE MASS OUT OF MASS TRANSIT," *TECHNOLOGY REVIEW,* July/August 1973.

be achieved to the extent that traffic is diverted from less energy-efficient modes.

the economics of demand responsive transportation

The economic viability of a demand responsive transportation service is determined by the supply characteristics of the service and the demand characteristics of the market area in which a service* is implemented. Generally, these factors interact to produce a steady level of ridership that is reasonably predictable for purposes of day-to-day operations and for analysis of longer-term potential. A pattern of normal variations by hour, day, or season will emerge, based on local conditions. The overall ridership of a service may increase over time, as the service is tailored to suit its particular market or may change in response to changes in the supply or demand variables. The object is to achieve a position that justifies operation of a demand responsive transportation service, ultimately in terms of financial performance. (Satisfactory financial performance does not necessarily imply a net operating profit, but includes providing services at an acceptable level of subsidy. It can also refer to the economic contribution of a service to the improved performance of another transportation service such as a line-haul transit system. These are matters for local decision.)

Characteristics of supply and demand that are necessary to achieve a viable service that is appropriate to local objectives have not been fully identified. For example, the sensitivity of demand to fare levels has not been established. (In one case, the reduction in demand predicted to result from a fare increase failed to materialize.) However, some insights have been gained from experience. These are noted in the following discussion of supply and demand factors.

SUPPLY. Demand responsive transportation is a labor-intensive enterprise. The overhead expense of the control center and driver wages represent the major portion of operating costs, and they are essentially fixed. They vary primarily with hours of operation, whether or not revenue is being generated. Thus, the economic object of the operator is to maximize the revenue-generating capacity of each vehicle, within the constraints of the service objectives. To do this, the operator may select or manipulate the key variables of a demand responsive transportation service: the size of the service area, the number and type of vehicles, the fare structure, hours of operation, operating patterns, and special services. The operator can determine the overall "level of service" for the demand responsive transportation service. Level of service is expressed in terms of wait times and travel times incurred by a patron. As a rule of thumb, it is considered necessary to maintain the level of service such that the ratio of waiting plus travel time for a demand responsive trip to the time required to make the same trip by private automobile does not

*"Service" is used to denote an operating entity that provides demand responsive transportation.

exceed 3.0.* Higher ratios would presumably deter potential patronage, except where the ratio represents short periods of time in absolute terms (e.g., a ratio of 5.0 might be derived from absolute values of 10 minutes and 2 minutes respectively.) The level of service measure is not entirely satisfactory because it incorporates waiting time. Surveys have shown that patrons waiting at home are more concerned with an accurate estimation of the arrival time than with the length of time spent waiting for the vehicle.

The key indicator of economic performance is vehicle productivity--the degree to which the fleet generates revenue--measured in terms of the number of trips or requests per vehicle per hour. An individual vehicle must be deployed efficiently so as to minimize mileage and time spent in picking up and transporting passengers; the fleet must be deployed efficiently so that a given fleet can accommodate as many requests for service as possible. However, there are important tradeoffs. The level of service decreases as productivity increases, so that at some point demand may be affected. Conversely, increasing the number of vehicles in an area increases the quality of service, but the marginal cost may not be offset by marginal revenue.

Experience has shown that vehicle productivity in the many-to-many mode generally averages 7.0. This may or may not be sufficient to cover driver costs, depending on local wage rates and the fare level. Maximum achievable productivity to date is from 15 to 20, however, Regina has shown a productivity significantly higher with subscription service. Below a minimum level of productivity, there is no advantage over conventional taxi service. The maximum level sets an upper limit on financial performance for a given fare level, since it represents the maximum number of fares that can be collected.

Productivity varies with the type of service and vehicle supplied: many-to-many is typically associated with lower productivity than many-to-one or many-to-few. The maximum potential productivity of taxis is inherently lower than that of buses, although this is offset by the lower capital and operating costs. In addition, productivity will vary with such operating parameters as average length of trip.

DEMAND. As noted in a MITRE report (Reference 59): "The size of the market for a demand responsive system cannot be directly manipulated by the operator. By varying such service characteristics as fleet size, fare, service area, and hours of operation, the operator can create conditions that will stimulate demand for service. However, there also exist a number of factors that he cannot vary and that will strongly influence the magnitude and nature of demand. Any operator must take these factors into account and structure his service to account for them in order to maximize ridership."

*Haddonfield and New Jersey D.O.T. use 2.5.

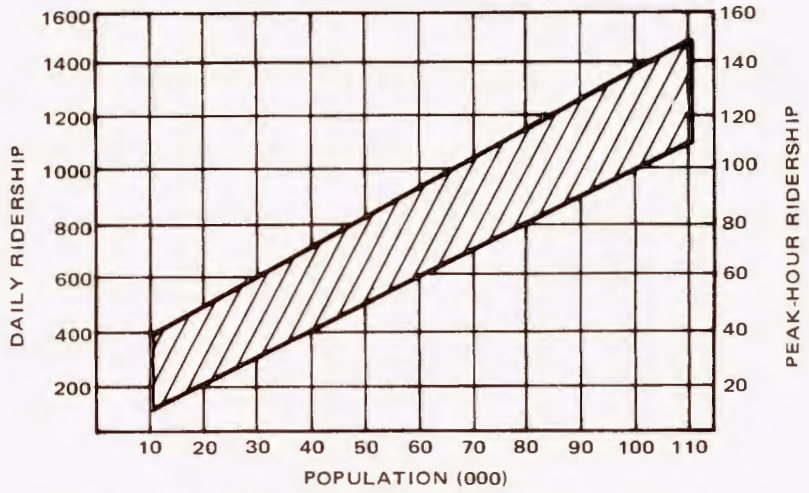
These factors are: (1) the origin and destination of trips made by the service area population; (2) quality of service available via alternative modes, including private automobiles; (3) user characteristics, such as age.

The limited demographic data available on users of demand responsive services indicates a disproportionate number of elderly and female users, although this may reflect largely the market sought by particular services. Demographic data may be particularly useful in considering latent demand. A Haddonfield survey showed that 12 percent of the trips made on Dial-A-Ride would not have been made if the service did not exist. A similar survey in Ann Arbor showed a 20 percent latent demand.

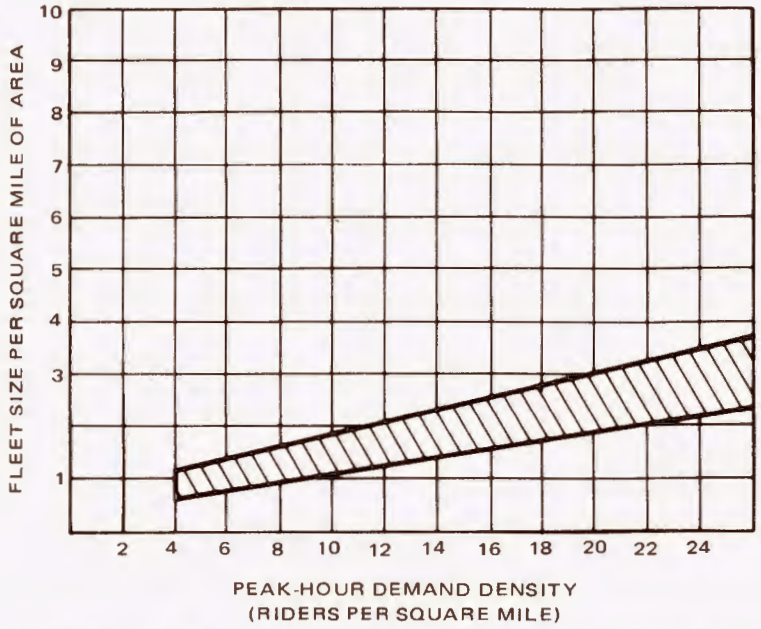
As important as the gross volume of demand, is the distribution of demand, in terms of spatial and temporal characteristics. The spatial distribution is expressed as demand density, i.e., the number of demands per square mile; the temporal distribution is the number of demands per hour, and is typically calculated for both peak hour and average daily demand. The more concentrated the demand, the more likely that satisfactory vehicle productivity can be achieved. Criteria for demand distribution have not been conclusively established for the various configurations of demand responsive service, although it is intuitively apparent that taxi-based services can be viable at lower concentrations of demand. Both taxi- and transit-type services are well-advised to exploit any opportunity for subscription services. These are efficient both in terms of vehicle productivity and in terms of control center efficiency, since subscription tours can be pre-planned at off-peak periods.

PLANNING GUIDELINES. A recent MITRE report (reference 59) has developed planning guidelines based on a very small sample for use by planners designing demand responsive transportation services. The facing illustration has been excerpted from this document and should not be used apart from the supporting materials contained in the report. These guidelines are presented only as an illustration of the types of relationships to be developed by a more complete study and identify important economic relationships. The Transportation Systems Center is in the process of identifying these relationships for the 80 services listed in Appendix A.

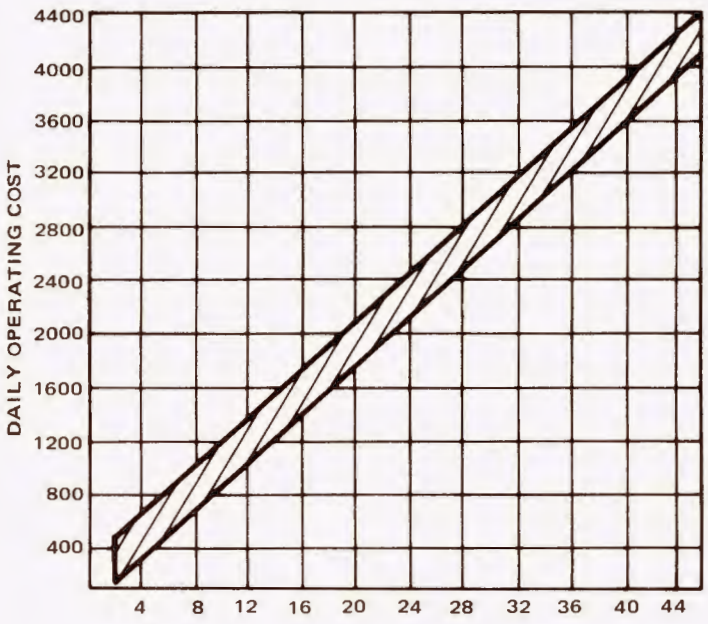
EXAMPLE OF PLANNING GUIDELINES*



DAILY AND PEAK-HOUR RIDERSHIP VERSUS POPULATION



FLEET SIZE PER SQUARE MILE VERSUS PEAK HOUR DEMAND DENSITY



DAILY OPERATING COST VERSUS FLEET SIZE

*Note. These graphs are only *examples* of the types of tools available to the planner and should not be used without the supporting materials of the total reference document.

Source: Reference 59

Figure 1. Chronology of 80 Demand Responsive Services

1916	Atlantic City, NJ*
1946	Little Rock, AK (E)
1958	Ft. Leonard Wood, MO
1961	Hicksville, NY (E)
1964	Peoria, IL (T)
1967	Gothenberg, Sweden
1968	
Feb:	Reston, VA
Sept:	Flint, MI (T)
1969	
Jan:	Menlo Park, CA
Dec:	Mansfield, OH (T)
1970	
May:	Emmen, Netherlands
July:	Bay Ridges, Ontario
Aug:	Merced, CA
Oct:	Ft. Walton Beach, FL (T)
Dec:	Buffalo, NY (E)
1971	
Jan:	Columbia, MD (E)
	Kent, OH (T)
July:	Scott-Carver Counties, MN
Sept:	Ann Arbor, MI (E)
	Regina, Saskatchewan
Oct:	Batavia, NY
	Columbus, OH (E)
1972	
Jan:	Willingboro, NJ
Feb:	Detroit, MI (E)
	Haddonfield, NJ (E)
	Franklin County, ME
	Toledo, OH (E)
June:	Lincoln, NB
	Medford, OR
Aug:	Klamath Falls, OR (T)
	Rhode Island State
Sept:	Dallas, TX
	Stratford, Ontario
	West Palm Beach, FL
Oct:	Kingston, Ontario
Nov:	Sudbury, Ontario
1973	
Jan:	Kent, OH
	La Habra, CA
	Lower Naugatuck Valley, CT
Feb:	Davis, CA
May:	La Mirada, CA
June:	Helena, MT (E)
July:	Grand Rapids, MI (E)
Aug:	Bramalea, Ontario
	Ottawa, Ontario
	Kingston, Ontario
	Rochester, NY
Sept:	Los Angeles, CA
	New Orleans, LA
	St. Petersburg, FL
Oct:	Toronto, Ontario (E)
Nov:	Bensenville, IL
Dec:	Cleveland, OH
	Calgary, Alberta
	El Cajon, CA
	Hartford, CT
1974	
Jan:	Hemet, CA
Feb:	Holland, MI
	Luddington, MI
Mar:	Mt. Pleasant, MI
Apr:	Sault Ste. Marie, MI
	La Mesa, CA
May:	Cambridge, Ontario
	Merced, CA
	Traverse City, MI
June:	Dover, DL
	Fairfax City, VA
	Midland, MI
	Isabella County, MI
July:	Alpena, MI
	Houghton-Hancock, MI
	Richmond, CA
Sept:	Washington, DC
	Benton Harbor-St. Joseph, MI
Fall:	Cleveland, OH
	Santa Clara County, CA
1975	Rockville, MD

(E) Subsequently Expanded
(T) Terminated

*Information on other jitney services in the United States was not available for this report.

Source: APPENDIX A

II SUMMARY OF DEMAND RESPONSIVE TRANSPORTATION SERVICES IN NORTH AMERICA

inventory and profile

A CHRONOLOGICAL LISTING of demand responsive transportation services appears as Figure 1. Although the forerunner of demand responsive transportation type service in the United States originated in 1910 with touring-car jitneys, the concept as applied to transit service was not implemented until 1964. Since that time demand responsive transportation has been developed to a point where the goal of providing services fully integrated with other community and regional transportation is now being pursued. As of May 1, 1974, there are 57 demand responsive transportation services in the U.S. and Canada known to be operating.*

Information on 80 demand responsive transportation services is presented in Appendix A. In addition to the 57 North American operations, these include 2 in Europe, 1 in South America, 6 U.S. services now terminated, 13 new services in the U.S. and 1 new service in Canada. They represent 2 jitney services, 9 taxi-based operations and 69 bus-based operations.

*This inventory does not purport to be exhaustive but represents all services identified in the course of reviewing the literature on demand responsive transportation. Many small-scale services are believed to be operating at the local level, generally limited to transportation of the elderly or handicapped. The Transportation Systems Center is planning to survey such services early in fiscal 1975.

Figure 2. Summary Profile of 57 Demand Responsive Transportation Services in North America as of May 1, 1974

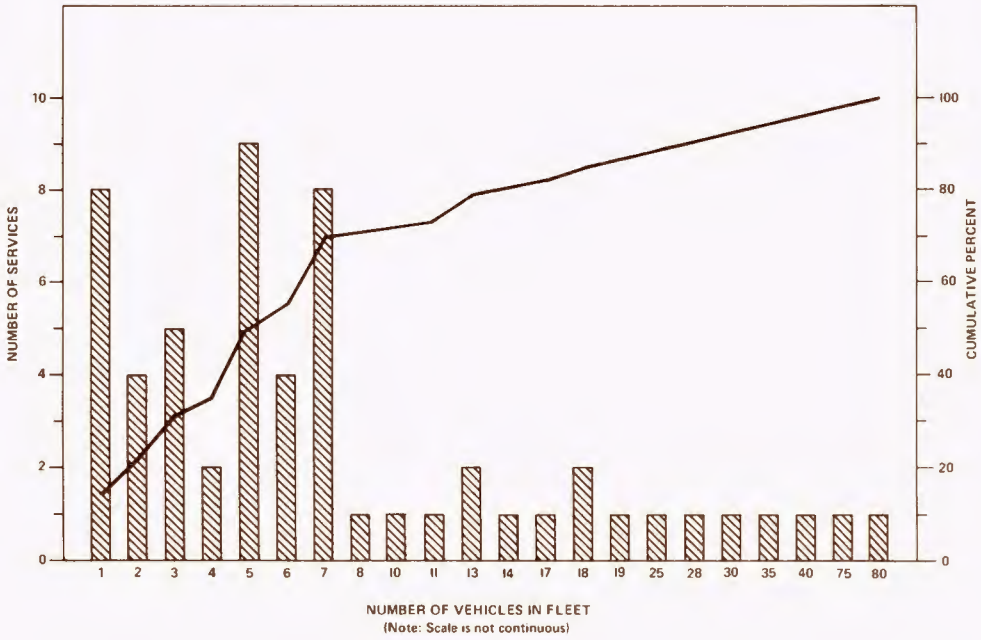
a) Number of Services

- Presently Operating 57
  - U.S. 48
  - Canada 9
- Terminated (U.S.) 6
- Expanded 19
  - U.S. 16
  - Canada 3
- Planned New Services (U.S.) 11
- Planned Expansion (U.S.) 1 (1974)

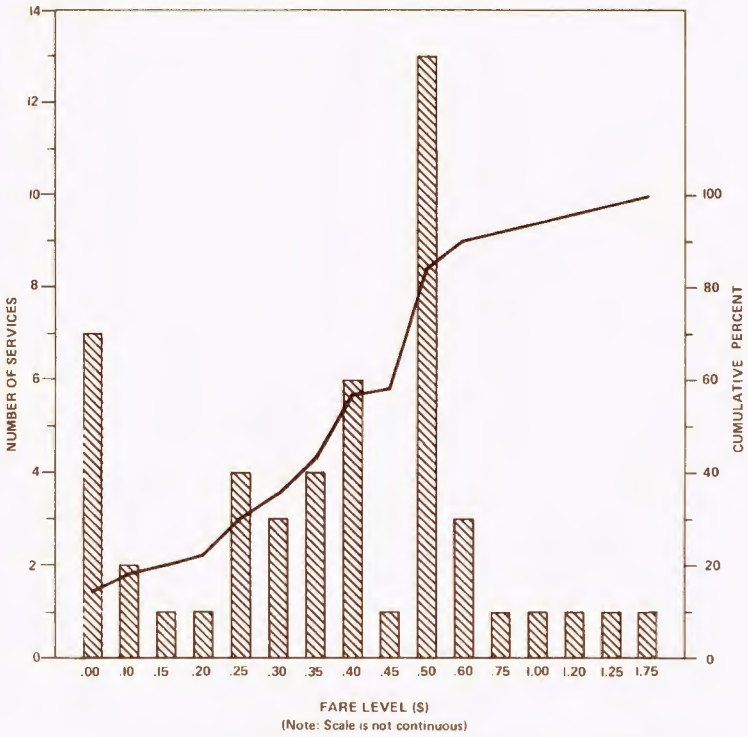
b) Service Patterns of Presently Operated Services

• Many-to-many only	35
• Many-to-one only	3
• Many-to-few only	5
• Many-to-many and many-to-one	7
• Many-to-many and many-to-few	1
• Other	6
	57

c) Fleet Size of 57 Services



d) Fare Level of 57 Services



Source: APPENDIX A

A summary profile of the 57 services in the United States and Canada is presented in Figure 2. The profile of operating services may be summarized as follows:

- Service Patterns: most offer many-to-many, although a few services offer either many-to-one or many-to-few only. Some operators employ a combination of service patterns, depending on the characteristics of the market being served.
- Vehicle Fleet: at present, most demand responsive services are extremely small-scale. Eighty percent of the demand responsive transportation services involve fewer than 14 vehicles. This is not surprising in view of the historical development of demand responsive transportation through local initiatives, but does suggest the difficulties as well as the opportunities inherent in expanding the number and scale of operations.
- Fare Structure: seven servi[illegible] are provided at no charge to their customers, including the Detroit Model Cities and the Davis, California senior citizen service. The senior citizen service in the Cleveland Model Cities area accepts donations for service (not shown on graph). Cash fares range from the most expensive, taxi-based fares of over $1.00 down to 10 cents for route deviation and jitney services. The single most popular fare is 50 cents (13 services). More than 50 percent of the services charge between 35 and 60 cents. Many services offer discounts for senior citizens, multiple trips, and group tickets.

characteristics of selected services

Data on operating characteristics of demand responsive transportation services and the demographics of demand responsive transportation service areas are limited. Figure 3 tabulates the operating characteristics of 15 American and 9 Canadian demand responsive transportation services for which data were available*. On the basis of the information in Figure 3 and Appendix A, characteristics of the 24 services may be summarized as follows:

- Service Objectives: varied widely from supplying first transit service in the area (Bramalea) to maximizing profit (Hicksville shared-taxi). Twelve services were attempting to improve transportation, and 8 services set out to evaluate or measure various demand responsive transportation parameters.

*Ann Arbor, Michigan; Batavia, New York; Bay Ridges, Ontario; Bramalea, Ontario; Buffalo, New York; Columbia, Maryland; Columbus, Ohio; Davenport, Iowa; Detroit, Michigan; Ft. Walton Beach, Florida; Grand Rapids, Michigan; Haddonfield, New Jersey; Hicksville, New York; Kingston, Ontario; La Habra, California; La Mirada, California; Little Rock, Arkansas; Lower Navgatuck River Valley, Connecticut; Mansfield, Ohio; Metropolitan Toronto, Ontario; Ottawa, Ontario; Regina, Saskatchewan; Rochester, New York; and Stratford, Ontario.

Note: Not all summaries are the result of all services reporting data. When less than the full 24 services reported data the number of the sample is indicated.

Figure 3. Selected Operating Characteristics of 24 Demand Responsive Transportation Services

City and State (date)	Objectives of Service	Route Selection Method	Population Density (Per/ Sq. Mi.)	Seats Per Vehicle (Vehicles)	Veh. Per Sq. Mi.	Average Vehicle Productivity (Trips/Hr./ Veh.)	Number of Employees (Equiv. Full Time)	Wage Scale	Hours of Operation
Ann Arbor, Michigan (5/74)	Test: Evaluate market response. Improve transportation for dependent groups. Test dynamic dispatching. Continuation and expansion: To provide a high quality of public transit for all.	Manual – Route radioed to driver at start of tour.	7,100	10(3) 15(6) 33(12)	1.25 to 1.8	8.0-8.5 (winter 1974)	10 disp. 80 drivers 13 admin. Includes those for scheduled buses.	Dispatcher- $5.69/hr. Driver- $5.50/hr. including benefits	Weekday 6:30 am– 11:00 pm Saturday & Sunday 8:00 am– 6:00 pm
Batavia, New York (5/74)	Reduce dependence on auto. Provide complete transit service for all.	Manual route selection. Digital communications tested. Radio to driver.	3,300	19(4)	1.4	14 subsc. 9 MTM	1 call taker 1 dispatcher	Drivers– $3.50 plus fringe benefits	6:00 am– 6:00 pm– Mon.-Fri.
Bay Ridges, Ontario (6/74)	Measure service characteristics of feeder bus service in residential community.	Manual route selection. Route radioed to driver.	10,100	17(3) 12(5) 11(6)	4.5	10.8 total 4.0-6.0 MTM	3 dispatchers	Dispatcher- $4.62/hr. Driver- $4.48/hr.	5:15 am– 1:30 am MTO 8:00 am– 4:00 pm MTM
Bramalea, Ontario (3/74)	First transit service in area.	Manual route selection.	5,250	17(3) 20(3) 24(4)	1.2	–	–	–	M-F: 6:30 am- 10:30 pm Sat: 9:30 am- 6:30 pm
Buffalo, New York (4/74)	Provide mobility and decrease isolation of blind, elderly and handicapped in Model Cities Area.	Manual route selection. 1-day advanced notice required.	2,300 eligible persons per square mile	11	2.3	–	1 dispatcher 1 secretary 3 admin. persons	Dispatcher $6.00/hr. Driver– $6.50/hr.	7:00 am– 12:00 pm
Columbia, Maryland (6/74)	Provide transit service to developing community.	Manual pick up addresses radioed to driver (evening only). Morning service prescheduled only.	3,400	10(3) 19(2) 23(5)	1.3 0.4	4-10	2 dispatchers	Drivers– $3.30 plus fringe benefits	6:30 am– 8:30 am (M-F) 7:30 pm- 11:00 pm (M-Sat)
Columbus, Ohio (9/72)	Provide mobility to Model Cities Area residents. Provide safe and convenient night transportation.	Manual-pick up addresses radioed to driver.	14,800	19	1.6	7.7	1 call taker 1 dispatcher	Drivers- $6.24/hr.	Weekday 6:00 am– 10.00 pm Saturday 8:00 am– 8:00 pm Sunday 8:00 am– 1:30 pm

Figure 3. Selected Operating Characteristics of 24 Demand Responsive Transportation Services (Cont.)

City and State (date)	Objectives of Service	Route Selection Method	Population Density (Per/ Sq. Mi.)	Seats Per Vehicle (Vehicles)	Veh. Per Sq. Mi.	Average Vehicle Productivity (Trips/Hr./ Veh.)	Number of Employees (Equiv. Full Time)	Wage Scale	Hours of Operation
Davenport, Iowa (5/74)	Provide low cost transportation to growing market area.	Computer assisted manual dispatch. Now manual – they outgrew the computer! Calls radioed to driver.	5,000	6(20)	1.0	3.55	4 Dispatchers	Dispatchers- $4.00/hr. Drivers can lease veh. or $2.50/hr. mini lease $240/wk (maxi-lease)	24 hours/ day
Detroit, Michigan (6/74)	Eliminate mobility barriers for Model City residents.	Manual route selection.	13,300	9(10) 12(2) 57(1)* 62(1)* 79(1)*	1.7	–	3 call takers 1 dispatcher 14 drivers 3 offices	$550/mo. and up. Some volunteers	7:00 am– 11:00 pm Mon-Sat Emergency Service after 11:00 pm
Ft. Walton Beach, Florida (9/72)	–	Manual-pick up addresses radioed to driver.	1,700	17	0.3 First Bus Only 24.2	–	1 dispatcher 1 office 6 drivers	–	6:00 am– 6:00 pm Mon-Sat
Grand Rapids, Michigan (9/73)	Provide transit to needy for work, personal, business, social.	Manual-pick up addresses radioed to driver.	–	17	5.5 avg. 8.0 max.	–	1 call taker 1 dispatcher	Service contracted to local bus company	6:00 am– 1:00 am 7 days/ week
Haddonfield, New Jersey (5/74)	Determine public attitude and acceptability of DRT Determine economic feasibility. Test computer	Manual-pick up addresses radioed to driver. Computer dispatching being implemented.	3,700	17(12) 10(7) 1 wheelchair	1.7	6.1 weekday 7.5 Saturday 5.1 Sundays	10 control centers 36 drivers	Dispatcher: $3.40/hr. + fringe benefits Driver: $5.67/hr. + benefits	24 hours/ day
Hicksville, New York (1/74)	Maximize profit.	Manual-pick up addresses radioed to driver.	7,100	5	4.4	2.12	–	Drivers lease the vehicle	24 hours/ day
Kingston, Ontario (3/74)	Improve evening transit service. Reduce evening transit deficit.	Manual route selection.	3,300	31(3)	0.6	12.7	–	–	6:30 pm– 11:30 pm Mon-Sat
La Habra, California (5/74)	Evaluate acceptability of DRT as primary source of local transit service.	Manual-pick up addresses radioed to driver.	6,700	19(6) 8(1)	1.0	5–7	3 Controllers 6 drivers	Drivers- $3.12 plus fringe benefits	7:00 am– 7:00 pm Mon-Sat
La Mirada, California (6/74)	Determine how well DRT would serve community transit needs.	Manual route selection. Radio to driver.	5,300	18(3) 14(3)	1	–	2 controllers 10 drivers	Dispatcher: $3.50 + benefits Driver: $3.00 + benefits	M-Sat. 7:00 am- 7:00 pm

*Schoolbuses are used for charter operations.

Figure 3. Selected Operating Characteristics of 24 Demand Responsive Transportation Services (Cont.)

City and State (date)	Objectives of Service	Route Selection Method	Population Density (Per/ Sq. Mi.)	Seats Per Vehicle (Vehicles)	Veh. Per Sq. Mi.	Average Vehicle Productivity (Trips/Hr./ Veh.)	Number of Employees (Equiv. Full Time)	Wage Scale	Hours of Operation
Little Rock, Arkansas (4/74)		Manual-pick up addresses radioed to driver.	2,500	5	1.4	--	–	–	24 hours/ day
Lower Naugatuck River Valley, Connecticut (5/74)	Develop methods to encourage transit usage to health and social services. Evaluate fares and use of credit cards.	Manual-pick up addresses radioed to driver.	40 registered persons per sq. mi.	16 in wheelchair vehicles	0.1	3 MTM plus subscription	2 call takers 1 dispatcher 3 offices 10 drivers	Drivers- $3.00- $3.25/hr. plus fringe benefits	6:00 am- 6:00 pm 5 days/ week
Mansfield, Ohio (8/70)	Test public reaction. Determine if DRT generates more revenue. Test driver as dispatcher.	Driver called directly. Driver selects route.	3,150	14	1.0	6.9 all trips	1 driver	$2.25/hr.	7:15 am- 6:15 pm Mon-Sat
Metropolitan Toronto (3/74)	Evaluate DRT as peak and off-peak mode. Measure impact on trip making. Fare and service experiments. Test computer dispatching.	Computer assisted manual dispatch. Digital communication planned.	–	17(14)	–	–	–	–	Mon-Fri: 6:30-10:30 Sat: 9:30-6:30
Ottawa, Ontario (3/74)	Service low density suburban fringe areas.	3 control centers	5,250	23(5) 22(12)	3.3	–	–	$4.67 + fringes	7:00 am 12:00 am Mon-Sat
Regina, Saskatchewan (5/74)	Reduce transit deficit. Provide viable alternatives to automobile. Reduce traffic congestion.	Manual-pick up addresses radioed to driver.	5,000	14(6) 22(4) 42(7)	2.2	18.8	2 dispatchers & 2 call takers in peak	Dispatcher- $990/mo. Driver- $4.97/hr. plus fringe benefits	6:00 am- 12:00 mid. Weekdays & Saturday 1:40 pm- 9:00 pm Sunday
Rochester, New York (5/74)	Increase and improve service in areas where little or no service existed before. To reduce costs, by improving utilization of manpower and equipment.	Manual-digital communication to driver.	4-5,000	23	0.7	10 Sub-DRT 5 Avg.	2 call takers 1 dispatcher 1 office	Drivers- $6.50- $7.00/hr. plus fringe benefits	6:00 am- .. 8:00 am Sub. 3:00 pm- 6:00 pm bus 8:00 am 4:00 pm MTM Mon-Fri
Stratford, Ontario (3/74)	Replace evening fixed route service with DRT.	Manual route selection.	5,050	31(1) 35(5)	0.7	11.3	–	–	6:00 pm- 12:00 pm Mon-Sat

Source: APPENDIX A

- Service Patterns: three route deviation, 10 many-to-many, 6 many-to-one, and 2 many-to-few. Many-to-one are primarily transit feeder operations; some serve shopping centers or schools. Hours of operation varied widely.
- Routing Method: manually selected and radioed to operator at beginning of tour. Computer-assisted manual dispatch is used in Regina and Toronto and was used in Davenport. Haddonfield and Rochester are implementing fully automated systems. Batavia, Toronto and Rochester have tested digital communications.
- Funding: Of 22 services, 9 obtained federal funds; 4, state; 12, local; and 6 used private resources. All of the reporting services are incurring net operating losses except the 3 taxi-based systems and Batavia. These 22 services may receive funding from more than one source.
- Service Areas: varied from 1.34 square miles (Bay Ridges) to over 50 square miles (Little Rock). Population ranged from 14,000 (Ann Arbor test area) to over 130,000 (Toronto, Little Rock).
- Activity Centers: schools, shopping centers, hospitals, commuter rail stations, senior citizens housing, nursing homes, business areas, hotels and motels, and fixed route bus stops.
- Competing Service Available: More than half (13) of the 24 services had at least one competing service (i.e., taxi, school bus, transit buses, and special service transportation) and some had more than one.
- Demand: The number of (one-way) trips per day ranged from 76 (Mansfield) to 2000 (Regina). Demand density was reported for 14 services and varied from 2.75 (Davenport) to 22.4 (Bay Ridges). The ratio of peak demands to daily demand ranged from 1.3 to 3.5 (5 services reporting). Average vehicle productivity was 7.1 trips per hour for the 16 services reporting this data.

Figure 4 tabulates demographic data based on the 1970 U.S. Census for the service areas of the 15 United States services. Although no extensive analysis was undertaken, the following observations indicate the wide range of areas in which demand responsive transportation has been implemented. (Data refer to the service area population, not to ridership on the demand responsive service.)

- Population by age: relatively homogeneous, at 9% pre-school, 30% age 5-19, 52% age 20-64, and 9% over 64, although proportion of elderly (over 64) ranged from 2.7% (La Mirada) to 15.6% (Detroit).
- Means of transportation to work: more than 75% of the work force used an auto to travel to work, either as a driver or as a passenger. The remaining 24% was divided evenly between public transit users and all other means.
- Unemployment rate: ranged from 1.8% (Haddonfield) to 12.4% (Grand Rapids). Excluding 4 Model Cities areas, the average rate was 3.3%.

Figure 4. Selected Demographic Characteristics of 15 Demand Responsive Service Areas in the United States

SERVICE AREA	POPULATION AGE GROUPS (%) <5	5-19	20-64	64+	TOTAL	NON COLLEGE SCHOOL ENROLLMENT	NUMBER OF WORKERS	MEANS OF TRANSPORTATION TO WORK % AUTO DRIVER	AUTO PASSENGER	BUS OR STREETCAR	SUBWAY; ELEVATED TRAIN OR RR	WALK	WORKED AT HOME	OTHER
ANN ARBOR MI TEST AREA	8.0	23.5	60.6	7.9	14065	3129	6668	73.3	12.7	1.5	0.1	8.0	1.5	2.9
BATAVIA NY	8.6	27.0	51.9	12.6	17338	4020	—	—	—	—	—	—	—	—
BUFFALO Ⓐ NY	10.7	35.1	45.1	9.1	41695	12823	9782	38.9	16.7	30.7	0.4	10.7	1.5	1.0
COLUMBIA MD	15.6	30.6	51.2	2.5	8815	—	—	—	—	—	—	—	—	—
COLUMBUS OH	9.0	28.8	48.3	14.0	28114	7156	10750	46.5	13.7	30.0	0.2	6.6	1.5	1.6
DAVENPORT IA	9.8	26.4	52.8	11.1	98469	25587	33188	70.6	13.8	3.7	0.1	7.6	1.6	2.7
DETROIT MI	8.3	22.9	52.9	15.6	103420	17491	31606	36.3	9.8	31.3	0.0	16.3	3.0	3.3
GRAND RAPIDS MI	13.7	33.3	45.0	8.0	15802	5119	4707	62.0	19.0	7.4	0.1	8.1	1.2	2.1
HADDONFIELD NJ	7.3	30.7	53.2	8.6	39882	11131	15338	68.6	9.4	3.2	10.3	3.7	1.6	3.1
HICKSVILLE NY	6.4	54.5	55.6	5.6	48075	15136	20041	68.3	11.2	1.4	10.2	6.0	1.0	1.9
LA HABRA CA	8.5	33.3	52.1	6.1	33026	9606	13274	86.4	7.6	0.2	—	2.3	1.0	2.4
LA MIRADA CA	7.0	38.7	51.6	2.7	30808	12981	12137	84.8	7.0	0.2	—	4.8	1.3	1.8
LITTLE ROCK AK	7.8	26.6	55.2	10.4	192523	45120	77386	72.2	10.7	4.8	0.0	4.1	5.8	2.4
LOWER NAUGA-Ⓑ TUCK VALLEY CT	8.7	28.3	54.3	8.6	73700	19395	—	—	—	—	—	—	—	—
ROCHESTER NY	8.8	27.9	55.3	7.9	55364	14039	23588	71.0	14.7	7.1	0.0	5.0	1.0	1.2
AVERAGES	9.1	29.8	52.1	9.0				64.5	12.0	10.0	2.1	7.3	1.8	2.3

Ⓐ Service Limited to Model Cities Residents.

Ⓑ Service Limited to Credit Card Holders.

Figure 4. Selected Demographic Characteristics of 15 Demand Responsive Service Areas in the United States (Cont.)

SERVICE AREA	EMPLOYMENT		INCOME GROUPS (%)					MEAN INCOME $(000)	AUTOMOBILES AVAILABLE			
	TOTAL CIVILIAN LABOR FORCE	UNEMPLOYMENT PERCENTAGE	<$4000	$4000-10,000	$10,000-15,000	$15,000-25,000	$25,500+		0	1	2	2+
ANN ARBOR MI TEST AREA	6973	2.9	6.3	21.8	27.5	34.7	9.6	13.2	7.0	52.0	33.7	7.3
BATAVIA NY	7400	5.2	10.3	40.8	31.5	14.6	2.9	9.9	17.6	61.6	17.9	2.8
BUFFALO Ⓐ NY	12766	9.6	34.6	44.5	15.9	3.9	1.1	6.7	60.1	33.8	5.7	0.4
COLUMBIA MD	3315	1.9	3.4	13.7	32.8	42.7	7.4	15.0	2.5	39.4	55.4	2.6
COLUMBUS OH	10750	8.3	37.3	39.2	15.8	6.7	1.2	5.4	50.2	36.9	10.7	2.1
DAVENPORT IA	40404	4.2	11.8	32.5	33.2	18.5	4.0	10.4	15.2	47.4	31.3	5.5
DETROIT MI	41405	10.9	29.1	41.3	16.7	10.5	3.1	7.9	58.1	32.6	7.3	1.8
GRAND RAPIDS MI	5420	12.4	28.1	49.2	16.3	5.7	0.6	6.4	34.4	46.9	16.6	2.1
HADDONFIELD NJ	15878	2.2	21.6	21.6	28.7	30.8	14.0	15.0	7.2	43.4	42.4	7.0
HICKSVILLE NY	31331	1.9	3.7	15.4	37.7	34.8	8.4	13.9	4.6	40.7	44.8	9.9
LA HABRA CA	12914	5.2	9.1	30.2	29.8	25.2	5.8	12.3	5.5	35.8	44.1	14.5
LA MIRADA CA	13024	4.8	4.1	17.9	36.2	35.3	6.5	13.9	1.8	24.2	56.8	17.3
LITTLE ROCK AK	80677	3.2	19.0	39.2	24.4	13.2	4.2	8.6	21.2	42.0	32.7	3.5
LOWER NAUGA-Ⓑ TUCK VALLEY CT	31648	3.2	5.7	25.9	37.8	26.4	4.2	12.1	7.5	33.7	49.2	9.6
ROCHESTER NY	24662	2.2	5.6	20.4	39.2	31.0	3.8	13.2	7.1	60.4	28.6	3.8
AVERAGES		5.2	14.1	29.9	28.2	22.2	5.6	11.0	20.1	42.1	51.6	6.2

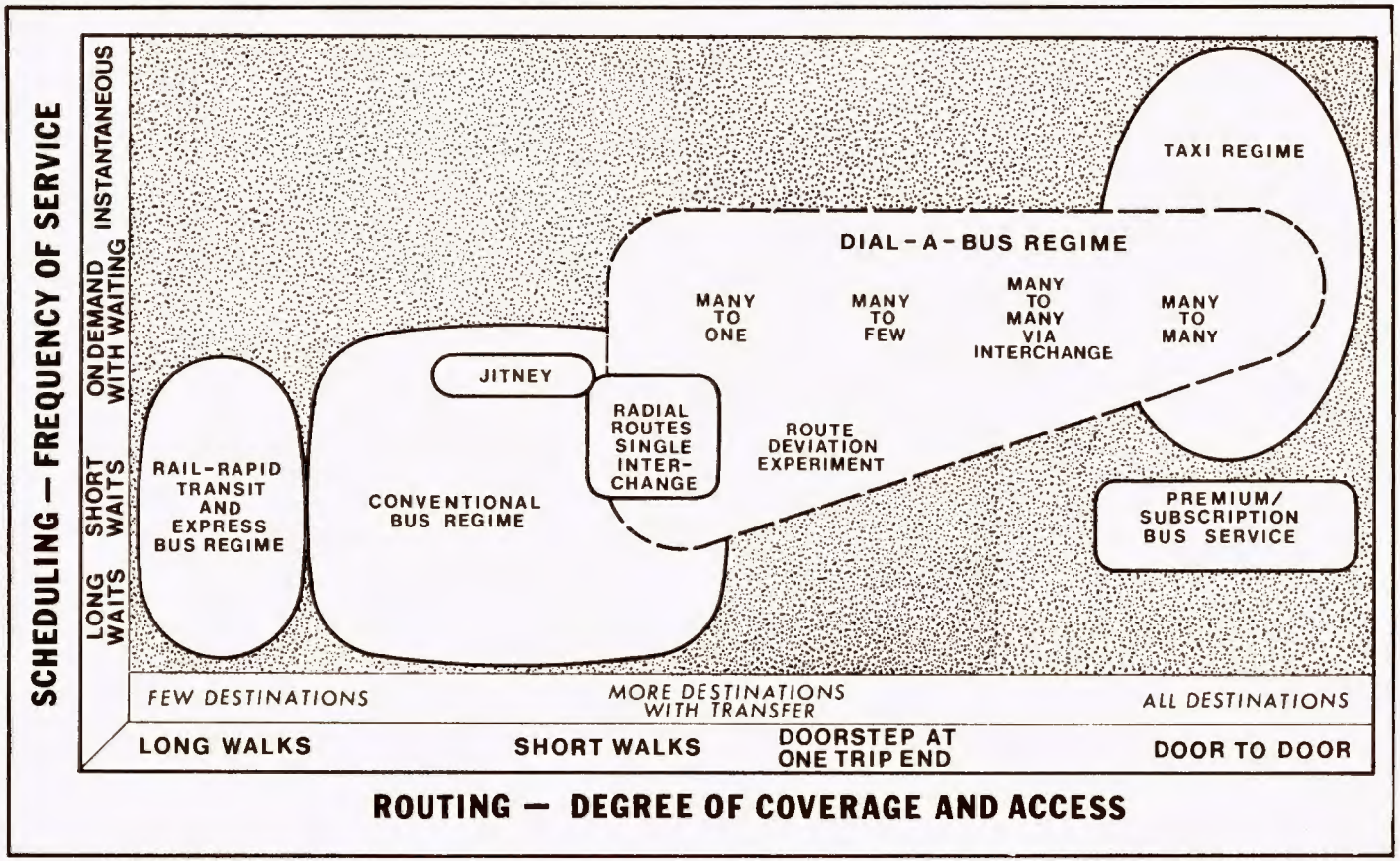
Ⓐ Service Limited to Model Cities Residents. Ⓑ Service Limited to Credit Card Holders. *Source: U.S. Bureau of the Census, 1970*

- Median income: averaged $11,000, ranging from $5,400 (Columbus) to $16,700 (Haddonfield). Areas range from poverty-stricken urban neighborhoods in Model Cities to upper-middle-class suburbs.
- Auto availability: on the average, 20% of the service area population had no auto available, 42% had only one auto available, while the remaining 38% had 2 or more autos available. In three areas, over 50% had no automobile available.

Demographic data on users of demand responsive transportation has been collected for only a few services. They indicate a disproportionate number of females and elderly persons, than the total population, using demand responsive transportation. This may reflect the market objectives of a particular service rather than a generally-applicable profile of potential users. On the other hand, females and elderly persons are also less likely to have an automobile available for their use.

Despite the limitations of the data, the overall experience reflected in this chapter demonstrates that demand responsive transportation offers significant promise of providing high-quality public transportation that can be tailored to a variety of urban and suburban situations. Initially a product of strong local initiatives, demand responsive transportation has developed to the point where highly-sophisticated, large-scale integrated systems are being instituted on a regional basis.

Conceptual Framework for Dial-a-bus Services



A Rochester, NY Demand Responsive Service Vehicle

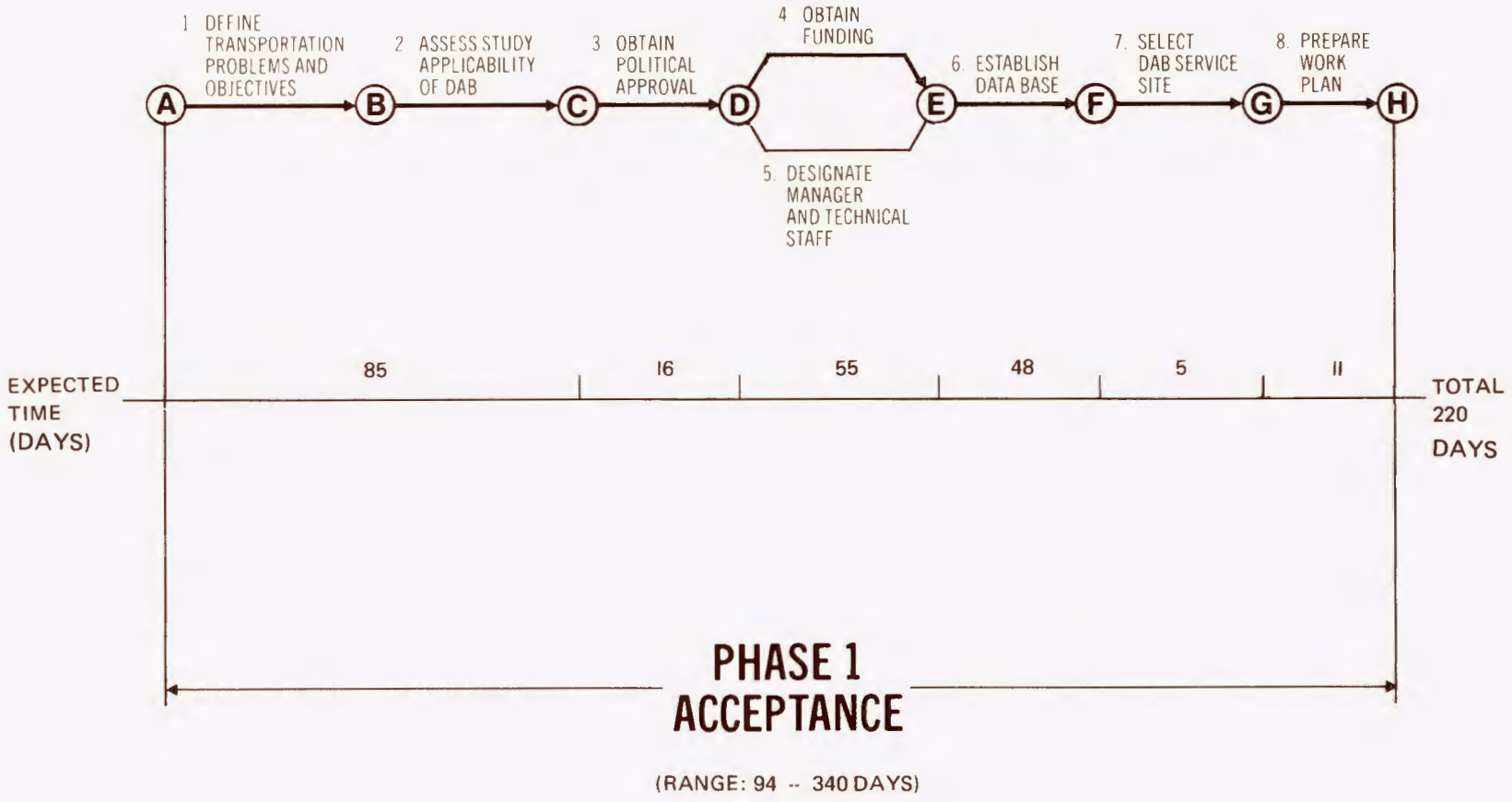
III IMPLEMENTATION OF DEMAND RESPONSIVE TRANSPORTATION

WHETHER OR NOT TO IMPLEMENT a demand responsive transportation service is a decision ideally based on thoughtful consideration of the complex factors involved in introducing an innovative transportation service. In practice, the development of demand responsive services has outpaced the analysis in many respects, and guidelines are still emerging from the experience of planners and operators to date. The purpose of this chapter is threefold: (1) to raise the major issues relevant to implementing demand responsive transportation; (2) to identify the guidelines or criteria for various aspects of demand responsive transportation that have been documented; and (3) to identify areas in which knowledge or experience is lacking. The material is organized into three sections corresponding to three phases of the implementation process: the initial decision to implement a demand responsive transportation service, planning for a specific service, and operations. The classifications are somewhat arbitrary, and in practice considerable overlap is both normal and desirable (see Figure 5).

decision-making aspects

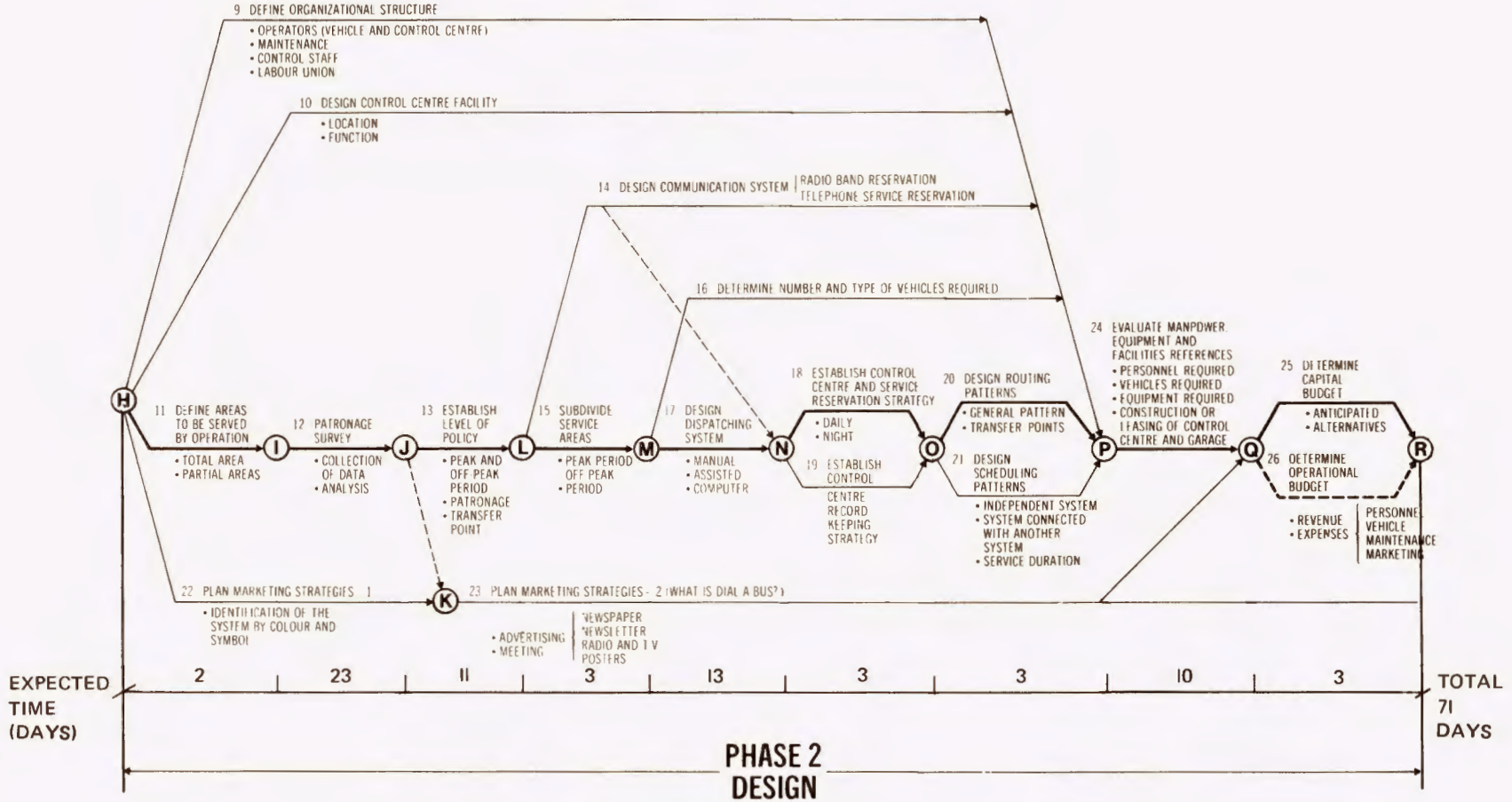
GENERAL. The product of the initial phase will be the policy decisions and objectives to support a preliminary system design. Although specific decision-making aspects are discussed here as if they were sequential and independent, it is important to recognize their interrelatedness. Many iterations may be necessary before the preliminary system design can be formulated.

Figure 5. Demand Responsive Transportation Planning Flow Chart



Source: Reference 77

Figure 5. Demand Responsive Transportation Planning Flow Chart (Cont.)



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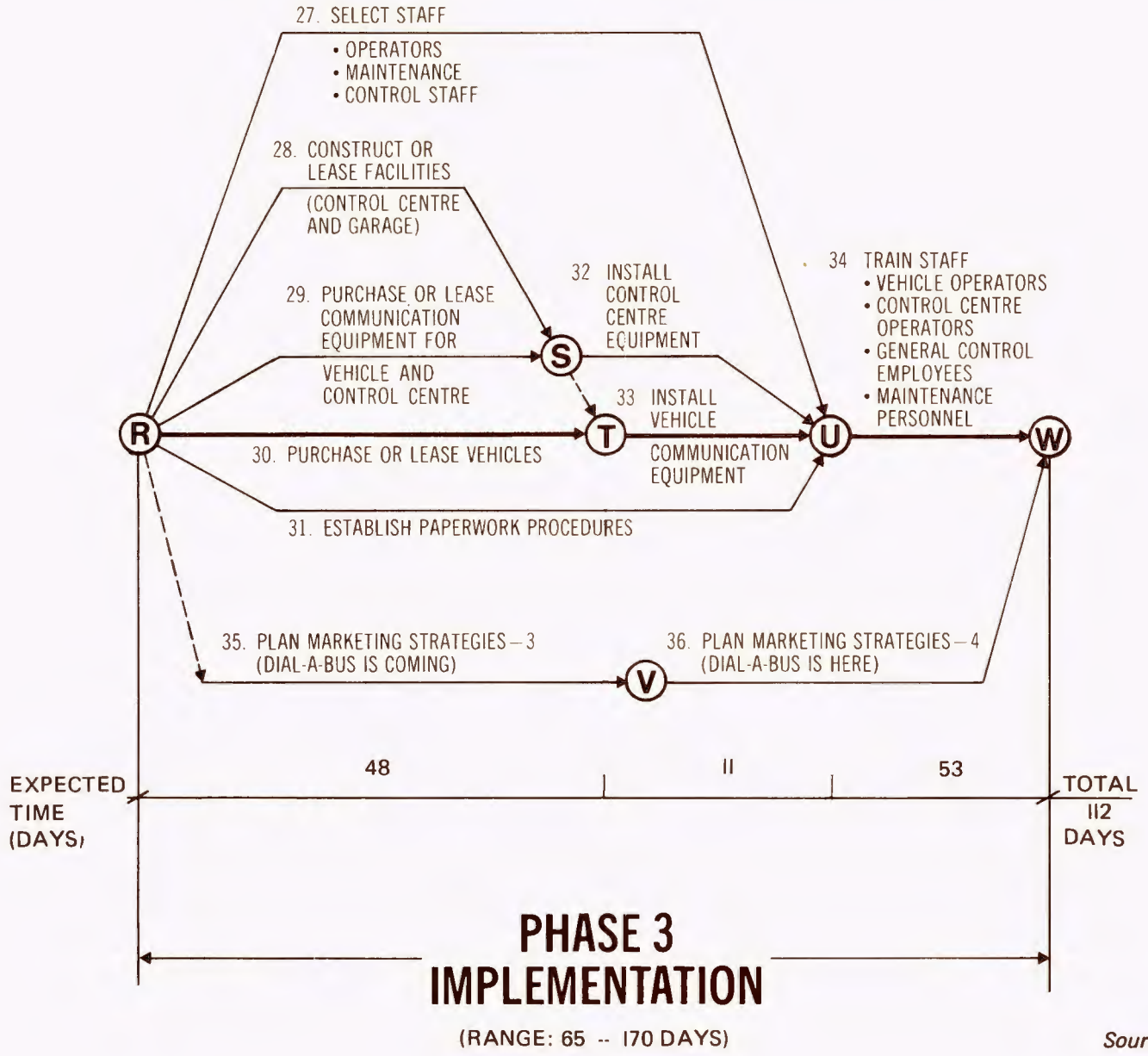
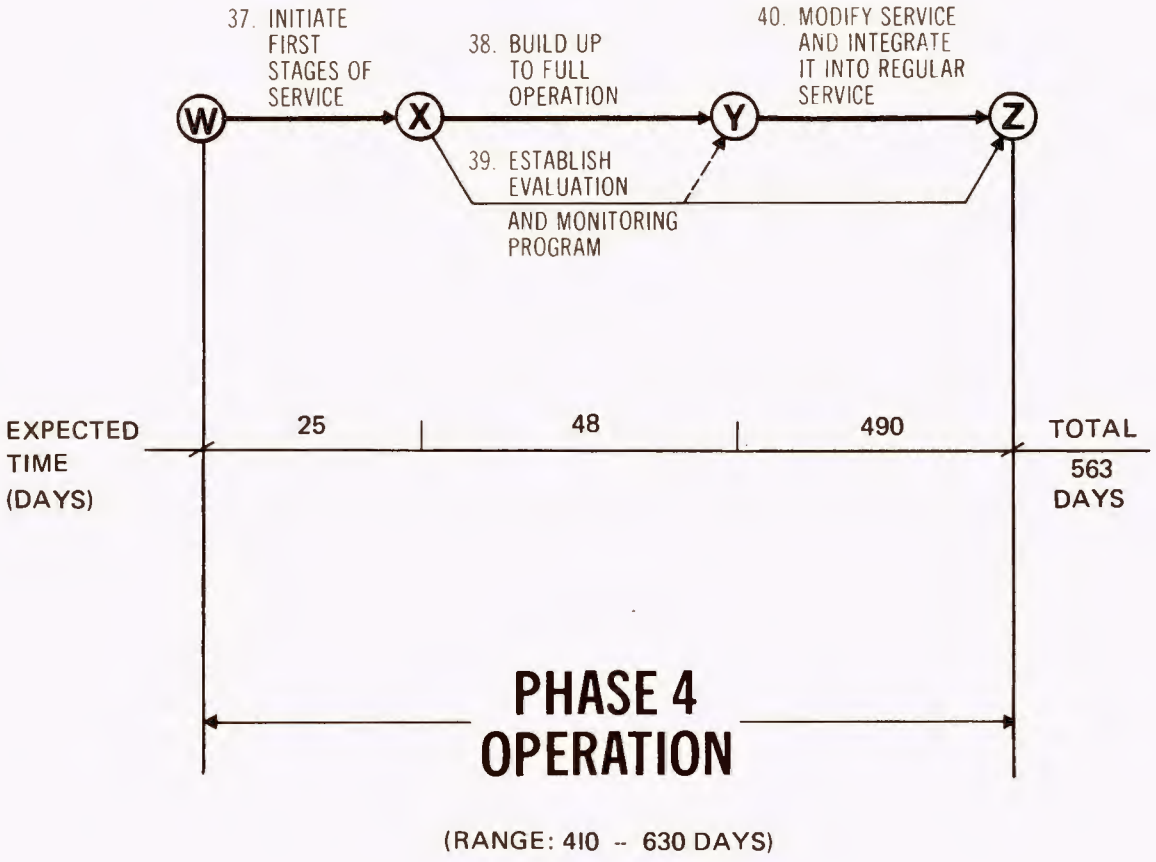
Source: Reference 77

Figure 5. Demand Responsive Transportation Planning Flow Chart (Cont.)



Source: Reference 77

Figure 5. Demand Responsive Transportation Planning Flow Chart (Cont.)



Source: Reference 77

The initial decision to approve a demand responsive transportation implementation is inherently a political decision. It typically involves many decision-makers (with the exception of the smallest-scale services, which can be instituted unilaterally by the operator). The key dimensions of a particular demand responsive transportation application--the nature of the service, where it will be, who will run it, who will be served--will be the product of negotiations among various interest groups. Figure 6 identifies the principal groups involved.

Although the inventory of existing services indicates the flexibility and scope of potential applications, very little work is available to identify systematically the available options to be investigated, and the strategies to be pursued in implementing and expanding demand responsive services.

Demand responsive transportation supplies a public service within the context of an industry that is subject to regulation by Federal, state and local governments. Thus, perhaps the single most important factor in the general decision to implement demand responsive transportation in terms of shaping subsequent decisions is the geo-political level at which interest in demand responsive transportation is generated. That is, the options for a specific demand responsive transportation application are to some extent predetermined by its institutional setting. For example, a metropolitan transportation authority would not be faced with many barriers to implementation that would confront a local taxi-operator trying to institute a demand responsive transportation service for the same metropolitan area.

A Sidewalk Demand Responsive Service Call Station

The stimulus to consider demand responsive transportation can come from various sources ranging from an individual citizen who has experienced demand responsive transportation in another community, local community organizations or an enterprising transportation operator, to the transportation professionals in both industry and government. A generally-acknowledged indispensable ingredient of success to date has been the presence of an enthusiastic, dedicated individual who will spearhead the effort. However, as demand responsive transportation is increasingly implemented on a larger scale than the pioneer and experimental services, presumably the role of the entrepreneur will diminish and the institutional advantages accruing to government agencies will be important factors in shaping the development of demand responsive transportation.

DEMAND. At this phase in the implementation process, the investigation of demand need not be highly refined, although it is important to identify the particular role that demand responsive transportation can play with respect to providing adequate public transportation in a given area. It is important for two reasons: first, to have the basis for building support for demand responsive transportation; and second, to be in a position to select the configuration of demand responsive transportation most appropriate to the particular role (and objectives) of the demand responsive transportation.

Figure 6. Principal Groups Involved in the Transportation Decision-Making Process

The initial demand analysis identifies the degree to which the proposed service area conforms to a generalized profile of demand responsive transportation applications, in terms of densities, major trip generators, specialized needs, and so on. While on the one hand, demand responsive transportation can be tailored to a wide variety of situations, careful analysis at this point, based on the body of accumulated experience, may avoid repetition of the Flint experiment which foundered on misperceptions of (1) demand densities and (2) the ability of demand responsive transportation to attract patrons from automobiles (see Reference 1).

The amount of funding available may determine the requirement for, and extent of, preliminary analysis. This will vary not only with the geo-political scale of the demand responsive transportation service but with sources of funds, particularly if Federal funding is anticipated.

Criteria for demand responsive transportation applications in large urban areas have been developed,* as follows:

- Population densities of 3000 to 7000 persons per square mile
- Good transfer connections
- Significant internal activity centers
- Capacity for integration with other transportation services.

More detailed criteria for site selection are discussed in the section on planning considerations.

INSTITUTIONAL ASPECTS. This section deals with six issues bearing on the implementation of demand responsive transportation services legal status, labor considerations, funding, impact on other transportation services, community acceptance, and management capability. Much work remains to be done in this general area.

1. Legal Status

At present the legal status of demand responsive transportation services has not been conclusively established, owing to the relative novelty of the concept, and the varying applications of the principles of demand responsive transportation. Many services are operating as experimental systems or with regulations tacitly waived at the local level. It is nonetheless important to consider the current regulatory environment to identify any significant constraints on implementation, and to evaluate, if necessary, alternative management organizations or service configurations. An understanding of the regulatory aspects is also useful in analyzing the basis for opposition, if any, to a proposed demand responsive transportation service.

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*Source: Unpublished draft of Fourth Annual International Conference, Rochester, October 1973.

Generally, demand responsive transportation services come under federal or state jurisdiction depending on the extent of interstate operations. The federal and state statutes do not address demand responsive transportation services specifically, but rather they establish a general framework of safety and economic regulation. (Safety matters are not discussed further, since presumably there would be no distinction for safety purposes between existing services and demand responsive transportation services.*)

For purposes of economic regulation at the federal level, demand responsive transportation services would be classified by the Interstate Commerce Commission as "Special Operations" within the meaning of the Motor Carrier Act of 1935. This classification is a catch-all for flexible or irregular route operations of a common carrier. A certificate of public convenience and necessity is required, with the exceptions noted below. The classic statement of the issues involved in the public-convenience-and-necessity test notes that,

> The question, in substance, is whether the new operation or service will serve a useful public purpose, responsive to a public demand or need; whether this purpose can and will be served as well by existing lines or carriers; and whether it can be served by applicant with the new operation or service proposed without endangering or impairing the operations of existing carriers contrary to the public interests. *Pan American Bus Lines Operation,* I.M.C.C. 190 at 203 (1936).

In exchange for undertaking the duty to serve the public, the carrier is protected by the certificate of public convenience and necessity from competition. However, compliance with regulations may be onerous.

Exceptions to the certification requirement are contract carriers, which are issued permits, and carriers which qualify for statutory exemption. Of particular relevance to demand responsive transportation operations are the following exemptions:

- Transportation of school children and teachers
- Bona fide taxicab operations with vehicle capacity not exceeding six passengers
- Transportation of persons or property "incidental to transportation by aircraft"
- Transportation within a municipality and adjacent commercial zone.

*Actually, there are important safety considerations in providing demand responsive transportation service that have not been adequately addressed. Also, the potential impact of no-fault insurance on an industry of self-insurers has not been investigated. See *Safety in Urban Mass Transportation: The State of the Art,* HRB Task Force, 1973.

In addition, transportation provided gratis to charitable institutions such as hospitals has been held to be exempt.

The only known federally-certificated demand responsive transportation service operated from 1966 to 1969. It was terminated for lack of ridership sufficient to break even.*

Demand responsive transportation services operating within a single state would be subject to state statutes restricting entry to the motor carrier, transportation or public utilities industries. In general, these statutes protect the existing transit operators. (For example, under antijitney legislation in many states taxis are prhibited from carrying more than one fare at a time. This would effectively preclude the implementation of demand responsive transportation service by taxi companies under their existing authority.)

For the purposes of economic regulation – rates, levels of service, schedules, and routes – most demand responsive transportation services can be classified as common carrier operations, which require a certificate of public convenience and necessity. Although the statutes and their interpretation vary widely from state to state, most states provide for exemptions from state regulation under limited conditions. Common carriers may be wholly exempt from regulation, or authority may be delegated to one or more local levels (e.g., municipal, metropolitan, transit district). Of particular relevance to demand responsive transportation are the following exemptions:

- Transportation services operated by a municipality or other public authority.
- Taxicab services – in most states, jurisdiction over taxis is a closely-guarded local prerogative. (Local ordinances governing taxi operations can be very restrictive and inflexible.)
- Contract carriage – wholly exempt in some states, certificates or permits required in others.

Both the municipal/metropolitan corporation statutes and the state transportation or public utility statutes should be reviewed to ascertain the requirements for commencing demand responsive transportation operations in a particular state, with emphasis on securing operating flexibility.**

The only reported state court decision relating to demand responsive transportation has been the Ann Arbor case, in which the city's right to institute a demand responsive transportation service was upheld against the challenge of the local taxi companies.

*The service, Arrow Line, was organized by a Connecticut taxi operator to provide door-to-door, 24-hour a day service between any origin in Hartford County, Connecticut and any destination in the boroughs of New York City using 7-passenger Lincoln limousines at a one-way fare of $14. A total of 10 passengers per round trip was needed to break even.

**Recent Michigan legislation (Act 327) has enabled the development of demand responsive transtation services throughout the state.

With some exceptions, such as Michigan, the regulatory environment at the state level is generally not conducive to the opportunities for innovation and experimentation inherent in demand responsive transportation services. Enabling laws or regulations may be required. The federal statutes and administrative interpretations may serve as "persuasive analogies" to the States in responding to applications for certification of demand responsive transportation services.*

2. Labor Considerations.

It is clear that a proposed demand responsive transportation service of any significance must take account of organized labor, particularly transit labor, although taxi unions may also be involved. One labor spokesman has announced his union's position in opposition to the implementation of a service that does not conform to current wage and benefit provisions.[1] Such a service would be ineligible for federal funding by virtue of Section 13(c) of the Urban Mass Transportation Act of 1964 (see Appendix G).

On the other hand, demand responsive transportation has shown that labor can be a most cooperative partner in developing this innovation in transportation service. A key issue is work rules, and negotiations at the local level have been highly satisfactory.** Transit labor has been a prime source of experienced drivers who apparently welcome the more challenging demand responsive transportation assignments. Further, labor should not be viewed as monolithic; in one case, an attempt to organize a neighboring demand responsive transportation service resulted in the formation of a new local union by the neighbor.

Finally, whether union or non-union labor is to be employed, it is important to recognize the impact of driver wages on the financial performance of a service, and to analyze this factor in light of wage levels prevailing locally.

3. Funding

The availability of funds can be a major constraint on the choice of demand responsive transportation configurations especially if operating deficits are anticipated. The limited funding available to the early demand responsive transportation services within the

*An analysis of ICC decisions supporting variants of demand responsive transportation services, together with a review of other case law and a proposal for "experimental exemption" to permit rapid, flexible implementation of demand responsive transportation, appears in Reference 34.

**In Ann Arbor, the union anticipated the desirability and availability of part-time employees and initiated arrangements to take advantage of this flexibility in the work force.

[1] Remarks of Earl Putnam, Amalgamated Transit Union, at Fourth Annual International Conference on Demand Responsive Transportation, Rochester, N.Y., October 1973.

context of a conservative, risk-averse industry dictated the development of small-scale services. While successful in many respects, they have not fully demonstrated the potential of demand responsive transportation. Moreover, valuable information pertaining to these operations could not be collected or preserved, for lack of funds.

However, the prospect of greatly-improved service characteristic of demand responsive transportation has stimulated some governmental response to funding needs. In Ontario the Highway Improvement Act was renamed the Public Transportation and Highway Improvement Act, and was amended to provide for subsidies from the provincial government covering planning studies, operating costs, and capital costs. The subsidy was considered an important element in gaining rapid acceptance of demand responsive transportation services.

In the United States federal funding is available from the Urban Mass Transportation Administration for technical studies and capital costs. These funds are available to any community that meets eligibility requirements. The grant application and funding criteria are designed to ensure that a proposed service is based on thorough analysis and evaluation of its cost-effectiveness and prospects for success in terms of local objectives. Federal funds are also supporting important demonstrations and vehicle studies.*

Most of the demand responsive transportation "action" in the United States is located in the states that can utilize gas-tax receipts or otherwise offer support to the demand responsive transportation concept, notably California and Michigan. Figure 7 displays the distribution by state of the 48 U.S. services. Wisconsin is currently exploring the demand responsive tranportation potential for its communities. An example of one state approach is Michigan where the state is underwriting the development of demand responsive transportation services for communities willing to contribute $1000. At the year's end of the experimental operation, the community can purchase the service components – vehicles, communications system, etc. – for $1.00. In addition the state provides technical assistance in designing and implementing the services.

Another constraint applicable in some states is statutory limitations on local funding for transportation facilities and services. For example, state law in Iowa provides for a two-mill municipal levy in the case of bond financing of transportation capital costs, and a limit of ten mills in any one year on the total funding of a municipally-operated service. This type of statute may have the effect of precluding the development of innovative services for lack of funds, in the absence of overwhelming community support. Such community support was expressed in Ann Arbor, Michigan, whose citizens voted an increase in local taxes to finance the expansion of their transit operations to include the expansion of their demand responsive transportation service.

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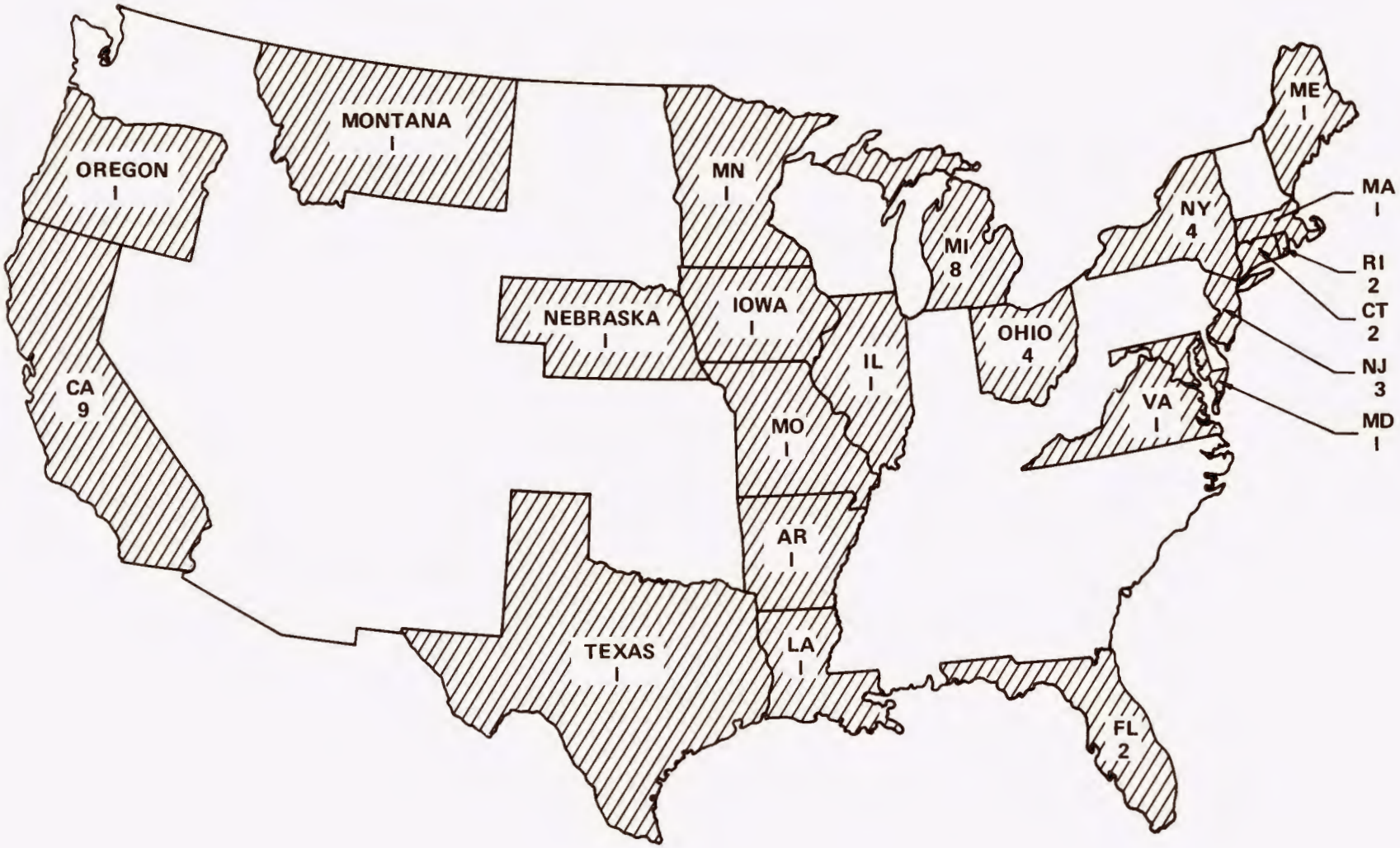
*See U.S. Department of Transportation, Urban Mass Transportation Administration, *External Operating Manual,* August 1972.

Figure 7. 48 Demand Responsive Transportation Services Operating in 22 States, May 1, 1974



4. Impact On Other Transportation Service

To date, demand responsive transportation services have been designed to enhance existing service or at least to avoid competing with it, whether taxi or transit. Data on diversion of patronage from other services are limited but suggest that a substantial amount is diverted from private automobiles. Developments in this area may depend upon the willingness of the management of existing local services to undertake demand responsive transportation services.

5. Community Acceptance

The general acceptance of demand responsive transportation service by the communities in which it has been implemented is shown by increasing ridership levels and the expansion of services. Nineteen services in the U.S. and Canada have been expanded. However, resistance has been encountered in many other communities so that demand responsive transportation services could not be implemented. The problems in this area have been documented (References 25, 27) but little guidance is available.

6. Management Capability

Demand responsive transportation service calls for a different type of organizational structure and management style than is characteristic of the generally conservative transit industry. The success of a particular demand responsive transportation service and the further diffusion and expansion of the demand responsive transportation concept in general may depend in large part on the ability and willingness of management to develop and replicate appropriate skills and organizations.

OPERATIONAL CONSIDERATIONS. The key operational characteristics to be considered in the preliminary decision-making process after the service area is determined are:

- Alternative management and organizational configurations
- Alternative fleet configurations
- Alternative service patterns
- Extent of automation required
- Levels of service to be provided.

These policy decisions should be made in light of two aspects which have been critical to the successful implementation of demand responsive services: the personalized nature of demand responsive transportation, and the dedication of the operator to providing high-quality service. At the same time, one of the prime attractions of demand responsive transportation is its inherent flexibility and capacity to accommodate changing transportation requirements. Thus, initial decisions are not irrevocable, and indeed modifications should be expected as the particular demand responsive transportation service evolves.

ECONOMIC CONSIDERATIONS. Enough experience has been accumulated and documented in the literature to support very rough estimates of the capital and operating costs associated with several types of demand responsive transportation operations. Therefore, for given levels of ridership and fares, net operating results can be calculated.

These results should be evaluated in terms of the objectives of the particular demand responsive transportation service. Only one demand responsive transportation service is known to have been instituted with the single objective of producing a net profit.* Rather, most demand responsive transportation services have been implemented by the public sector to provide important transportation services with no expectation of meeting full costs out of the farebox. Indeed, a key element of the financial structure — the fare — is frequently set low arbitrarily as a political determination. Thirty-three services charge 50 cents or less per ride, as shown in Figure 8. Unfortunately, despite several indications of the public's willingness to pay higher fares for improved service, little experimenting with the fare structure has been undertaken to determine either the elasticity of demand generally, or the effects on particular segments of the population. (As noted earlier, special fares for senior citizens are generally provided.)

Figure 8. Top-Ranking Fare Levels in 50 Demand Responsive Transportation Services

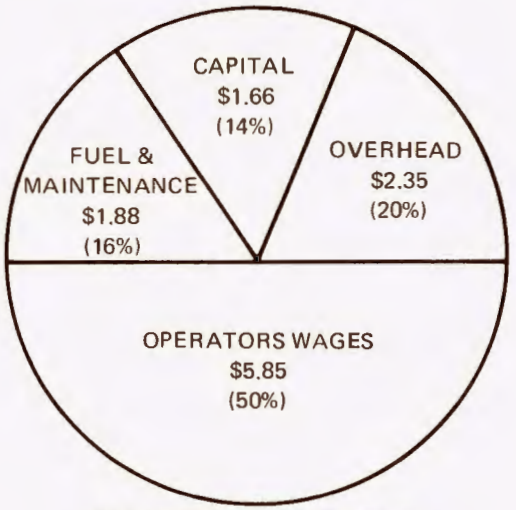
Rank	Amount	# Services	% All Services
1	50¢	10	20
2	40¢	8	16
3	free	6	12
4	25¢	5	10
5	35¢	4	8
		33	66

Source: Appendix A

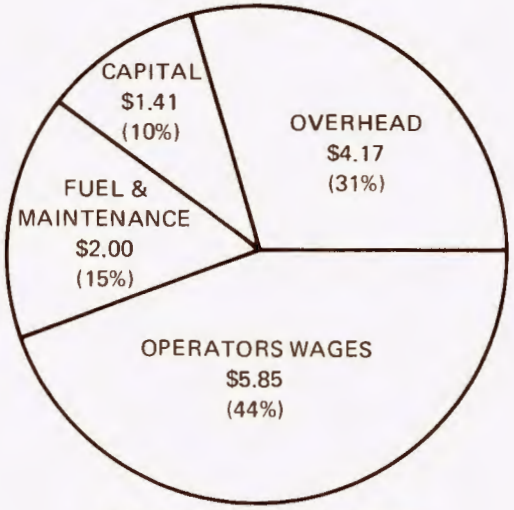
On the other hand, a demand response transportation service can produce net economic benefits even while operating at a deficit as demonstrated in Regina. There the overall annual transit deficit was reduced by $67,000 as a result of the demand responsive transportation service, which generated revenues in excess of its higher costs. Similarly, demand responsive transportation can replace unprofitable transit services or routes with better service at lower net cost, and can reduce or minimize the costs of providing

*Shared-taxi operations in Hicksville, New York (cf. Davenport shared-taxi service in which the profit motive has been secondary to the objective of improving public transportation, and "staggering" expense has been incurred to develop computerized functions).

Figure 9. Comparative Cost Per Revenue Hour in Regina



$11.74 PER REVENUE HOUR
FIXED SYSTEM



$13.43 PER REVENUE HOUR
TELEBUS SYSTEM

Source: Reference 69

off-peak service. (Another alternative to conventional transit – subsidizing conventional taxi operations – has not been documented, but presumably will be examined in the course of studies on taxi/jitney services now underway under the sponsorship of DOT.)

Noneconomic benefits of demand responsive transportation, such as increased mobility for various population groups, elimination of stress associated with driving under congested conditions, relief for the suburban mother's "station-wagon syndrome," or decreased street crime and increased security are more difficult and sometimes impossible to quantify. Nevertheless it is important to identify them so that there is an adequate basis for setting priorities for the expenditure of public funds.

The cost structure of demand responsive transportation reflects its labor-intensive nature. Thus, wages typically represent more than 50% of operating costs. In addition to the cost of drivers, demand responsive transportation involves the wages and other overhead expense associated with the dispatching or command-and-control function. Figure 9 compares the cost breakdown of fixed route and demand responsive transportation services in Regina. Comparative operating costs may vary substantially among services depending on prevailing wage scales and the type of service offered. In some areas the cost of demand responsive service will be less than transit costs.

More data are needed to fully analyze the costs of providing the various kinds of demand responsive transportation services, although it is now apparent that many-to-many is generally the most costly. While many-to-one or many-to-few services can be more efficient, they may also result in excess capacity during off-peak hours. However, the flexible nature of demand responsive transportation could allow many-to-few service for peak hour operations and many-to-many for off-peak hour operations thus minimizing excess capacity. As demand responsive transportation services become increasingly computerized, more sophisticated management analysis can be applied to the problems of joint costing and cross-subsidization.

The capital costs of demand responsive transportation have been fairly well established, although alternative financing arrangements such as leasing have not been fully documented. Capital costs of demand responsive transportation components are shown in Figure 10.

The cost of computer applications varies with the degree and sophistication of automation and the cost of tailoring the hardware and software to a particular area. One rule-of-thumb says that computer costs will add about 15 percent to total operating costs. The Haddonfield experiment should yield more information on these costs. Although total operating costs are increased, the benefits of increased capacity and more efficient utilization of the fleet are expected to be reflected in an improved net position.

Figure 10. Major Capital Costs of Demand Responsive Transportation Service

15-Passenger van	$ 4,000 - $10,000
Modifications to van	5,000
20-passenger bus	13,000 - 40,000
Wheelchair lifts	2,000- 4,000
Base Radio	6,000- 8,000
Mobile Radio	1,200- 1,500
Base Antenna	400- 600

Sources: (1) Summary of Field Experience with Small Transit Vehicles (unpublished draft report) April 1974;

(2) MITRE Corp., Demand Responsive Transportation System Planning Guidelines, Reference 59.

planning considerations

GENERAL. The planning considerations at this stage involve refining the preliminary system design and laying the groundwork for implementation of operations. Experience to date indicates that a period of 6 to 9 months after the initial decision is required for implementation, of which 4 to 6 months is needed for delivery of equipment.* The prospect of successful implementation is considerably enhanced by a close working relationship between planners, whether in-house or consultants, and operators, including staff where feasible (see Figure 5).

Many of the early demand responsive transportation services were developed without extensive preplanning. Operational experience informed subsequent practice, and many problems that now can be anticipated were overcome by sheer force of an operator's personal commitment. Planning has become increasingly sophisticated. An excellent discussion of planning for a large-scale service to be implemented in three phases (manual, computer-aided, computer-based) is available in the Santa Clara County report (Reference 42). Santa Clara is developing a regional, integrated service with fixed-route segments fed by demand responsive transportation services.

*The Transportation Development Agency, Montreal, has recently published a two volume *Dial-A-Bus Manual.* Volume I is a *General Description* of Dial-A-Bus. Volume II is *Guidelines for Design and Implementation,* a technical report presenting general principles and concepts based on experimental and theoretical studies.

SITE SELECTION. Given a large area, decisions to select particular portions of that area can be based on a careful comparative evaluation of the characteristics of the portions, in such respects as socio-economic characteristics, topographical configuration, trip generators, street network, demand densities, and population densities. It requires matching up available services with the anticipated nature of the demand. Thus, a high-income neighborhood may be attracted only to an extremely high level of service, whereas transit-dependent areas may respond well to more limited service. Accurate ridership figures cannot be obtained at this point, and experience has shown that it may take some months for ridership to develop. (On the other hand, the Bramalea experience showed that demand was grossly underpredicted.) The characteristics of other municipalities which have had demand responsive transportation service may suggest appropriate site selections in a new area. (Appendix A lists such communities.) Figure II presents an example of site selection guidelines which were developed in the Tampa Bay Study (Reference 76) on the basis of a review of demand responsive analyses to date. However, it is important to recognize that demand responsive services have been implemented in areas that do not meet one or more of these particular guidelines.

Several analytical tools exist that have been employed to estimate demand for demand responsive transportation, and the literature contains detailed descriptions and forms of these tools. (see References 3, 8, 9, 10, 18, 19, 20, 24, 30, 65, 82). They are, however, subject to important limitations.

- Modal split analysis--may underestimate demand because it does not adequately treat latent demand or effect of quantum jump in level of service that demand responsive transportation provides.
- Surveys of potential users--respondents have great difficulty envisioning the the proposed system and therefore cannot gauge whether or not they would use it, so that results are unreliable.
- Attitudinal surveys--used both to determine potential ridership and to identify appropriate service parameters to meet consumer preferences, this tool suffers from unreliability due to difference between theoretical judgments and actual decisions.

SPECIAL TRANSPORTATION NEEDS. The special needs of the elderly or handicapped ridership deserves careful attention in terms of:

1. providing an appropriate level of service, which may require special equipment such as accommodations for wheelchairs and special attention from drivers (assisting the patron from house to vehicle)
2. recognizing that meeting special needs constrains the level of service in terms of time for the general population, so that special needs may require an essentially separate service.

DEMAND RESPONSIVE TRANSPORTATION MARKETS

AREA	POTENTIAL APPLICATIONS	CURRENT STATUS
LARGE METROPOLITAN AREAS	• SUBURBAN FEEDER/DISTRIBUTION IN LARGE COORDINATED TRANSIT SYSTEMS	• INDEPENDENT MODULES WITH MANUAL OR COMPUTER DISPATCH—NEEDS DEVELOPMENT FOR AREA-WIDE APPLICATION
	• SUBURB-TO-SUBURB TRANSPORTATION	• SIMILAR TO FEEDER/DISTRIBUTION STATUS
	• LOCAL SUBURBAN TRANSPORTATION	• INDEPENDENT MODULES WITH ANNUAL SUBSIDIES OF $15 TO $25 PER CAPITA
	• HANDICAPPED AND OTHER SPECIAL NEEDS GROUPS TRANSPORTATION	• DEMONSTRATED - ECONOMIC ADVANTAGES TO CONSOLIDATION LIKELY
MEDIUM-SIZE CITIES AND REGIONS	• INTEGRATED IN BUS-BASED TRANSIT SYSTEMS	• MANUAL CONTROL SYSTEMS IN USE FOR SMALLER APPLICATIONS
		• NEAR-TERM R&D PROGRAM TO PROVIDE FOR LARGER APPLICATIONS
	• SPECIAL NEEDS GROUPS	• DEMONSTRATED
SMALL URBAN AREAS AND RURAL AREAS	• NEW SERVICE WHERE NOT NOW AVAILABLE	• READY FOR LOCAL USE
	• BETTER QUALITY THAN CURRENT SERVICE	

There are unresolved issues with respect to service to the poor, particularly in urban areas, and some employment-oriented services have not been able to maintain patronage. However, there are several successful Model Cities demand responsive transportation services in operation.

LEGAL ANALYSIS. In addition to the routine legal matters associated with business operations, including insurance, the necessary certificates, permits, and licenses must be secured. Of particular importance is the need to obtain communication channels from the FCC.

Figure 11. Example of Site Selection Guidelines: Tampa Bay Study Criteria

	Demand Criteria
1a.	Minimum average demand = 20 demands/mi^2/hr
1b.	Minimum mid-day demand = 50 demands/mi^2/hr
1c.	Minimum population density = 4,000 people/mi^2
	Physical Criteria
2.	Minimum site area = 4 mi^2
3.	No major natural barriers to travel
4.	Rectilinear street pattern with good connectivity
5.	Reasonably regular site shape
	Demographic Criteria
6.	Range of socio-economic conditions included
7.	Low rate of auto ownership
	Operational Criteria
8.	No existing bus service in area*
9.	Many-to-many/many-to-few service
10.	Good potential for future expansion

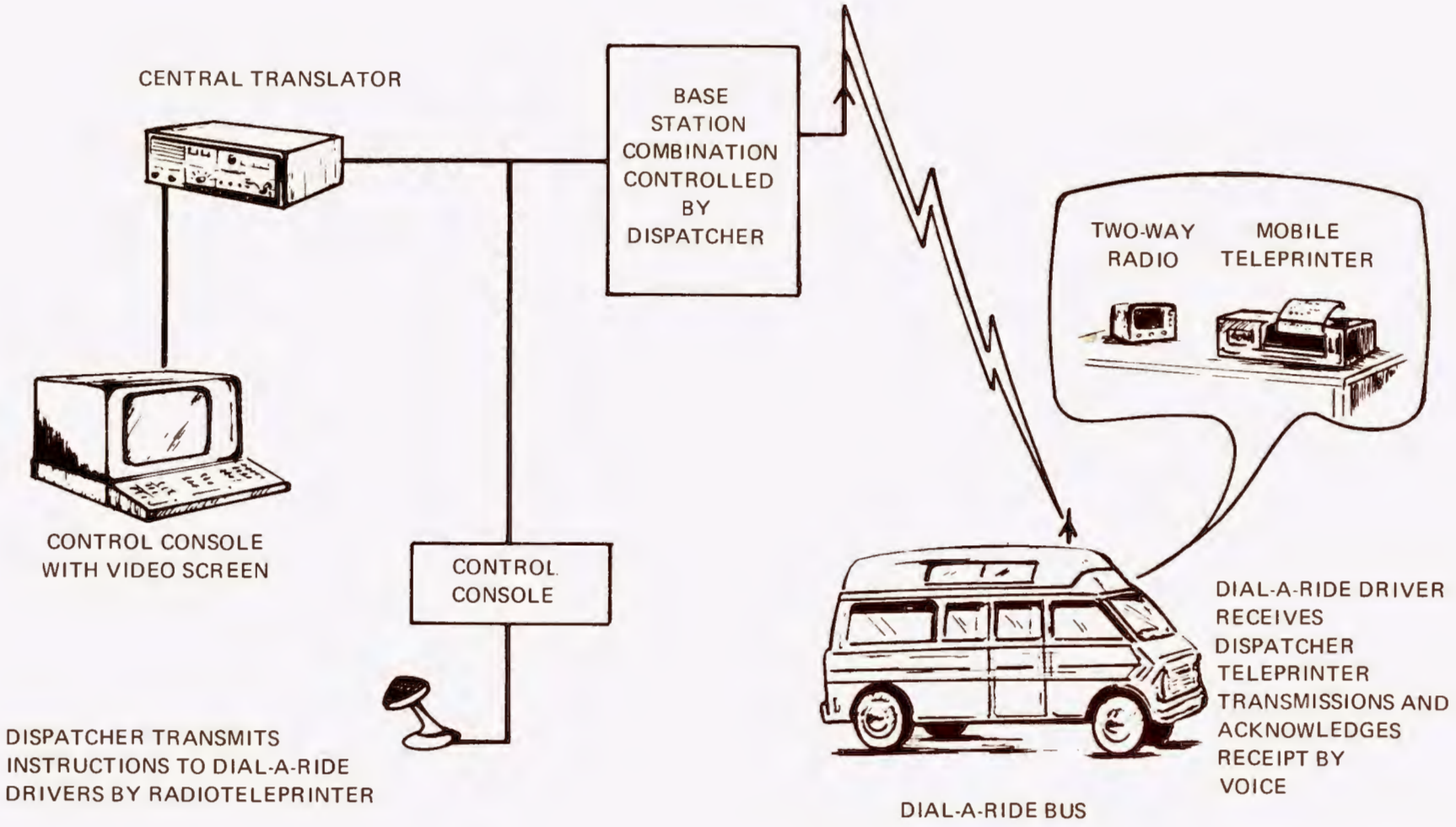
*One objective of this service was to avoid competing with bus service.

Source: Reference 76

Demand Responsive Transportation Service Control Center

BATAVIA DIAL-A-RIDE RADIO TELEPRINTER

SCHEMATIC OF SYSTEM LAYOUT



Source: Ford Motor Company, Batavia, New York Radio Teleprinter Test

Teleprinter Message Format - Vehicle Printout

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 002
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P 4 MC ARTHUR DR
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P 164 SUMMIT
.
P 167 ROSS
.
DR JOHN KENNEDY
.
P 177 VINE
.
P GOLDEN HAIR PIN
.
P 8 HALL ST.
.
DR JACKSON SCHOOL
.
DR CHERRY ST.
.
P ST MARYS DAY CARE
.
DR BROOKLYN SCHOOL
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 003
.
P MARINE MIDLAND I PASS
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DR HIGH RISE
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P HIGH RISE
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P LOBLAWS
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DR BIG N
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DR 4982 E MAIN
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P 704 N ST EX
.
DR DOWN TOWN
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Source: Ford Motor Company, Batavia, New York Radio Teleprinter Test

PROJECT INITIATION. The first step in detailed planning is to work out appropriate objectives, goals, and policies for the service within the overall concept determined earlier in the decision-making process. The next step is to structure an overall project and management plan. Other tasks are to:

- Design and prepare control center
- Develop operating procedures, updating as necessary
- Determine service patterns; prepare maps, directories, files
- Order fleet and other hardware
- Determine integration criteria, policies, transfer points
- Calibrate computer software, if any
- Conduct recruiting and training.

MANAGEMENT RESPONSIBILITIES. Within the policies and objectives established for the demand responsive transportation service, the management is responsible for providing the best possible service. In addition, the management can be expected to develop the basis for future expansion or integration of the service. Many services have found that vesting authority in an executive director who has complete charge of operations is appropriate. One key responsibility of management during the planning stage is to ensure that the initial operations will be conducted in such a way as to generate a good public image. In general, this has benefited from a team approach. Many services have cited the important roles played by enthusiastic drivers and other staff members, who have contributed to the development of strong public acceptance of "their own" service.

NEW TOWNS APPLICATIONS. Demand responsive transportation has been used to a limited extent in "new towns" where transportation has been considered an integral part of the land use development. However, with the exception of commuter bus subscription service, surprising resistance to transit service has been encountered. Nevertheless, as a spokesman for the Regina service observed, demand responsive transportation opens the way to using transit as a planning tool for the development or modification of neighborhoods and the improvement of land use patterns. Columbia, Maryland has operated a successful demand responsive transportation service since 1971.

operational considerations

SCHEDULING AND ROUTING. The level of service that can be achieved with a given fleet in a particular area depends on the efficient utilization of the vehicles available. (see discussion of productivity, page 6). Scheduling and routing are therefore key functions, and much research has yielded fruitful ways of improving performance in this area. In demand responsive transportation practice, the range has been from a single-driver/

dispatcher who performed all control and service functions to advanced computer-aided systems. It has been generally established that the maximum capacity of a manual system is 15 – 20 vehicles, representing 100 demands per hour. (Automated techniques are discussed below.) A variety of manual approaches are detailed in reports on specific demand responsive transportation services, with illustrations of maps, message holders, and other support equipment.

COMMUNICATIONS. Two communication components are involved in demand responsive transportation: one to enable the patron to request service, the other to enable the vehicle driver to receive scheduling instructions. For customer communication, voice communication via the telephone is generally employed. Direct service lines can be provided at high activity centers. Digital communication is an attractive alternative, although it should not be expected to totally supplant voice communication. Digital communication via radio teleprinters has been used successfully to relay information to drivers. Dispatching hardware is generally considered very satisfactory, although the profusion of competing systems suggests that a technical study would be useful.

COMPUTER APPLICATIONS. The purpose of automation in demand responsive transportation applications is not to reduce the cost of the dispatch operation or command and control center, but to increase the capacity of a given staff, improve productivity, provide higher levels of service, and provide better management and planning data. However, automation has not been implemented generally for two reasons: first, fully automated functions are still being developed; and second, most of the services are small enough to be adequately controlled manually. Computer assistance is generally confined to record-keeping, as in the case of subscriber files and management data. Elaborate studies have been conducted to develop algorithms for computerized scheduling and routing. The Haddonfield demonstration is designed to develop an automated control system and identify the benefits of automation.

The development of automated dispatching in the taxi industry has been documented, and has been highly successful in meeting the objectives of two different taxi companies. In one case, it achieved faster, more accurate throughput of customer calls and almost paid for itself in manpower savings; in the other case, traditional sources of friction between driver and dispatcher were overcome. In both cases, more than a year was required to make the automated systems fully operational.

VEHICLES. The consensus is that a 15-20 passenger vehicle is adequate for most demand-responsive operations, although smaller vehicles may be appropriate in some cases. The vehicle must be capable of traversing narrow suburban streets unobtrusively. The initial fleet size is related to the projected demand density, level of service, and type of service offered. A major determinant is whether the subscription service is offered, since subscription service generally entails capacity operations at peak hours.

A Typical Demand Responsive Transportation Vehicle

An All Electric Vehicle

Many different vehicles are in use for demand responsive transportation service today. Figure 12 shows the distribution of vehicle models ranked by the number of services utilizing a vehicle and the total number of vehicles in service.

Figure 12. Top-Ranking Vehicles Used in 18 Demand Responsive Transportation (Excluding Taxi Services)

By # Services[a]	Rank	By # Vehicles
Courier, Flxette	1	Twin Coach
Twin Coach	2	Rec Vee
Econoline	3	Flxette
Maxivan	4	Maxivan
Vanhool, Grumman	5	Courier

[a] Includes combination fleets counted as 1 service per vehicle type.

Source: Ford Motor Company, Internal Listing

However, none is fully satisfactory in terms of meeting performance standards for demand responsive transportation service. Two problem areas are the initial purchase decision, and operations/maintenance.

The initial purchase decision involves choosing between a 3-year "throw-away" vehicle or a longer-life more expensive vehicle. Although there is operating experience no clear cut decision criteria exist.

The problems in operations and maintenance are related to the fact that the vehicles typically have been converted from another original function (minibuses, vans, recreational vehicle, or motor home). The various mechanical systems of the vehicles are not suited to the heavy duty requirements of demand responsive transportation service. Problems have appeared in braking, propulsion, and suspension systems, body design, and quality control. A contributory factor to unsatisfactory vehicle performance is the lack of maintenance experience on these vehicles by the service operators, particularly in the case of transit companies. Their maintenance facilities and mechanics are geared to conventional buses, and have not yet adapted to the requirements of demand responsive transportation vehicles. In contrast, the van type vehicles of one Canadian service are maintained by a local garage, resulting in better-than-average experience with mechanical problems.

Some progress has been made in developing a suitable vehicle. The Government of Ontario, Canada, and the United States Department of Transportation have recognized the inadequacies of present day vehicles and are in the process of developing standards for demand responsive transportation service vehicles. The Ontario Department of Trans-

Rochester, NY Promotional Handbill

portation and Communication has commissioned a newly designed vehicle for service in Toronto. This vehicle combines a "throw-away" chassis with a long life, fiberglass body. The U.S. DOT is developing small-bus specifications and is in the process of awarding a contract aimed at production of a para-transit vehicle.

In terms of the supply of demand responsive transportation vehicles, there seems to be no problem. Although manufacturers of conventional buses are operating at capacity, excess production capacity exists in the motor home sector of the industry and among producers of other specialized vehicles.

The most recent information on vehicles is contained in a draft DOT report based on a survey of operating experience with small (7-25 passengers) bus-type vehicles currently available in the U.S. A general description and full specifications are provided for each of the 20 vehicles surveyed in addition to a brief discussion of user experience. The report concludes that "no vehicle has been free of problems. No vehicle appears to be clearly better than all others, although certain vehicles are better for certain applications. . . No single approach is appropriate for all possible applications."[1]

MARKETING AND TRAINING. Marketing efforts on behalf of demand responsive transportation services have ranged from simple flyers and local media spots to full-scale promotions, including in one case the rendition of "Tijuana Taxi" to announce the arrival of the demand responsive transportation vehicle. While operators have emphasized the importance of an adequate marketing budget, little is known about the relative advantages of different approaches. At a recent industry conference, it was suggested that a clearinghouse be established for marketing ideas. At a minimum, it is essential to provide for disseminating information about the service to actual and potential patrons.

One approach that has been successfully employed by several demand responsive transportation services is the adoption of one or more identifying elements, such as distinctive colors, logos, and uniforms. In addition to fostering consumer recognition and appeal, this approach offers the organizational advantage of strengthening staff morale and identification with the service.

Experience has shown that careful attention to training staff is essential for successful service. Both the control center staff and the drivers require training programs with some aspects of demand responsive transportation service common to both programs. The programs can be tailored to the particular demand responsive transportation configuration and patronage profile. In general, the introduction of new procedures or equipment into service should be preceded by an experimental phase in which feedback from actual operating experience is incorporated. Although typically the demand responsive trans-

[1] Summary of Field Experience with Small Transit Vehicles, April 1974 (unpublished draft), pp. 73-74.

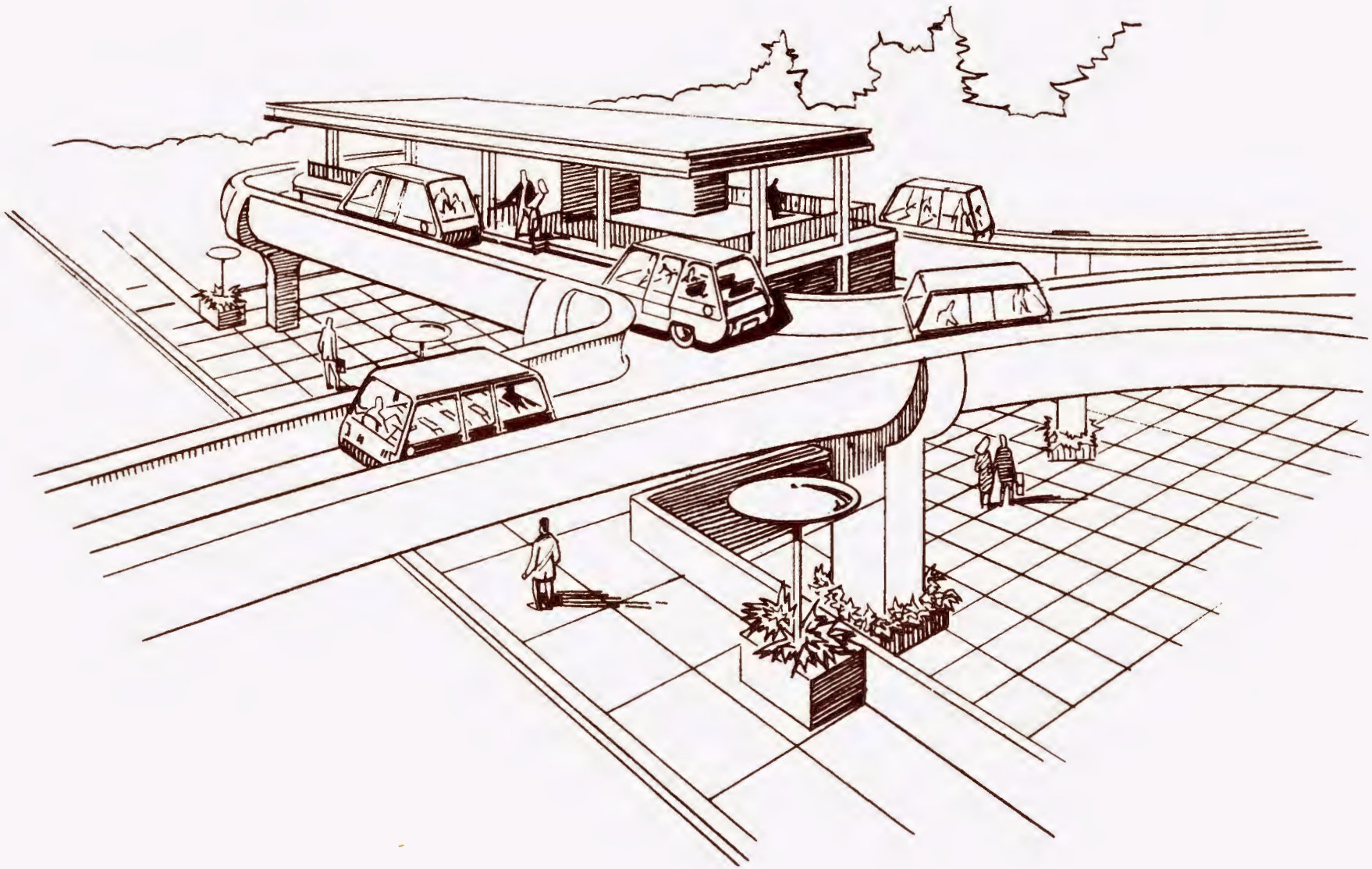
portation services have been staffed by transit or taxi workers, there has been successful experience in training unskilled residents of a Model City to perform various control center functions, including public contact.

The Urban Mass Transportation Administration's Office of Transit Management has recently initiated a "Transit Marketing Project," that addresses some of the marketing problems inherent in the operation of a transit service.

MANAGEMENT RESPONSIBILITIES. In the context of demand responsive transportation, management is called upon to monitor operations more closely than may be expected in less service-oriented organizations. Only by collecting and analyzing information on performance and demand can the inherent flexibility and efficiency of demand responsive transportation be realized. Fortunately, automated means of generating the data base are being developed.

Some of the operating problems that have emerged among the demand responsive transportation services have been:

- Bureaucratic roadblocks to expansion or innovation
- Disruption of service occasioned by driver illness, absence or change of assignment
- Difficulties with chronically-late patrons, no-shows, and cancellations
- Exaggerated peaking associated with school-oriented service
- Problems in integrating schedules and establishing transfer points for feeder/transfer services
- Paper-handling and other logistical difficulties.



IV DEMAND RESPONSIVE TRANSPORTATION IN THE FUTURE

DEMAND RESPONSIVE TRANSPORTATION in the future is expected to evolve from its present status as a relatively independent mode of transport to an integral element of a regional transportation service. Sophisticated methods now exist for analyzing the requirements and performance of independent demand responsive transportation service. Much more work is needed to address the complex issues involved in integrated services, such as (1) cross-subsidization and (2) trade-offs between demand responsive transportation, fixed route, and taxi services. Institutional and management analysis are other areas requiring further investigation.

demand responsive transportation technology

The future technology of a demand responsive service includes the areas of computer dispatching, automatic vehicle monitoring, automatic scheduling, fully dynamic routing, and advanced management analysis systems. Prototypes of these technological developments are available today. For example, computer dispatching has been simulated by researchers and is presently being demonstrated in Haddonfield, and UMTA has demonstrated Automatic Vehicle Monitoring (AVM) with the Chicago Transit Authority bus system.

The technology of computerized dispatching and of automatic vehicle monitoring can be combined under the umbrella of command and control technology. Experience to

date reflects that demand responsive transportation services can be controlled manually to a limit of about 15-20 vehicles providing many-to-many service with about 100 demands per hour. For many present day services manual controls are adequate. However, it is today's problem to develop a means for handling the expanded and growing services of the future.

An initial problem with automated control systems is to define the interface of manual/computerized operation. That is, to define the functions of the computer, the drivers, and the dispatcher, and how they interact. The purpose of some of the contemporary computer efforts is to define these relationships and to provide a basis for improving the performance of the various elements in the command and control system.

Presently, dispatching algorithms have been developed by several groups, including WABCO, Northwestern, MITRE, MIT, and DAVE/Lex. (Reference 35.) The computerization at Haddonfield is the largest test to date of automated demand responsive transportation. These algorithms have a common element of travel time prediction. Present technology allows a continuous measurement of travel time but assignment is based on static predictions. Future software research may lead to assignments based on continuous travel time to provide a higher level of service.

Automatic vehicle monitoring is the use of radio signals between vehicle and stationary receivers to keep track of the location of vehicles on their respective tours. The locations are displayed on a control console in a central dispatch office. Current technology provides only a sampling of vehicle locations, as the actual location is known only when a vehicle is close to a receiver. Intermediate locations can be determined by the knowledge of the route point where the receiver is located. This technique was demonstrated by the Chicago Transit Authority. Technological advancement would provide for direct continuous surveillance of all vehicles while operating, with direct input to the control computer. The knowledge of exact vehicle locations for a demand responsive transportation service can improve vehicle assignments by minimizing backtracking.

A near-term advanced type of communications might be called "touch-a-bus", using "Touch-Tone" telephone equipment. A patron would call for service and enter a predetermined sequence of numbers to give the patron's request to a computer. Electronic interfacing equipment would translate the telephone code, and service would be scheduled by the dispatching computer. The system could also return a prerecorded call automatically to the patron prior to the arrival of the vehicle, thus minimizing pickup times and improving service. This automatic requesting process could overcome the limitations on service associated with the receptionist function.

The use of computers for other functions beyond scheduling and dispatching can lead to more efficient means of compiling data and analyzing system characteristics such as:

- Level of service--wait time, ride time, and vehicle productivity
- Vehicle use parameters--e.g. fuel consumption, maintenance records
- Vehicle operations monitoring--tracking vital signs from the vehicle on a realtime basis.
- Vehicle locating.

The future development of demand responsive transportation service lies in its flexibility as a subsystem of an integrated regional transport service. To this end technology must progress to meet the requirements of this future system. The use of present day operating procedures must be refined so as to present an efficient methodology to centralize regional transport control. Optimally, a regional integrated transport service can be controlled by the use of sophisticated operations and management techniques.

In an integrated transportation environment computerized information bases will be essential to perform such calculations as scheduling rendezvous times for links between subsystems.

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future use of demand responsive transportation services

Demand responsive transportation service of the future will be integrated with other advanced modes of transport as well as other segments of a regional service. Other advanced modes might include dual-mode services, PRT's, other guideway vehicles, and high-speed intercity links. Although the technology for these new modes of transport has been researched and prototype systems developed, the concept of service integration has yet to be addressed on a large scale.*

Another development in demand responsive transportation might involve long distance trip scheduling. For example, by making one phone call to a regional dispatcher or similar source travellers could take a demand responsive vehicle to an urban transport terminal, make an intercity trip, and have a demand responsive vehicle waiting to transport them to the final destination. With demand responsive service the potential problem of a vehicle not available upon arrival could be eliminated by prescheduling the trip by 'long distance' demand responsive transportation.

Operational experience with demand responsive transportation service has provided valuable guidance to planners and managers considering demand transportation services. Presently, the major area of concern is to review the operational experience to identify

*See U.S. Congress, House of Representatives; *Department of Transportation and Related Agencies Appropriations for 1975,* Part 4. Hearings before a Subcommittee, 93d Cong. 2d Sess., (Washington, Government Printing Office, 1974), pp. 744-750.

the parameters that are appropriate to larger-scale services. Some of the questions to be addressed might include:

- For area and service parameters, what operating characteristics can be expected and what is the sensitivity of these operating characteristics to the service parameters? These subjects are currently being investigated but more work is necessary in order to have a better understanding of these interrelationships.
- What are the costs and benefits of an integrated transportation system? How are these costs and benefits allocated to the components of the integrated system? On what basis should cross-subsidization decisions be made?
- What further technological developments are necessary to support interfacing with advanced transportation modes?
- Does demand responsive transportation technology have any spin-off application to other transport problem areas such as urban goods movement or dual-mode technology?
- What is the potential for an integrated fleet of various vehicles to provide a full range of demand responsive service, i.e., taxicabs for many-to-many and minibuses or vans for many-to-one or many-to-few?

Although large strides have been made in demand responsive transportation service since the 1960's, aspects requiring further development have surfaced as operational experience accrues. In order to make demand responsive transportation a viable future mode in an integrated transport system the questions raised above are only the beginning and the present is the time to begin addressing them.

SUPPLEMENTARY MATERIAL

APPENDIX A

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES

	ALPENA, MI	ANN ARBOR, MI		ATLANTIC CITY, NJ	BATAVIA, NY B-LINE DIAL-A-BUS
		"DIAL-A-RIDE" INITIAL	"TELTRAN" EXPANDED		
DATE INITIATED	July, 1974	Sept. 1971	Summer 1974	1916	Oct. 1971
TYPE OF SERVICE	many-to-many	many-to-few	many-to-many	jitney, fixed route, varied stops	many-to-many
POPULATION SERVED	13,805	6500	100,000		18,000
SERVICE AREA (MI^2)	7.4	1.36	21.8	4-mile route	5.5
NUMBER OF VEHICLES	4	3	45	35	7
AVERAGE WEEKDAY RIDERSHIP		214	5-6,000 projected		455
FARE (ADULT CASH)	50¢	60¢	25¢	30¢	60¢
FUNDING SOURCE (%)	State	State 63% City Ford	City 100%	private	Local 100%
SPECIAL SERVICES FEATURES:	Senior citizens half fare		5 buses with wheelchair lifts		Subscription service for workers; jr. college students; package delivery

References/Sources of further information:

Alpena: Phone conversation with Jerald Geile, Michigan State Highway Commission, Urban Transportation Division. (517) 373-6572. 4/74.

Ann Arbor: Dial-a-Ride Project Final *Report*, April 1973. Ann Arbor Transportation Authority.
Phone conversation with Karl Guenther. 5/74.

Atlantic City: Heathington, Kenneth W. "Dial-a-bus," Industrial Design, Jan. 1971, pp 32-33.
"Origin and History of Jitneys in Atlantic City, N.J."
Phone conversation with office of Traffic Commission Bryant, 4/8/74.

Batavia: Ford Motor Co., Dearborn, MI. Transportation Research & Planning Office.
Batavia, New York Dynamically-Responsive Bus Service. Reconnaissance Report.
R.G. Augustine and Karl W. Guenther. March 1972.
Phone conversation with Robert Aex. 5/74.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	BAY RIDGES, ONTARIO GO-TRANSIT DIAL-A-BUS		BENSENVILLE, IL DIAL-A-BUS	BENTON HARBOR-ST. JOSEPH, MI	BRAMALEA, ONT.
	INITIAL SYSTEM	EXPANDED SYSTEM			
DATE INITIATED	July, 1970	Feb. 1971	Nov. 1973	Sept. 1974	August, 1973
TYPE OF SERVICE	Transit feeder	many-to-many off peak	many-to-many	many-to-many	many-to-many
POPULATION SERVED	13,700	25,000	14,000	70,000	30,000
SERVICE AREA (MI^2)	1.34	12	7		5.1
NUMBER OF VEHICLES	4	14	2	8	10
AVERAGE WEEKDAY RIDERSHIP	460	950	150		1800
FARE (ADULT CASH)	25¢	30¢ (May 1972)	50¢	50¢	35¢
FUNDING SOURCE (%)	province 100%	province 50% township 50%	local	state	local
SPECIAL SERVICES FEATURES:	weekly booking		1/2 price for students; elderly	Senior citizens half-fare.	

References/Sources of further information:

Bay Ridges:

Ontario Dept. of Transportation & Communication. Toronto.
Dial-a-bus: the Bay Ridges Experiment. J.A. Bonsall, August, 1971
Simpkins, B.D. (Ontario Ministry of Transportation and Communications).
Some Characteristics of Dial-A-Bus Operations In Ontario. March, 1974
Phone conversation with Les Dickout, supervisor of transportation. 6/24/74

Bensenville:

Phone conversation with Frank DeVita, supervisor of Dial-A-Bus. 4/9/74
Malcolm, Andrew H. "Gasoline Lack Forces Suburban Change" New York Times, Feb. 17, 1974, pp. 1, 56

Benton Harbor:

Phone conversation with Jerry Geile, Michigan State Highway Commission, Urban Transportation Div. (517) 373-6572. 7/12/74

Bramalea:

Bonsall, J.A. (Ottawa-Carleton Regional Transit Commission, Ontario) and B.D. Simpkins (Ministry of Transportation and Communication, Ontario). Dial-A-Bus: Three Years' Experience in Ontario.
Paper presented at the Roads and Transportation Association of Canada, Annual Conference, Halifax, Nova Scotia, October 9-12, 1973.
Simpkins, B.D. (Ontario Ministry of Transportation and Communications).
Some Characteristics of Dial-A-Bus Operations in Ontario. March, 1974.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	BUFFALO, N.Y. MODEL CITIES JITNEY	CALGARY, ALBERTA BLUE ARROW BUS EXPRESS	CAMBRIDGE, ONT.	CARACAS, VENEZUELA POR PUESTOS
DATE INITIATED	Dec. 1970	Dec. 1973	May 1974	
TYPE OF SERVICE	many-to-many	many-to-one; many-to-many	many-to-many	fixed route demand stops
POPULATION SERVED	7,000	11,000		1,760,000
SERVICE AREA (MI^2)	3.0			(est.) 40 miles of routes
NUMBER OF VEHICLES	7	8	6	6,000
AVERAGE WEEKDAY RIDERSHIP	350 (1/74)	950		460,000
FARE (ADULT CASH)	free	35¢	40¢	10¢ up to 6 miles 20¢ over 6 miles
FUNDING SOURCE (%)	Federal (HUD) 100%	City	Province	Private
SPECIAL SERVICES FEATURES:	For those 60 yrs. old and up plus handicapped. Groups may charter.	Subscription Service	Senior citizens 10¢	Parcel post, messenger service

References/Sources of further information:

Buffalo: White, Michael "Model Cities Jitney Transportation in Buffalo", Demand Responsive Transportation Systems: Highway Research Board Special Report No. 136, 1973
Notess, Charles B. and R.E. Passwell (State Univ. of New York at Buffalo). "Demand Activated Transport for the Elderly". Transportation Engineering Journal. Vol. 98, No. 4, Nov. 1972, pp. 807-821
Phone conversation with Michael White, 4/74.

Calgary: Phone conversation with Lloyd Morasch, Calgary Planning Department. 4/26/74. (403) 268-2424

Cambridge: Phone conversation with Cambridge Transit Authority. (519) 623-7721

Caracas: Kudlich, Walter. "Carros por Puesto - The jitney taxi system of Caracas, Venezuela," Highway Research Record No. 283. pp 1-10.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	CLEVELAND, OH		COLUMBIA, MD "CALL-A-RIDE"		COLUMBUS, OH MODEL CITIES DIAL-A-RIDE	
	DIAL-A-RIDE FOR SENIORS	BUCKEYE, TREMONT AND MODEL CITIES	INITIAL SYSTEM	EXPANDED SYSTEM	INITIAL SYSTEM	EXPANDED SYSTEM
DATE INITIATED	Nov. 1973	Fall 1974	Jan. 1971	Aug. 1971	Oct. 1971	
TYPE OF SERVICE	many-to-many	many-to-many	"Easy Rider" (home-to-work) many-to-many	many-to-many	many-to-many	
POPULATION SERVED	14,000	12,000	17,300	30,000	37,045	55,000
SERVICE AREA (MI^2)	9	12	6.0	10.0	2.56	
NUMBER OF VEHICLES	1	10	2	3	4	5
AVERAGE WEEKDAY RIDERSHIP	35		54	80-100	355	485
FARE (ADULT CASH)	donations accepted	10¢	25¢	50¢	20¢	25¢
FUNDING SOURCE (%)	Federal	Federal 70% Local 30%		Local	Federal (HUD) 100%	
SPECIAL SERVICES FEATURES:	For elderly only	For senior citizens and handicapped.		Children (6-11) half fare	Charter service to day care centers	

References/Sources of further information:

Cleveland: Collinwood Eldercare Center. Third Grant Year - First Quarter Report from October 1, 1973 through December 31, 1973. Rileigh F. Coleman, Director.
Phone conversation with Rileigh Coleman, 4/74.
Phone conversation with Goldie Lake, director, Neighborhood Elderly Transportation Project. 6/26/74

Columbia: Bartolo, Robert. (Rouse Co., Columbia, MD). A new transit system for Columbia, Maryland.
Paper presented at the Connecticut Transportation Symposium, May, 1971.
Phone conversation with Mark Weissart, transportation supervisor. 4/4/74.

Columbus: Mid-Ohio Regional Planning Commission, Columbus, OH, and Ford Motor Co.,Transportation Research and Planning Office.
REPORT ON THE COLUMBUS, OHIO, MODEL CITIES SECOND YEAR TRANSIT PROJECT. Sept. 1972.
Sponsored by the City of Columbus and the Model Neighborhood Assembly.
Phone conversation with office of Edward Cummings, project manager. 4/4/74

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	CRANSTON, RI "TRANSVAN"	DALLAS, TX DIAL-A-TRIP		DAVENPORT, IA	DAVIS, CA SENIOR CENTER TRANSPORTATION
		INITIAL SYSTEM	EXPANDED SYSTEM		
DATE INITIATED	Sept. 1971	Sept. 1972	Fall, 1974		Feb. 1973
TYPE OF SERVICE	many-to-many	route deviation to 1 fixed location	transit feeder	shared taxi	many-to-many
POPULATION SERVED	10-11,000 eligible 545 subscribed	200-250	6,000	98,500	1,700
SERVICE AREA (MI^2)	28		2-3	19.7	
NUMBER OF VEHICLES	3	1	6	20	1
AVERAGE WEEKDAY RIDERSHIP	160	30		1300	25-30
FARE (ADULT CASH)	subscription: $1.25/mo.	10¢ (regular fare)	25¢	by zones Average $1.03	free
FUNDING SOURCE (%)	UMTA 86.4% local 13.6%	local 100%	federal	private	
SPECIAL SERVICES FEATURES:	elderly (62+) & handicapped. One bus with wheelchair ramp.	one block deviation to a senior-citizens complex		package delivery	For senior citizens or handicapped.

References/Sources of further information:

Cranston:
"Transvan History, 1971-1974"
Phone conversation with Arthur Butler, Jr., Executive director. 4/5/74

Dallas:
"DTS Begins "Dial-a-trip" Service" Passenger Transport July 7, 1972, p. 2
Phone conversation with Jerry Johnson, director of public information for Dallas Transit. 4/3/74
Phone conversation with City Transit Planning office. 7/11/74

Davenport:
Cherry, Robert C. "Computer, Taxis, and Grass Roots Transportation" HRB Special Report No. 136. 1972
Heathington, Kenneth W. and Marcil T. Zobrak, An Analysis of Two Privately Owned Demand-Responsive Transportation Systems.
Heathington, Kenneth W. and Frank Davis, Jr. An Example of Demand-Responsive Transportation Systems in the Private Sector. For presentation at 53rd Annual HRB Meeting. Jan. 1974
Phone conversations with Bob Hill, 4/3/74 and Robert Cherry, 5/74

Davis:
Phone conversation with Sue Snively, supervisor of Senior Center, 630 Second St., Davis, DA 95616. 758-4020 4/5/74

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	DETROIT, MI	DOVER, DEL SENIOR SURRY	EL CAJONE, CA "EL CAJONE EXPRESS"	EMMEN, NETHERLANDS BUXI	FAIRFAX CITY, VA	FLINT, MI MAXI-CAB COMMUTER CLUB
DATE INITIATED	Feb, 1972	June, 1974	Dec. 1973	May, 1970	June 3, 1974	Sept. 1968
TYPE OF SERVICE	many-to-many	many-to-many	many-to-many	route deviation; one-to-many	many-to-many	subscription home-to-work
POPULATION SERVED	120,000	16,800	60,000	4,000	23,000	196,940
SERVICE AREA (MI^2)	9.0	21	17	0.5	6.3	
NUMBER OF VEHICLES	13	4	14	2	3	26
AVERAGE WEEKDAY RIDERSHIP	500	102	600	110	est. 400	230
FARE (ADULT CASH)	free	free	50¢	30¢	25¢	by zones
FUNDING SOURCE (%)	HUD, local	local	local		local 100%	US. DOT 66.4% private 5.3% local 28.3%
SPECIAL SERVICES FEATURES:		For senior citizens		Discontinued May, 1972		

References/Sources of further information:

Detroit: Phone conversation with William McGuire, project director for transportation. 4/4/74

Dover: Phone conversation with Don Hodge, assistant city manager for Dial-A-Ride. (302) 674-1000. 6/21/74

El Cajone: Phone conversation with Norman Bryant, Yellow Cab Operations manager. (714) 239-8061. 7/10/74

Emmen: Hupkes, Geurt. "Buxi: Demand-responsive bus experience in the Netherlands," HRR No. 397. 1972. pp. 38-41

Fairfax City: "Dial-a-Ride Concept is Spreading," Passenger Transport, June 7, 1974, p. 1.
Phone conversation with Mark Weiss, project director. 4/11/74

Flint: Flint Transportation Authority. Fare Structure: Design, Implementation and Evaluation, June 1970
American Academy of Transportation, Flint, MI. Flint Transportation Authority Demonstration Project MICH-MTD-2. Feb. 1970
American Academy of Transportation. Origin-Destination Data Plotting and Analysis. June 1970

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	FT LEONARD WOOD, MO FORT CAB CO. LONG CAB CO.	FT WALTON BEACH, FL "CALL-A-BUS"	GOTHENBURG, SWEDEN	GRAND RAPIDS, MI MODEL CITIES
DATE INITIATED	1958	Oct. 1970	1967	July 1973
TYPE OF SERVICE	many-to-many	route deviation	many-to-many	many-to-few
POPULATION SERVED	est. 40,000	12,000	12,000	17,000
SERVICE AREA (MI^2)	12	7.0		20
NUMBER OF VEHICLES	80	2	40	5
AVERAGE WEEKDAY RIDERSHIP	1000	60	2000	300
FARE (ADULT CASH)	40¢	50¢ door-to-door 35¢ regular	25¢	50¢
FUNDING SOURCE (%)	private	private	local 100%	UMTA 67% City 33%
SPECIAL SERVICES FEATURES:				subscription service

References/Sources of further information:

Fort Leonard Wood:
Phone conversation with Robert Forrester, manager, Fort Cab. Co. (314) 368-2494 4/23/74
Phone conversation with Edward Saul, supervisor, Long Cab Co. (314) 368-7101. 4/23/74

Ft. Walton Beach:
"Demand-Activated Transit" Motor Coach Age. Sept. 1972 pp. 14-15
"Telephone Brings Bus to Door" Passenger Transport. March 3, 1971, p. 8

Gothenberg:
"Dial-a-bus," New Concepts in Urban Transportation, v. 4, no. 1, p. 2.

Grand Rapids:
Ford Motor Co., Deaborn, MI. Transportation Research and Planning Office. Grand Rapids Model Cities Dial-a-Ride: Summary report on design and implementation, Dec. 1972 - Aug. 1973
Michael Dewey and Betty Mikkelsen, Oct. 9, 1973
Phone conversation with Robert Paul Rosson, project director, 4/4/74.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	HADDONFIELD, NJ		HARTFORD, CT	HELENA, MT	
	INITIAL SYSTEM	EXPANDED SYSTEM		INITIAL SYSTEM	EXPANDED SYSTEM
DATE INITIATED	Feb. 1972	Aug. 1973	Dec. 1973	June, 1973	Jan. 1974
TYPE OF SERVICE	transit feeder (peak) many-to-many (off peak)		many-to-many	many-to-one	many-to-many
POPULATION SERVED	24,381	44,000	25,000	27,000	4,000 (senior citizens)
SERVICE AREA (MI^2)	6.5	11	est. 20	12	12
NUMBER OF VEHICLES	10	19 (1 wheelchair)	6	2	5
AVERAGE WEEKDAY RIDERSHIP	360	1200	100	50	60
FARE (ADULT CASH)	50¢	30¢	donations	$3.75/week	40¢
FUNDING SOURCE (%)	Federal (UMTA) 80% NJ DOT 20%		state local	UMTA 67% local 33%	local 100%
SPECIAL SERVICES FEATURES:	Subscription service wheelchair accommodations (expansion dates: 9/72, 3/73, & 8/73) Senior citizens half fare		Senior citizens only.		

References/Sources of further information:

Haddonfield: "New Jersey Dial-a-Ride System Building Ridership in 2nd Year", Highway Research News, No. 51 Summer 1973

Zobrak, Marcel and Douglas M. Medville. Haddonfield Dial-a-ride Experiment: Interim Results. Presented at the International Conference on Transportation Research.

Implementation and Operation of a Demand Responsive Public Transportation System (Haddonfield Dial-A-Ride). Prepared for UMTA and New Jersey Dept. of Transportation by LEX Systems, Inc. and DAVE Systems, Inc. March 1974.

Hartford: Telephone conversation with William Knopf, director. (203) 278-9950 ext. 306. 6/25/74.

Helena: Telephone conversation with William Emge, manager of transportation systems. 4/5/74.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	HEMET, CA DIAL-A-RIDE	HICKSVILLE, NY	HOLLAND, MI	HOUGHTON-HANCOCK, MI	ISABELLA CO., MI VAN-TRAN	KENT, OH DRUBS
DATE INITIATED	Jan. 1974	1961	Feb. 1974	July, 1974	June, 1974	Jan. 1971
TYPE OF SERVICE	many-to-many	many-to-many	many-to-many	many-to-many	many-to-few	many-to-one
POPULATION SERVED	17,200	48,100	26,000	10,900	43,769	105 households
SERVICE AREA (MI^2)	6.5	6.8	13.8	3.8	572	75
NUMBER OF VEHICLES	2	30	5	3	2	1
AVERAGE WEEKDAY RIDERSHIP	90	814	250		8.14	55
FARE (ADULT CASH)	50¢	By zones	50¢	50¢	$1.00	Free
FUNDING SOURCE (%)	Local	Private	State	State	State	UMTA 100%
SPECIAL SERVICES FEATURES:		24-Hr. Service	Senior Citizens Half Fare	Senior Citizens Half Fare	Senior Citizens Half Fare	Discontinued May 1971 (end of grant)

References/Sources of further information:

Hemet: Phone conversation with David Oltman, superintendent of public works. 658-9411

Hicksville: Heathington, Kenneth W. and Marcel Zobrak. An Analysis of Two Privately Owned Demand-Responsive Transportation Systems. Paper presented at the International Conference on Transportation Research, Bruges, Belgium, June 18-21, 1973
Heathington, Kenneth W. and Frank Davis, Jr. An Example of Demand-Responsive Transportation System in the Private Sector. Presented at the 53rd Annual Highway Research Board Meeting, Jan. 1974
An Analysis of Two Privately Owned Demand-Responsive Transportation Systems, Research Progress Report, Transportation Research Center, U. of Tennessee, August 16, 1973

Holland: Phone conversation with Jerry Geile, Michigan State Highway Commission. Urban Transportation Division (517) 373-6572. 4/74.

Houghton-Hancock: Phone conversation with Jerry Geile, Michigan State Highway Commission. Urban Transportation Division (517) 373-6572. 4/74.

Isabella Co.: Phone conversations with Jerry Geile, Michigan State Highway Commission, Urban Transportation Division, (517) 373-6572, 7/12/74, and Jill Kooiman, Isabella Co. Commission on Aging, (517) 772-0911, 7/12/74.

Kent: Kent State University (Kent, OH) Center for Urban Regionalism. DRUBS: Demand-Routed Urban Bus Service Report. OHIO-MTD-4.
"When Does the Bus Leave"? When Can You Make It? Transport Central, June 26, 1972, pp. 6-8.
Phone conversation with Joseph Fiala, general manager, 4/11/74

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	KENT, OH CAMPUS BUS SERVICE	KINGSTON, ONTARIO		KLAMATH FALLS, OR		LA HABRA, CA
		INITIAL SYSTEM	EXPANDED SYSTEM	INITIAL SYSTEM	EXPANDED SYSTEM	
DATE INITIATED	July, 1974	Oct. 1972	Aug. 1973	Aug. 1972	Summer 1973	Feb. 1973
TYPE OF SERVICE	many-to-few	many-to-many within many-to-one without		Fixed route Flag down		many-to-many
POPULATION SERVED	40	18,000		32,000		47,000
SERVICE AREA (MI^2)	6.0		5.4			7.0
NUMBER OF VEHICLES	2	3	4	1	2	7
AVERAGE WEEKDAY RIDERSHIP	165	150	450	30	100	450
FARE (ADULT CASH)	$8/3 month subscription		35¢	25¢		50¢
FUNDING SOURCE (%)				Federal (UMTA) 71% State 21% Local 8%		Local (Gas tax)
SPECIAL SERVICES FEATURES:	Handicapped only			Originally off-peak only using school buses. Expanded to full time for summer. Discontinued		Senior citizens 25¢. All propane vehicles.

References/Sources of further information:

Kent:

Kent State University (Kent, OH) Center for Urban Regionalism. DRUBS: Demand-Routed Urban Bus Service Report. OHIO-MTD-4.
"When Does the Bus Leave? When Can You Make It?" Transport Central, June 26, 1972, pp. 6-8
Phone conversation with Joseph Fiala, general manager, 4/11/74

Kingston:

Bonsall, J.A. (Ottawa-Carleton Regional Transit Commission, Ontario) and B.D. Simpkins (Ministry of Transportation and Communication, Ontario).
Dial-a-Bus: Three Years' Experience in Ontario.
Paper presented at the Roads and Transportation Association of Canada, Annual Conference, Halifax, Nova Scotia
Oct. 9-12, 1973
Simpkins, B.D. (Ontario Ministry of Transportation and Communications).
Some Characteristics of Dial-A-Bus Operations in Ontario. March, 1974

Klamath Falls:

Klamath Area Transit. Community School Bus Project: Midterm report. Jack Graham, project coordinator, March, 1973

La Habra:

Shilling, David R. "Dial-a-Ride: The La Habra Experiment"
Paper presented at the 26th Annual Western Dist. Conf. of the Institute of Traffic Engineers, Las Vegas, 1973
OCTD Dial-A-Ride: A Summary of the First Year of Operation in La Habra.
Prepared by DAVE Systems, Inc. for the Orange County Transit District. May, 1974.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	LA MESA, CA	LA MIRADA, CA	LINCOLN, NEB SENIOR HANDIBUS	LITTLE ROCK, ARK SHARE-A-RIDE	LOS ANGELES, CA GREATER WATTS MODEL CITIES DIAL-A-BUS
DATE INITIATED	April, 1974	May, 1973	June, 1972	1946	Sept. 1973
TYPE OF SERVICE	many-to-many	many-to-many	many-to-many	many-to-many	many-to-many
POPULATION SERVED	45,000	32,000	3500 eligible 1130 registered	190,000	110,000
SERVICE AREA (MI^2)	7.0	6.0	51.0	53.0	8.6
NUMBER OF VEHICLES	5	6	6	75	7
AVERAGE WEEKDAY RIDERSHIP	275	360	100	3000	250
FARE (ADULT CASH)	50¢	25¢	40¢	By zones	15¢
FUNDING SOURCE (%)	State Local	Local	UMTA 90% Local 10%	Private	UMTA 100%
SPECIAL SERVICES FEATURES:			Handicapped only		

References/Sources of further information:

La Mesa: Phone conversation with Norman Bryant, operations manager. (714) 239-8061. 7/10/74.

La Mirada: Lindsey, Robert. "Dial-a-ride system may help suburbs." New York Times, August 23, 1973. p. 66
Phone conversation with Donald Pruyn, administrative assistant for public transit. (213) 943-0131. 7/11/74.

Lincoln: Phone conversation with James Zeitlow, administrator for the city/county commission on the aged. 477-1241. 4/5/74.

Little Rock: Phone conversation with John W. Hall, president, Black and White Cab Co. 1010 Markham St., Little Rock. Ark. 374-0333

Los Angeles: Phone conversation with John Maxwell, project director. (213) 564-4401. 4/10/74

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	LOWELL, MA	LUDINGTON, MI	MANSFIELD, OH DIAL-A-RIDE	MEDFORD, OR	MENLO PARK, CA
DATE INITIATED		Feb. 1974	Dec. 1969	June, 1972	1969
TYPE OF SERVICE	shared taxi	many-to-many	route deviation	route deviation	many-to-one
POPULATION SERVED	90,000	9021	3150	30,000	2500
SERVICE AREA (MI^2)		3.2	1.0		
NUMBER OF VEHICLES	40	3	1	1	1
AVERAGE WEEKDAY RIDERSHIP		200	76 (14.4 door-to-door)	50-100; 5-10 use deviation	45
FARE (ADULT CASH)	By zones 60¢ in first zone, 30¢ additional zone	50¢	35¢ regular 50¢ door-to-door	25¢	Free
FUNDING SOURCE (%)		State	Local	Federal (OEO) until July 1973. Local continuation.	Private
SPECIAL SERVICES FEATURES:		Senior citizens half fare	Discontinued Jan. 1971	4.8 miles of possible deviation from 12 mile regular route.	For senior citizens

References/Sources for further information:

Lowell: Phone conversation with Mr. Sullivan of Diamond Cab of Lowell. (617) 458-6861

Ludington: Phone conversation with Jerry Geile, Michigan State Highway Commission. Urban Transportation Division. (517) 373-6572.

Mansfield: Richland County Regional Planning Commission, OH. The Mansfield, Ohio, Dial-a-ride Experiment. August, 1970

Medford: "Dial-a-ride Experimentation Spreading", Passenger Transport, August 11, 1972, p. 6
Phone conversation with Mr. Nelson, county commissioner for transportation. 4/74.

Menlo Park: Phone conversation with office of Ms Jean Von Ezdorf, executive director of "Little House" (415) 326-2025. 4/10/74
"Little House Transportation Report, 1969-70."

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	MERCED, CA YELLOW CAB CO. DIAL-A-BUS	MERCED, CA DIAL-A-RIDE	MIDLAND, MI	MT PLEASANT, MI	NEW ORLEANS (ST. BERNARD PARISH) "PORTAL-TO-PORTAL) SERVICE
DATE INITIATED	Aug. 1970	May 1974	June 1974	March 1974	Sept. 1973
TYPE OF SERVICE	many-to-many	many-to-many	many-to-many	many-to-many	many-to-many; route deviation
POPULATION SERVED	25,000	25,000	35,176	20,504	54,000
SERVICE AREA (MI^2)	16	16	24.9	5.1	150
NUMBER OF VEHICLES	18	4	6	4	4
AVERAGE WEEKDAY RIDERSHIP	130			200	100-130
FARE (ADULT CASH)	50¢/person $1.00 minimum	25¢	50¢	50¢	extra 40¢
FUNDING SOURCE (%)	Private	Local	State	State	Private
SPECIAL SERVICES FEATURES:			Senior citizens half fare	Senior citizens half fare	

References/Sources for further information:

Merced Cabs: Phone conversation with Mr. Ed Hladick, president. (209) 772-2741. 4/10/74

Merced (city): Phone conversation with Ms. "Pete" Hansen (209) 722-4131. 4/10/74

Midland: Phone conversation with Jerry Geile, Michigan State Highway Commission, Urban Transportation Div. (517) 373-6572 4/74.

Mt. Pleasant: Phone conversation with Jerry Geile, Michigan State Highway Commission, Urban Transportation Div. (517) 373-6572 4/74.

New Orleans: Phone conversation with Peter Rusck, manager of St. Bernard Bus Co. (504) 279-5556. 4/11/74

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	OTTAWA, ONT "TELE-TRANSPO"		PEORIA, IL "PREMIUM SPECIAL SERVICE"	REGINA, SASKATCHEWAN "TELEBUS"	
	INITIAL SYSTEM	EXPANDED SYSTEM		INITIAL SYSTEM	EXPANDED SYSTEM
DATE INITIATED	Aug. 1973	March 1974	Dec. 1964	Sept. 1971	June 1972
TYPE OF SERVICE	many-to-one	many-to-one	many-to-one	line feeder; many-to-few	many-to-many
POPULATION SERVED	27,400	32,500	4900	18,000	35,000 peak 60,000 off-peak
SERVICE AREA (MI^2)	5.2			2.75	5.0 peak 8.5 off-peak
NUMBER OF VEHICLES	17	26	17	7	17
AVERAGE WEEKDAY RIDERSHIP	1410	2000		1200	2000
FARE (ADULT CASH)	50¢ peak 35¢ off-peak	50¢ peak 35¢ off-peak	25¢	35¢	40¢
FUNDING SOURCE (%)		Province 50% Local 50%	Federally funded test; private continuation	Local Provincial Federal	
SPECIAL SERVICES FEATURES:			Discontinued Jan. 1971		

References/Sources of further information:

Ottawa: Bonsall, J.A. (Ottawa-Carleton Regional Transit Commission, Ontario) and B.D. Simpkins (Ministry of Transportation and Communication, Ontario).
Dial-A-Bus: Three Years' Experience in Ontario.
Paper presented at the Roads and Transportation Association of Canada, Annual Conference, Halifax, Nova Scotia, October 9 - 12, 1973
Simpkins, B.D. (Ontario Ministry of Transportation and Communications).
Some Characteristics of Dial-A-Bus Operations in Ontario. March, 1974.
Phone conversation with Joel Coffman, transit planning officer. (416) 248-3785. 6/28/74

Peoria: Blurton, Michael A.S. "Special Bus Service" Traffic Engineering, Feb. 1967 pp. 17-21

Regina: Regina Telebus Study. Operation Report and Final Report, 1972.
Phone conversation with Jerry McAdoo, General Manager, Regina Transit System. 5/74.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	RESTON, VA COMMUTER BUS	RHODE ISLAND SENIOR CITIZEN'S TRANSPORTATION	RICHMOND, CA	ROCHESTER, NY "PERT" "PILOT PROJECT"	ROCKVILLE, MD DIAL-A-BUS
DATE INITIATED	Feb. 1968	Aug. 1972	July 1974	Aug. 1973	1975
TYPE OF SERVICE	many-to-few	many-to-many	many-to-many	subscription; many-to-many	many-to-many
POPULATION SERVED	25,000	150,000	44,000	30,000	50,000
SERVICE AREA (MI^2)	11.5	1214	4.9	10.0	
NUMBER OF VEHICLES	25	28	13	7	12
AVERAGE WEEKDAY RIDERSHIP	2000	900		440	
FARE (ADULT CASH)	$1.40	free	25¢	basic fare $1.00 25¢ each additional person	25¢
FUNDING SOURCE (%)	Private	Federal 75% State 25%	Federal Local		County
SPECIAL SERVICES FEATURES:	subscription home-to-work	for those 60 and over		digital communications subscription service for peak hours	

References/Sources of further information:

Reston:
American Society of Planning Officials. Planning Advisory Service Report No. 286. Dec. 1972.
"Demand-Responsive Transit Service; a new transportation tool." Barry D. Lundberg and Charles W. Lustig.
Phone conversation with Ms. Hed, office manager. 7/12/74

Rhode Island:
A DEMAND RESPONSIVE TRANSPORTATION SYSTEM DESIGNED FOR RHODE ISLAND'S OLDER POPULATION.
A report to the U.S. Senate Special Committee on Aging, hearing on Transportation and the Elderly. Feb. 25, 1974
Phone conversation with Catherine O'Reilly Collette, program planner. (401) 277-2858. 7/9/74.

Richmond:
"AC Dial-a-ride arrives with the Sound of Music" Passenger Transport, Jan. 25, 1974
Phone conversation with Dale Goodman, manager of transportation. (415) 654-7878. 6/21/74.

Rochester:
"PERT; Dial-a-bus is underway:" Passenger Transport, v. 31, n. 32, Aug. 10, 1973 p. 1.
Phone conversation with Robert Aex, 5/74

Rockville:
Phone conversation with Wayne Hucke, transportation planner (301) 424-8000. 4/74.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	ST. PETERSBURG, FL "TOTE"	SANTA CLARA COUNTY, CA	SAULT STE. MARIE, MI	SCOTT-CARVER COUNTIES, MN	STRATFORD, ONT. "DART"
DATE INITIATED	Sept. 1973	Fall, 1974	April, 1974	July, 1971	Sept. 1972
TYPE OF SERVICE	many-to-many	many-to-many	many-to-many	many-to-many	many-to-many
POPULATION SERVED	30,000 eligible 15,000 registered	1.1 million	15,136	5,403	24,000
SERVICE AREA (MI^2)	10.0	241	15.7	688	7.0
NUMBER OF VEHICLES	13 (including 2 wheelchairs)	90	5	1	5
AVERAGE WEEKDAY RIDERSHIP	400 (10,000/month)			20	200
FARE (ADULT CASH)	1 day reservation $.35 same day $.60	25¢	40¢ or 50¢	25¢ to 30 miles	35¢
FUNDING SOURCE (%)	UMTA 67% Local 33%	UMTA County 25%	State	State 20% Local 80%	
SPECIAL SERVICES FEATURES:	Those over 60 or handicapped.	Blind, free. Subscription service.	Senior citizens half fare	Senior citizens only	Evenings only.

References/Sources of further information:

St. Petersburg:

"DOT News: Funds Flow to 18 States." Passenger Transport.
Phone conversation with Ken Schreiber. 4/3/74.

Santa Clara:

LEX Systems, Inc., Santa Clara Transit District: Integrated Demand Responsive/Express Bus System. Report on Requirements and Preliminary System Design. October 1973

Phone conversation with James T. Pott, assistant executive director for the Santa Clara County and assistant executive director for the Santa Clara Transit District. 4/18/74.

Sault Ste. Marie:

Phone conversation with Jerry Geile, Michigan State Highway Commission, Urban Transportation Div., (517) 373-6572

Scott-Carver:

Transportation Systems Center, Cambridge, MA. "The Handicapped and Elderly Market for Urban Mass Transit". Final Technical Report. Martin Costello, Charles Phillips, William Barker and Hans Scott. Oct. 1973. Sponsored by UMTA.

Stratford:

Bonsall, J.A. (Ottawa-Carleton Regional Transit Commission, Ontario) and B.D. Simpkins (Ministry of Transportation and Communication, Ontario).
Dial-A-Bus: Three Years' Experience in Ontario.
Paper presented at the Roads and Transportation Association of Canada, Annual Conference, Halifax, Nova Scotia, October 9-12, 1973
Simpkins, B.D. (Ontario Ministry of Transportation and Communications).
Some Characteristics of Dial-A-Bus Operations in Ontario. March, 1974

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	SUDBURY, ONT.	TOLEDO, OH MODEL NEIGHBORHOOD	TORONTO, ONTARIO "GO DIAL-A-BUS"		TRAVERSE CITY, MI
			YORK MILLS	ARMOUR HEIGHTS	
DATE INITIATED	Nov. 1972	Feb. 1972	Oct. 1973	Dec. 1973	May 1, 1974
TYPE OF SERVICE	many-to-few	many-to-many	many-to-one	many-to-one	many-to-many
POPULATION SERVED	1000	40,000	20,800	34,300	18,048
SERVICE AREA (MI^2)		3.5			7.8
NUMBER OF VEHICLES	1	7	7	7	5
AVERAGE WEEKDAY RIDERSHIP	28	350	800	630	
FARE (ADULT CASH)	45¢	10¢	40¢	40¢	50¢
FUNDING SOURCE (%)		HUD	Province 100% for 3-year trial		State
SPECIAL SERVICES FEATURES:	Subscription only	1 day notice Dial-A-Ride to clinics (expanded July 1973)	3 vehicles adapted for wheelchairs		Senior citizens half fare

References/Sources of further information:

Sudbury: Bonsall, J.A. (Ottawa-Carleton Regional Transit Commission, Ontario) and B.D. Simpkins (Ministry of Transportation and Communication, Ontario).
Dial-A-Bus: Three *Years'* Experience in *Ontario.*
Paper presented at the Roads and Transportation Association of Canada, Annual Conference, Halifax, Nova Scotia, October 9-12, 1973.

Toledo: Phone conversation with Robert Taylor, project director, (419) 248-6676. 7/3/74.

Toronto: "GO Dial-a-bus to make debut this month," *Transit* Topics, 23 Oct. 1973, p.13.
Simpkins, B.D. (Ontario Ministry of Transportation and Communications).
Some Characteristics of Dial-A-Bus Operations in Ontario. March, 1974.

Traverse City: Phone conversation with Jerry Geile, Michigan State Highway Commission, Urban Transportation Div. (517) 373-6572. 4/74.

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	VALLEY TRANSIT DISTRICT DERBY, CT		WASHINGTON, DC METROPOLITAN COUNCIL OF GOVERNMENT	WEST PALM BEACH, FL "LIFT-LINE"
	INITIAL SYSTEM	EXPANDED SYSTEM		
DATE INITIATED	Jan. 1973	April 1973	Sept. 1974	Sept. 1972
TYPE OF SERVICE	shuttle	many-to-many	subscription service many-to-one	route deviation
POPULATION SERVED	25,000 (est.)	75,000	30,000	18,000
SERVICE AREA (MI^2)	15	56.0	2.0	300
NUMBER OF VEHICLES	2	3	6-8	7
AVERAGE WEEKDAY RIDERSHIP	130	200	1000	620
FARE (ADULT CASH)	25-35-45¢	Varies 25¢ to $2.50	free for 2 months; evaluation to follow	free
FUNDING SOURCE (%)	Federal (UMTA) State Local		FHA 100% for 1-1/2 year demonstration	State; DOT Federal (HEW)
SPECIAL SERVICES FEATURES:	1 vehicle adapted for handicapped. Credit card fare collection.			For elderly, handicapped, and disadvantaged.

References/Sources of further information:

Valley Transit: Kent, John. Remarks Proceedings of the Demand Response Conference, Oct. 4, 1973.
Phone conversation with J. Norensky, director of Valley Transit District. 735-6408. 5/74.

Washington: Phone conversation with Christopher Neumann, transportation engineer, 4/11/74

West Palm Beach: Phone conversation with David Duffy, Florida DOT Urban Transportation Operations Bureau. 488-3251. 4/30/74
Phone conversation with Eugene Eddy, Transportation coordinator for State Dept.of Human Resources. 686-4555. 4/30/74

SUMMARY OF SELECTED CHARACTERISTICS OF 80 DEMAND RESPONSIVE TRANSPORTATION SERVICES (CONT.)

	WESTERN OLDER CITIZEN'S COUNCIL PROJECT INDEPENDENCE TRANSPORTATION (ANDROSCOGGIN-FRANKLIN-OXFORD CO., ME)	WILLINGBORO, NJ "DIAL-A-JITNEY"
DATE INITIATED	Feb. 1972	Jan. 1972
TYPE OF SERVICE	many-to-many	many-to-many
POPULATION SERVED		45,000
SERVICE AREA (MI^2)		9.0
NUMBER OF VEHICLES	10	2
AVERAGE WEEKDAY RIDERSHIP	224	90
FARE (ADULT CASH)	free	$.75 avg (by zones)
FUNDING SOURCE (%)	Federal Local	Private
SPECIAL SERVICES FEATURES:	For senior citizens only.	

References/Sources of further information:

Western Older Citizens:

Matteson, S. "Spirit of 76 - Independence in Old Age". Trial Magazine, March-April 1974, pp. 20-22

Phone conversation with Project Independence office (207) 645-4222

Willingboro:

Lundberg, Barry D. and Charles W. Lustig
"Demand-Responsive Transit Service: a new transportation tool". ASPO Planning Advisory Service Reports No. 286, Dec. 1972

Phone conversation with office of Mr. James Schoonover, manager 871-9300.

APPENDIX B

REFERENCES

NOTE: Materials available from the National Technical Information Service are indicated by a "PB" order number.

1. American Academy of Transportation, Ann Arbor, MI. MAXI-CAB COMMUTER CLUB. Final Report, May, 1972. Sponsored by UMTA PB 220-903

2. Archer, E. (Air Canada) and J.H. Shortreed (Univ. of Waterloo, Ontario): POTENTIAL DEMAND FOR DEMAND-SCHEDULED BUS SERVICES. Highway Research Record No. 367 1971 pp. 141-151.

3. Blurton, Michael A.S. (Kent State Univ., OH). SPECIAL BUS SERVICE. *Traffic Engineering* February 1967 pp. 17-21.

4. Bonsall, J.A. (Ottawa-Carleton Regional Transit Commission, Ontario) and B.D. Simpkins (Ministry of Transportation and Communication, Ontario). DIAL-A-BUS: THREE YEARS' EXPERIENCE IN ONTARIO. Paper presented at the Roads and Transportation Association of Canada, Annual Conference, Halifax, Nova Scotia. October 9-12, 1973.

5. Bruggeman, J.M. (Peat, Marwick, Livingston and Co.) and K.W. Heathington (Purdue Univ, West Lafayette, IN). SENSITIVITY TO VARIOUS PARAMETERS OF A DEMAND-SCHEDULED BUS SYSTEM, COMPUTER SIMULATION MODEL. *Highway Research Record* No. 293 1969 pp. 117-125.

6. Brumble, Stephen D. (Boeing Co., Philadelphia, PA. Surface Transportations Systems Div.) DIAL-A-RIDE IS HERE! Paper presented at the American Transit Association, 1972 Mid-Year Meeting, Detroit, Michigan.

7. Canty, Eugene T. (General Motors Research Labs., Warren, MI). THE DEMAND-RESPONSIVE JITNEY: A SOCIALLY ORIENTED TRANSPORTATION SYSTEM DESIGN STUDY. In: Federation Internationale de Societes d'Ingenieurs des Techniques de l'Automobile (FISITA), *1970 International Automobile Safety Conference Compendium,* Detroit, Michigan, May 13-15, 1970, Brussels, Belgium, June 8-11, 1970, Pt. 19.B.

8. Clark, J.M. (Cranfield Inst. of Tech., England). DEMAND RESPONSIVE SYSTEMS. In: *Public Road Transport Analysis;* Proceedings of Planning and Transport Research and Computation Company Seminar, London, Sept. 29-Oct. 2, 1970, pp. 111-116.

9. DEMAND ACTUATED TRANSPORTATION SYSTEMS. *Highway Research Board Special Report* No. 124,1971, Proceedings of the First Annual Conference on Demand Responsive Transportation Systems, Purdue University, September 1970.

10. DEMAND RESPONSIVE TRANSPORTATION SYSTEMS. *Highway Research Board Special Report* No. 136, 1973, Proceedings of the Third Annual Conference on Demand Responsive Transportation Systems, Ann Arbor, June 12-14, 1972.

11. Department of Housing and Urban Development, Washington, DC. TOMORROW'S TRANSPORTATION: NEW SYSTEMS FOR THE URBAN FUTURE. Charles M. Haar, Leon Monroe Cole, Harold W. Merritt May 1968. PB 178-811.

12. Department of Transportation, Office of R&D Policy, Washington, DC. SUBURBANIZATION AND ITS IMPLICATIONS FOR URBAN TRANSPORTATION SYSTEMS. J.D. Ward and N.G. Paulhus, April 1974. Report DOT-TST-74-8

13. Fielding, Gordon J. and David R. Shilling (Orange County Transit District, CA). DIAL-A-RIDE: AN OPPORTUNITY FOR MANAGERIAL CONTROL. Paper presented at the Fourth Annual International Conference on Demand-Responsive Transportation Systems, Rochester, New York, Oct. 3-5, 1973.

14. Ford Motor Co., Dearborn, MI. Transportation Research and Planning Office. BATAVIA, NEW YORK DYNAMICALLY-RESPONSIVE BUS SERVICE, Reconaissance Report, R.G. Augustine and K.W. Guenther, Mar. 1972

15. Ford Motor Co., Dearborn, MI. Transportation Research and Planning Office. GRAND RAPIDS MODEL CITIES DIAL-A-RIDE, SUMMARY REPORT ON DESIGN AND IMPLEMENTATION, DECEMBER 1972–AUGUST 1973. M. Dewey and B. Mikkelsen Oct. 9, 1973 Report 73-7

16. Garcia, J.D. (Teknekron, Inc., Washington, D.C.). DEMAND ACTUATED TRANSIT SYSTEMS. In: Organization for Economic Co-operation and Development, Consultative Group on Transportation Research, First Technology Assessment Review, Paris, Oct. 1969. *Proceedings* pp. 199-252.

17. General Motors Research Labs., Warren, MI. A CASE STUDY OF A DEMAND-RESPONSIVE TRANSPORTATION SYSTEM. Herbert J. Bauer, Sept. 1970, Research Publication GMR-1034.

18. General Motors Research Labs., Warren, MI. SURVEY DATA: MEASUREMENT OF USER PREFERENCES FOR A DEMAND-RESPONSIVE TRANSPORTATION SYSTEM. Richard L. Gustafson, Harriet N. Curd and Thomas F. Golob 1971 Research Publication GMR-1057.

19. General Motors Research Labs., Warren, MI. THE SURVEY OF USER CHOICE OF ALTERNATE TRANSPORTATION MODES. Thomas F. Golob, Jan. 1970 Research Publication GMR-950.

20. General Motors Research Labs., Warren, MI. USER ATTITUDE SURVEYS AND TRANSPORTATION SYSTEM DEVELOPMENT. Herbert J. Bauer, Jan. 1972 Research Publication GMR-1138; SAE paper 720176.

APPENDIX B (CONT.)

21. General Research Corp., Santa Barbara, CA. DEMONSTRATION PLAN FOR A DYNAMICALLY-ROUTED TRANSIT FEEDER SYSTEM. J.R. Brennand, Aug. 1967 Report IMR-695.

22. Golob, Thomas F. and Richard L. Gustafson (General Motors Research Labs., Warren, MI). A CASE STUDY OF THE ECONOMIC REASIBILITY OF A DEMAND-RESPONSIVE TRANSPORTATION SYSTEM. Paper presented at the Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Michigan, Jan. 10-14, 1972. Research Publication GMR-1150; SAE Paper 720219.

23. Golob, Thomas F. and Richard L. Gustafson (General Motors Research Labs., Warren, MI) ECONOMIC ANALYSIS OF A DEMAND-RESPONSIVE PUBLIC TRANSPORTATION SYSTEM. *Highway Research Record* No. 367 1971 pp. 114-127.

24. Golob, Thomas F., et al. (General Motors Research Labs., Warren, MI). AN ANALYSIS OF CONSUMER PREFERENCES FOR A PUBLIC TRANSPORTATION SYSTEM. *Transportation Research*, Mar. 1972, pp. 81-102.

25. Guenther, Karl W. (Ford Motor Co., Dearborn, MI). IMPLEMENTATION OF DIAL-A-RIDE IN YOUR COMMUNITY: A PRACTICAL CHECKLIST. Paper presented at the University of Waterloo Conference on Demand Response Buses, Ontario, Canada, March 20-21, 1972. Report 72-5.

26. Guenther, K.W. (Ford Motor Co., Dearborn, MI). THE MANFIELD DIAL-A-RIDE EXPERIMENT. In: Transportation Research Forum, *Papers--Eleventh Annual Meeting, "Tackling the Problems of the 1970's"*, New Orleans, Oct. 22-24, 1970, pp. 215-232.

27. Guenther, K.W. (Ford Motor Co., Dearborn, MI). PUBLIC TRANSPORTATION SERVICE INNOVATIONS: WHAT ARE THE LESSONS FOR DIAL-A-BUS? Paper presented at the Massachusetts Institute of Technology Urban Systems Laboratory CARS Seminar, Cambridge, Massachusetts, Nov. 17, 1969. Report USL-TR-69-18.

28. Guenther, K.W. and W.E. Givens (Ford Motor Co., Dearborn, MI). THE COURIER: A PROTOTYPE VEHICLE FOR DIAL-A-RIDE SERVICE. Paper presented at the Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Michigan, Jan. 12-16, 1970. SAE Paper 700186.

29. Guenther, K.W. (Ford Motor Co., Dearborn, MI). and P.R. Oxley (Ford of Europe, Inc.). DIAL-A-RIDE FOR NEW TOWNS. Paper presented at the International Road Federation, Sixth World Highway Conference, Montreal, Quebec, Oct. 4-10, 1970. Report 70-12.

30. Gustafson, Richard L., Harriet N. Curd and Thomas F. Golob (General Motors Research Labs., Warren, MI). USER PREFERENCES FOR A DEMAND-RESPONSIVE TRANSPORTATION SYSTEM: A CASE STUDY REPORT. *Highway Research Record* No. 367, 1971, pp. 31-35.

31. Gwynn, David W. (New Jersey State Dept. of Transportation, Trenton), Anthony U. Simpson (DAVE Systems, Inc.) and Marcel J. Zobrak (Urban Mass Transportation Administration, Washington, D.C.). THE HADDONFIELD, NEW JERSEY DIAL-A-RIDE DEMONSTRATION. *Traffic Quarterly*, Oct. 1973, pp. 541-562.

32. Heathington, Kenneth W. (Chicago Area Expressway Surveillance Project), Joel Miller (Alan M. Voorhees and Associates, McLean, VA), Ronald R. Knox (Illinois State Div. of Highways) et al. COMPUTER SIMULATION OF A DEMAND-SCHEDULED BUS SYSTEM OFFERING DOOR-TO-DOOR SERVICE. *Highway Research Record* No. 251, 1968, pp. 26-40.

33. Heathington, Kenneth W., Frank W. Davis, et al, (Univ. of Tennessee, Knoxville, TN). AN ANALYSIS OF TWO PRIVATELY OWNED DEMAND-RESPONSIVE TRANSPORTATION SYSTEMS. Progress Report, August 16, 1973.

34. Hines, J. Michael (Dow, Lohnes and Albertson, Washington, D.C.) and David W. Sloan (Brobeck, Phleger and Harrision, San Francisco, CA). TRANSPORTATION REGULATION AND INNOVATION: THE DIAL-A-BUS. *Transportation Law Journal*, Jan. 1971, pp. 59-123.

35. Howson, Larry L. (General Motors Research Labs., Warren, MI) and Kenneth W. Heathington (Purdue Univ., West Lafayette, IN). ALGORITHMS FOR ROUTING AND SCHEDULING IN DEMAND-RESPONSIVE TRANSPORTATION SYSTEMS. *Highway Research Record* No. 318, 1970, pp. 40-49.

36. Hupkes, Geurt (Centre for Transportation Studies, Utrecht, Netherlands), BUSI: DEMAND-RESPONSIVE BUS EXPERIENCE IN THE NETHERLANDS. *Highway Research Record* No. 397, 1972, pp. 38-41.

37. Institute of Public Administration, New York, NY. DEMAND-ACTUATED ROAD TRANSIT (DART) PERFORMANCE AND DEMAND, Mar. 1969, Sponsored by UMTA, PB 189-330.

38. INTERPLAN Corp., Santa Barbara, CA. ECONOMICS OF JITNEY SERVICE. Interim Technical Report. R. Remak, R. Krzyczkowski, and S. Henneman, April 1974. Prepared for Transportation Systems Center, U.S. Department of Transportation. Report 7348 IR.

39. Iowa Univ., Iowa City. Center for Urban Transportation Studies. APPLICATION OF DEMAND ACTIVATED TRANSIT TECHNOLOGY TO IOWA CITY, IOWA. James W. Stoner, Aug. 1972, PB 221-449.

40. Kent State Univ, OH. DRUBS: DEMAND-ROUTED URBAN BUS SERVICE. Sponsored by UMTA.

41. Kershner, Dennis Leroy. THE POTENTIAL MARKET FOR DIAL-A-RIDE. Unpublished Master's thesis, Massachusetts Institute of Technology, Department of Civil Engineering, 1970.

42. LEX Systems, Inc., Menlo Park, CA. SANTA CLARA COUNTY TRANSIT DISTRICT: INTEGRATED DEMAND-RESPONSIVE/EXPRESS BUS SYSTEM. REPORT ON REQUIREMENTS AND PRELIMINARY SYSTEM DESIGN. Oct. 1973.

APPENDIX B (CONT.)

43. Lundberg, Barry D. (Barton-Aschman Associates, Inc. Chicago, IL) and Charles W. Lustig (W.C. Gilman & Co., NY). DEMAND-RESPONSIVE TRANSIT SERVICE: A NEW TRANSPORTATION TOOL. ASPO Planning Advisory Service Report #286, Dec. 1972.

44. Mason, F.J. and J.R. Mumford (Ford Motor Co., Dearborn, MI). COMPUTER MODELS FOR DESIGNING DIAL-A-RIDE SYSTEMS. Paper presented at the Society of Automotive Engineers, Automotive Engineering Congress, Detroit, Michigan, Jan. 10-14, 1972. SAE Paper 720216.

45. Massachusetts Inst. of Tech., Cambridge, MA. Dept. of Civil Engineering. DEVELOPMENT OF THE FIRST PERSONAL TRANSIT SYSTEM FOR THE ROCHESTER METROPOLITAN AREA. Jan. 1974. Sponsored by Rochester-Genesee Regional Transportation Authority.

46. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. CARS (COMPUTER-AIDED ROUTING SYSTEM), A PROTOTYPE DIAL-A-BUS SYSTEM. Sept. 1969, Report USL-TR-69-53 PB 187-647.

47. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. DIAL-A-RIDE: AN OVERVIEW OF A NEW DEMAND-RESPONSIVE TRANSPORTATION SYSTEM. Mar. 1971. Sponsored by UMTA, Report USL-TR-71-03. PB 199-121.

48. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. THE DIAL-A-RIDE TRANSPORTATION SYSTEM, Summary Report. Daniel Roos, et al. Mar. 1971. Sponsored by UMTA. Report USL-TR-70-10, PB 201-129.

49. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. DIAL-A-RIDE VEHICLE SPECIFICATIONS. John B. Suomala, Mar. 1971. Sponsored by UMTA. Report USL-TR-70-17, PB 202-027.

50. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. ECONOMIC CONSIDERATIONS FOR DIAL-A-RIDE. Joseph Stafford, et al. Mar. 1971. Sponsored by UMTA. Report USL-TR-70-11, PB 204-054.

51. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. HISTORY OF TRANSIT AND INNOVATIVE SYSTEMS. Richard J. Solomon and Arthur Saltzman, Mar. 1971. Sponsored by UMTA, Report USL-TR-70-20, PB 199-408.

52. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. IMPLICATIONS OF DIAL-A-RIDE FOR THE POOR. Douglas Gurin and John Wofford, Mar. 1971. Sponsored by UMTA. Report USL-TR-70-18, PB 199-406.

53. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. LEGAL ANALYSIS OF TRANSPORTATION REGULATION AND INNOVATION: THE DIAL-A-RIDE. J. Michael Hines and David W. Sloan, Mar. 1971. Sponsored by UMTA. Report USL-TR-70-19, PB 119-407.

54. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. MODELLING THE CARS SYSTEM. J.D. Kennedy and N.H.M. Wilson, Sept. 1969, Report USL-TR-69-56.

55. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. SCHEDULING ALGORITHMS FOR A DIAL-A-RIDE SYSTEM. Nigel H.M. Wilson, et al. Mar. 1971. Sponsored by UMTA. Report USL-TR-70-13, PB 201-808.

56. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. SITE SELECTION FOR DIAL-A-RIDE DEMONSTRATION. Alan Altshuler and T. Melone, Mar. 1971. Sponsored by UMTA, Report USL-TR-70-16, PB 199-405.

57. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. TOPICS IN THE DESIGN OF DIAL-A-RIDE DEMONSTRATION EXPERIMENTS. Henry W. Bruck, et al. Mar. 1971. Report USL-TR-70-12, PB 199-404.

58. Massachusetts Inst. of Tech., Cambridge, MA. Urban Systems Lab. VEHICLE COMMUNICATIONS FOR A DIAL-A-RIDE SYSTEM. John E. Ward and Robert G. Rausch, Mar. 1971. Sponsored by UMTA, Report USL-TR-70-15, PB 206-062.

59. MITRE Corp., McLean, VA. DEMAND-RESPONSIVE TRANSPORTATION SYSTEM PLANNING GUIDELINES. B. Arrillaga and G.E. Mouchahoir, April 1974. Sponsored by UMTA. Report MTR-6659.

60. MITRE Corp., McLean, VA. SUMMARY OF AN AUTOMATED SCHEDULING SYSTEM FOR DEMAND-RESPONSIVE PUBLIC TRANSPORTATION. K. Rebido, R.L. Scott, et al., March 1974 Sponsored by UMTA. Report UMTA-VA-06-0012-74-2.

61. MITRE Corp., McLean, VA. TRANSPORTATION SYSTEM CANDIDATES FOR URBAN APPLICATIONS. A.L. Handman, R.W. Bee and R.L. Bush, May 1970. Sponsored by UMTA, PB 198-616.

62. MITRE Corp., Washington, D.C. A CONCEPTUAL OVERVIEW OF DEMAND-RESPONSIVE TRANSPORTATION SYSTEMS. Douglas Medville, Feb. 1973. Sponsored by UMTA. PB 220-863/5.

63. MITRE Corp., Washington, D.C. A DEMAND, SUPPLY, AND COST MODELING FRAMEWORK FOR DEMAND RESPONSIVE TRANSPORTATION SYSTEMS. Bert Arrillaga and Douglas M. Medville, Dec. 1973, Paper M73-232.

64. MITRE Corp., Washington, D.C. A LOW-COST, LOW-RISK DIAL-A-RIDE BUS PROGRAM. M.J. Costello, 1969, Working Paper WP-1188.

65. Navin, Francis P.D. (R.H. Pratt Associates, Garrett Park, MD) THE INTERACTION BETWEEN PERSONALIZED RAPID TRANSIT AND DEMAND ACTIVATED BUS TRANSIT. In: *Personal Rapid Transit*, J. Edward Anderson, et al., ed., University of Minnesota, 1972, pp. 149-173.

APPENDIX B (CONT.)

66. New Jersey State Dept. of Transportation, Trenton. IMPLEMENTATION AND OPERATION OF A DEMAND-RESPONSIVE TRANSPORTATION SYSTEM (HADDONFIELD DIAL-A-RIDE). LEX Systems, Inc. (Menlo Park, CA) and DAVE Systems, Inc. (Haddonfield, NJ), Mar. 1974, Report UMTA-NJ-06-0002-74-3.

67. Notess, Charles B. and R.E. Paaswell (State Univ. of New York at Buffalo). DEMAND ACTIVATED TRANSPORT FOR THE ELDERLY. *Transportation Engineering Journal,* Vol. 98, No. 4, Nov. 1972, pp. 807-821; Paper presented at the American Society of Civil Engineers, Conference on Emerging Transportation Technologies and Issues, Seattle, Washington, July 26-30, 1971.

68. Oregon State Dept. of Transportation, Mass Transit Division, Salem, OR. SPECIAL TRANSPORTATION PROGRAM (STP). A PROPOSAL FOR A COOPERATIVE PROGRAM TO PROVIDE MOBILITY FOR TRANSPORTATION DISADVANTAGED PERSONS IN SIX AREAS OF OREGON. Nov. 1973.

69. Regina Transit System (Saskatchewan). REGINA TELEBUS TRANSPORTATION PROJECT. Summary Report. W.G. Atkinson, L. Suen and L.G. Grimble, Nov. 1972, PB 225-315/1WT.

70. Roos, Daniel (Massachusetts Inst. of Tech., Cambridge, MA). DEMAND-RESPONSIVE TRANSPORTATION SYSTEMS. In: *Urban Transportation Innovation,* Daniel Brand, ed. New York, American Society of Civil Engineers 1970, pp. 123-139.

71. Roos, Daniel (Massachusetts Inst. of Tech., Cambridge, MA). OPERATIONAL EXPERIENCES WITH DEMAND-RESPONSIVE TRANSPORTATION SYSTEMS. *Highway Research Record* No. 397, 1972, pp. 42-54.

72. Shilling, David R., (Orange County Transit District, Santa Ana, CA). DIAL-A-RIDE, THE LA HABRA EXPERIMENT Paper presented at the Greater Los Angeles Area Transportation Symposium, Los Angeles CA, October 2, 1973.

73. Slevin, R. and A.E. Cooper (Cranfield Inst. of Tech., England. Centre for Transport Studies). MINIBUS AND DIAL-A-RIDE: INITIAL EXPERIENCES WITH THE ABINGDON EXPERIMENT. *Traffic Engineering and Control,* Apr. 1973, pp. 586-589.

74. Soliman, A.H. and R. Manastersky (Manitoba Univ., Winnipeg). POTENTIAL DEMANDS OF A DIAL-A-BUS SYSTEM. *Traffic Engineering and Control,* Dec. 1973, pp. 402-403.

75. Stafford, Joseph H., Richard de Neufville, and Rodney Plourde (Massachusetts Inst. of Tech., Cambridge, MA). DIAL-A-BUS REVENUE POTENTIAL. In: Transportation Research Forum, *Papers—Eleventh Annual Meeting, "Tackling the Problems of the 1970's",* New Orleans, Oct. 23-25, 1970, pp. 233-242.

76. Tampa Bay Regional Planning Council, St. Petersburg, FL and Community Sciences, Inc., Washington, D.C. TAMPA BAY REGION MASS TRANSPORTATION, PHASE III, TECHNICAL REPORT, Final Report. Apr. 1972, PB 218-360/6.

77. Transportation Development Agency, Montreal, Canada. DIAL-A-BUS MANUAL—VOLUME I. January 1974; VOLUME II, March 1974.

78. Transportation Systems Center, Cambridge, MA. DEMAND-RESPONSIVE TRANSPORTATION: AN ANNOTATED BIBLIOGRAPHY. Interim Report (Draft). Apr. 1974.

79. Transportation Systems Center, Cambridge, MA. THE HANDICAPPED AND ELDERLY MARKET FOR URBAN MASS TRANSIT. Final Technical Report. Martin Costello, Charles Phillips, William Barker, and Hans Scott, Oct. 1973. Sponsored by UMTA, PB 224-821.

80. Transportation Systems Center, Cambridge, MA. OPERATIONAL DIAL-A-RIDE COMPUTER PROGRAM. VOL. 1: TEST AND EVALUATION REPORT: VOL. 2: TEST SCENARIOS AND TEST DATA. Juan F. Bellantoni, Sept. 1971, Report DOT-TSC-UMTA-72-1.

81. Twin Cities Area Metropolitan Transit Commission, St. Paul, MN. REPORT ON DIAL-A-RIDE TECHNOLOGY. July 1972, PB 212-152.

82. Vitt, J.E., H.J. Bauer, Eugene T. Canty and Thomas F. Golob (General Motors Research Lab., Warren, MI) and Kenneth W. Heathington (Purdue Univ., West Lafayette, IN). DETERMINING THE IMPORTANCE OF USER-RELATED ATTRIBUTES FOR A DEMAND-RESPONSIVE TRANSPORTATION SYSTEM. *Highway Research Record* No. 318, 1970, pp. 50-65.

83. Wilson, Nigel H.M. (Massachusetts Institute of Technology, Cambridge, MA). THE STATE OF THE ART OF ROUTING ALGORITHMS FOR DEMAND ACTUATED SYSTEMS. In: Association for Computing Machinery, Sixth Annual Urban Symposium On the Application of Computers to Urban Society, 1971, *Papers.* pp. 257-271.

84. Wilson, Nigel H.M., J.M. Sussman, B.T. Higonnet (Massachusetts Inst. of Tech., Cambridge, MA) and L.A. Goodman (MITRE Corp.) SIMULATION OF A COMPUTER-AIDED ROUTING SYSTEM (CARS). *Highway Research Record* No. 318, 1970, pp. 66-76.

85. Zobrak, Michael J. (Urban Mass. Transportation Administration, Washington, D.C.) and Douglas Medville (MITRE Corp., McLean, VA). THE HADDONFIELD EXPERIMENT: INTERIM RESULTS. Paper presented at the International Conference on Transportation Research, Bruges, Belgium, June, 1973.

APPENDIX C

SUGGESTED PERIODICALS AND OTHER SOURCES OF CURRENT INFORMATION

This list represents the more important trade journals and other periodical literature that are known to contain articles and information on demand-responsive transportation. These sources are available by subscription or at major public and university libraries.

Current Literature in Traffic and Transportation (bibliographic source)

Lea Transit Compendium

Motor Coach Age

New Concepts in Urban Transportation

Passenger Transport

Taxicab Management

Traffic Engineering

Traffic Engineering and Control

Traffic Quarterly

Traffic World

Transit Topics

Transitrends

Transport Central

Transportation Engineering Journal (ASCE)

Transportation Research

Transportation Research Board Publications (formerly Highway Research Board)

APPENDIX D

DIRECTORY OF CONSULTING AND RESEARCH ORGANIZATIONS

Amalgamated Transit Union
5025 Wisconsin Ave. N.W.
Washington, DC

American Transit Association
475 L'Enfant Plaza W SW
Washington, DC
(202) 484-5410

Barton-Aschman Associates
1771 West Howard
Chicago, IL
(312) 388-3200

1730 K Street NW
Washington, DC
(202) 466-8230

Bendix Corp.
Bendix Center
Southfield, MI 48076
(313) 352-5000

Boeing Surface Transportation Systems
The Boeing Co. Boeing Center
P.O. Box 16858
Philadelphia, PA 19142
(215) 522-7270

Booz, Allen Applied Research
4733 Bethesda Ave.
Bethesda, MD
(301) 656-2200

Canadian Urban Transit Association
1138 Bathurst St.
Toronto, Ontario

Centre for Transportation Surveys
Utrecht, Holland

Crain and Associates, Urban Consultants
625 South Kingsley Drive,
Los Angeles, CA
(213) 387-3546

Cranfield Institute of Technology
Cranfield, Bedfordshire, England

DAVE Systems, Inc.
Hotel Claremont
Suite 221
41 Tunnel Road
Berkeley, CA
(415) 548-7037

De Leuw, Cather and Co.
165 West Wacker
Chicago, IL
(312) 346-0424

DGA International
1225 Nineteenth St., N.W.
Washington, DC 20036

ECI Systems
1033 Massachusetts Ave.
Cambridge, MA
(617) 864-5810

Ecole Polytechnique
Montreal, Canada

Ford Motor Co., Transportation Research and Planning Office
23400 Michigan Ave.
Dearborn, MI 48124

Ford of Europe Inc.
Laindon, Essex, G.B.

General Motors Research Laboratories
Transportation Research Dept.
Warren, MI

GEC-Marconi Electronics Ltd.
Badden Research Laboratories
Stanmore, England

General Research Corp.
P.O. Box 3587
Santa Barbara, CA 93105

Goodell, Grivas & Associates, Inc.
Southfield, MI

L.G. Grimble and Associates
Edmonton, Canada

Huron River Group, Inc.
209 East Washington
Ann Arbor, MI 48103

Isuzu Motors, Ltd.
Japan

Kates, Peat, Marwick & Co.
Commerce Court West
P.O. Box 31 Commerce Court
Postal Station
Toronto, Ontario
(416) 863-3500

N.D. Lea Transit Research Corp.
110 Lily Flagg Road
Huntsville, AL 35802

LEX Systems, Inc.
3000 Sandhill Rd.
Menlo Park, CA 94025

Massachusetts Institute of Technology
Urban Systems Laboratory
Cambridge, MA

MITRE Corp.
Westgate Research Park
McLean, VA 22101
(703) 893-3500

Pratt (R.H.) and Associates
Garrett Park, MD
Kensington, MD

Rouse Co.
American City Building
Columbia, MD 21043
(301) 730-7700

RRC International
Peoples Avenue
Troy, NY

Simpson & Curtin
1405 Locust St.
Philadelphia, PA 19102
(215) 545-8000

Stanford Research Inst.
333 Ravenswood Avenue
Menlo Park, CA
(415) 326-6200

Sverdrup and Parcel and Associates, Transportation Technology Div.
800 North 12th Boulevard
St. Louis, MO 63101
(314) 436-7600

Teknekron Inc.
1610 Massachusetts Ave. NW
Washington, DC
(202) 667-1002

University of Oklahoma
Urban Transportation Institute
Norman, OK

University of Tennessee
Transportation Research Center
Knoxville, Tennessee
(614) 974-5311

The Urban Institute
2100 M Street, NW
Washington, DC 20037
(202) 223-1950

Alan M. Voorhees & Associates
Westgate Research Park
McLean, VA 22101
(703) 893-4310

APPENDIX E

DIRECTORY OF GOVERNMENTAL UNIT, OPERATING AGENCIES, & TRANSIT AUTHORITIES

AC Transit
508 16th Street
Oakland, CA 94612
(415) 654-7818

Alpha Communications Development Corp.
57 E. Canfield
Detroit, MI
(313) 833-0159

Ann Arbor Transit Authority
400 W. Washington
Ann Arbor, MI 48104
(313) 663- 0546

Bensenville, Village of, Dial-a-Bus
700 West Irving Park Road
Bensenville, IL
(312) 766-1010

Black and White Cab Co.
1010 Markham St.
Little Rock, AK 72201
(501) 374-0333

Buffalo (NY) Model Cities
Jitney Transportation
Buffalo, NY
(716) 852-5344

City of Calgary Planning Dept.
Calgary, Alberta
(403) 268-2424

Cambridge Transit Authority
Cambridge, Ontario
(519) 623-7721

Collinwood Eldercare Center
995 E. 152 St.
Cleveland, OH 44110
(216) 249-5100

Columbia (MD) Transit System
Columbia Assn.
1000 Century Plaza
Columbia, MD 21044
(301) 730-6100

Dial-a-Ride Transit Corp
of Columbus, Inc.
994 E. Broad St.
Columbus, OH
(614) 258-8422

City of Dover
City Manager's Office
Dover, DL
(302) 674-1000

Cranston TransVan
858 Park Avenue
Cranston, RI
(401) 461-2400

Dallas Transit System
101 N. Peak St.
E. Dallas, TX 75226
(214) 827-3400

Davis California Senior Center
Davis, CA
(916) 758-4020

Detroit Model Neighborhood
Transportation Service
57 E. Canfield
Detroit, MI
(313) 833-0155

Fort Cab Co.
Fort Leonard Wood, MO
(314) 368-2494

Grand Rapids Transit Authority
1151 Sheldon Ave. S.E.
Grand Rapids, MI 49507
(616) 245-2136

Community Renewal Team of
Greater Hartford
2580 Main Street
Hartford, CT
(205) 278-9950

Dial-a-Bus
10921 Hooper Ave.
Greater Watts Model Cities
Los Angeles, CA 90059
(213) 564-4401

Helena Bus Co.
Helena, MT

Hemet Dial-A-Ride
450 E. Latham
Hemet, CA
(714) 925-7000

Kent State Univ. Campus
Bus Service
112 Wilson Avenue
Kent, OH 44240
(216) 672-2712

City of La Mirada
13700 La Mirada Boulevard
La Mirada, CA 90638
(213) 943-0131

Lewiston-Auburn Dial-a-Ride
Hudson Bus Co.
Lewiston, ME
(207) 783-2033

Lincoln Senior Handibus
411 South Thirteenth, Room 204
Lincoln, NB
(402) 477-1241

Little House
800 Middle Ave.
Menlo Park, CA 94025
(415) 326-2025

Long Cab Co.
Fort Leonard Wood, MO
(314) 368-7101

Montgomery County Dept. of
Transportation
6110 Executive Blvd
Rockville, MD
(301) 770-2521

Michigan Department of Highways
and Transportation
P.O. Drawer K
Lansing, MI
(517) 373-6572

New Jersey Dept. of Transportation
1035 Parkway Avenue
Trenton, NJ
(609) 292-3250

Neighborhood Elderly Transportation
Project
1404 E. Ninth St.
Cleveland, OH 44114
(216) 694-2278

Northern Virginia Transportation
Commission
2009 North 14th Street
Arlington, VA 22201
(703) 524-3322

Ontario Ministry of Transportation
and Communications
Operational Planning Office
1201 Wilson Avenue
East Building
Downsview, Ontario

Orange and White Cab Co.
Hicksville, NY
(516) 433-8181

Orange County (CA) Transit District
611 Civic Center Drive W.
Santa Ana, CA 92701
(714) 834-6190

Oregon DOT Mass Transit Division
(503) 378-8201

Ottawa-Carlton Regional Transit
Commission
1500 St. Laurent Boulevard
Ottawa, Ontario
(613) 445-2171

Regina Transit System
1157 Albert St.
Regina, Saskatchewan

Reston, Virginia
Volunteer Citizen Corp.
Reston, VA

Reston Commuter Bus, Inc.
11404 Washington Plaza
Reston, VA 22090
(703) 437-7800

Rhode Island Division on Aging
150 Washington St.
Providence, RI 02903

Richland County OH Regional
Planning Commission
248 Park Ave. West
Mansfield, OH
(419) 522-9454

APPENDIX E (CONT.)

Rochester-Genesee Regional
Transportation Authority
2 State Street
Rochester, NY 14614
(716) 546-7340

Royal Cab Co.
315 Harrison St.
Davenport, IA 52801
(319) 383-0151

St. Bernard Bus Lines
6732½ St. Claud
Arabi, LA
(504) 279-5556

St. Petersburg Municipal
Transit System
1830 Ninth Ave. N
P.O. Box 2842
St. Petersburg, FL 33731
(813) 893-7171

Santa Clara Transit District
1555 Berger Drive
San Jose, CA 95112

Toledo Area Regional Transit Authority
Box 4702
Toledo, OH 43620
(419) 243-1241

Toronto Transit Commission
1900 Yonge Street
Toronto 295
Ontario
(416) 481-4250

Transportation Development Agency
2085 Union
Montreal, Quebec, Canada H3A 2C3

Valley Transit District
59 Elizabeth Street
Derby, CT
(203) 735-6408

Metropolitan Washington DC Council
of Governments
1225 Connecticut Ave. NW
Washington, DC
(202) 223-6800

West Palm Beach, Florida
City Hall
(305) 655-6811

Western Older Citizens Council
Wilton, ME
(207) 645-4222

Willingboro Dial-a-Jitney
Willingboro, NJ
(609) 871-9300

Yellow Cab Co.
639 Thirteenth St.
San Diego, CA 92101

APPENDIX F

DIRECTORY OF VEHICLE MANUFACTURERS

Airstream, Inc.
Jackson Center, OH 45334
(513) 596-6111

Apeco Transit Division
White Pigeon, MI 49099
(616) 483-7621
Apeco MRB

Battronic Truck Corp.
Boyertown, PA 19512
(215) 367-2146

Carpenter Body Works, Inc.
Mitchell, IN 47446
(812) 849-3131
Carpenter Cadet

Chrysler Corp.
Detroit, MI 48231
(313) 956-5252
Dodge Maxivan

Coach and Equipment Sales Corp.
Penn Yan, NY 14527
(315) 536-3316
Fortivan

Electrobus
Studio City, CA 91604
(213) 877-3556

Flxible Co.
Loudonville, OH 44842
(419) 994-4141
Flxette

Ford Motor Co.
Dearborn, MI 48121
(313) 322-3000
Ford Econoline, Courier

GMC Truck and Coach Division
Pontiac, MI 48053
(313) 335-4111
GMC Van, Rallywagon,
Chevrolet Van, Sportsvan

Grumman Allied Industries, Inc.
Garden City, NY 11530
(516) 741-3500
Grumman

Highway Products, Inc.
Kent, OH 44240
(216) 673-9821
Twin Coach

Mercedes Benz of North America
Fort Lee, NJ 07024
(201) 947-4747
Mercedes 0930D

Minibus, Inc.
Pico Rivera, CA 90660
(213) 723-9071

Pace-Arrow, Inc.
Ontario, CA 91761
(714) 984-1252

Rek Vee Industries
Scarborough, Ontario
(416) 759-1963

Superior Coach Corp.
Lima, OH 45802
(419) 222-6010
Superior Coach

Volkswagen of America, Inc.
Englewood Cliffs, NJ 07632
(212) 524-8881

Winnebago Industries, Inc.
Forest City, IA 50436
(515) 582-3535

APPENDIX G

URBAN MASS TRANSPORTATION ACT OF 1964
Section 13 (c) *

It shall be a condition of any assistance under section 3 of this Act that fair and equitable arrangements are made, as determined by the Secretary of Labor, to protect the interests of employees affected by such assistance. Such protective arrangements shall include, without being limited to, such provisions as may be necessary for (1) the preservation of rights, privileges, and benefits (including continuation of pension rights and benefits) under existing collective bargaining agreements or otherwise; (2) the continuation of collective bargaining rights; (3) the protection of individual employees against a worsening of their positions with respect to their employment; (4) assurances of employment to employees of acquired mass transportation systems and priority of reemployment of employees terminated or laid off; and (5) paid training or retraining programs. Such arrangements shall include provisions protecting individual employees against a worsening of their positions with respect to their employment which shall in no event provide benefits less than those established pursuant to section 5 (2) (f) of the Act of February 4, 1887 (24 Stat. 379), as amended. The contract for the granting of any such assistance shall specify the terms and conditions of the protective arrangements.

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*49 U.S.C. 1609 (c)

APPENDIX H
GLOSSARY

algorithm
A set of rules used in mathematical computations.

attitudinal survey
A survey of users of transportation facilities to try to identify psychological factors associated with patronage of transportation services.

automatic inferfacing
Process of conveying customer requests for demand responsive transportation service to control center via digital communication in lieu of voice communications.

automatic vehicle monitoring (AVM)
Process of collecting information on vehicle location via electronic communication.

BUXI
Combination of "bus" and "taxi". Name of demand responsive transportation service (route deviation) in Emmen, Netherlands.

Call-a-bus
Name of demand responsive transportation service in Ft. Walton Beach, Florida (now defunct).

Call-a-ride
Name of demand responsive transportation service in Columbia, Maryland.

C.A.R.S.
Acronym for Computer-Aided Routing System. Used by MIT Urban Systems Laboratory to designate its project on demand responsive transportation.

computer aided service
A demand responsive transportation service in which some, but not all, control center functions are performed by a computer.

D-J
Demand-jitney. Name used by General Motors Lab to denote demand responsive transportation service.

D.A.B.
Acronym for Dial-a-Bus, popular name for demand responsive transportation service.

daily demand
The total number of requests for service per day.

D.A.R.T.
Acronym for (1) Dial-a-Ride Transit, Name of demand responsive transportation service in Stratford, Ontario; (2) Demand Activated Road Transit, Name used by the Institute of Public Administration; (3) Dynamically Activated Road Transit; (4) Name of Michigan DOT demand responsive transportation services.

demand density
The number of requests for service per unit area. Typically per square mile (kilometer).

demand responsive transportation (DRT)
Generic term for range of public transportation services characterized by the flexible routing and scheduling of relatively small vehicles to provide shared-occupancy, door-to-door personalized transportation on demand for a modest fare.

Dial-a-bus
Popular name for demand responsive transportation service. Used in Batavia, New York; Bensenville, Illinois; Los Angeles, California and other communities.

Dial-a-ride
Name most commonly used for demand responsive transportation services, e.g., Haddonfield, New Jersey; Mansfield, Ohio.

Dial-a-trip
Name of demand responsive transportation service provided by Dallas Transit System.

dispatch
Function of relaying service instructions to drivers. May include vehicle scheduling, routing and monitoring. Dispatching can be manual, or partly or fully automated.

DRT
Initialism for Demand Responsive Transportation.

DRUBS:
Demand Routed Urban Bus Service. Name of demand responsive transportation service under Kent State University Demonstration Project.

dynamic routing
Process of constantly modifying vehicle routes to accommodate service requests received since vehicle commenced operations, as opposed to predetermined route assigned to vehicle.

extra-off
Patron who wishes to depart vehicle at point before or after scheduled destination.

extra-on
Patron who has not called for service but wishes to board vehicle.

feeder service
Local transportation service which connects with another, usually express or long distance, transit service.

APPENDIX H (CONT.)

few-to-many (FTM)
Reverse operation of many-to-few service.

flexicab
Generic term for variety of innovative taxi/jitney services representing extensions or modifications of conventional taxi service.

gather
Refers to demand responsive transportation service in which passengers are collected from multiple origins for transportation to a common destination such as a transit terminal, typically involving pre-scheduled or regular service; also known as many-to-one.

hardware
The various pieces of equipment necessary for operation: radios, vehicles, computers, etc.

jitney
A transportation service characterized by a fixed route and picking up and discharging passengers upon demand for a low fare.

level of service
A quantitative measure of transport service. For demand responsive transportation expressed as a ratio of total travel time (including waiting) for demand responsive transportation to auto.

manual service
A demand responsive transportation service that operates without the assistance of automatic data processing equipment in the control center.

many-to-few (MTF)
Refers to demand responsive transportation service in which passengers are collected from multiple locations (origins) within the service area, for transportation to a few pre-selected destinations, typically activity centers or transfer points.

many-to-many (MTM)
Refers to demand responsive transportation service in which passengers are collected from multiple locations (origins) and transported to their individual destinations; generally, service offered between any combination of origin-destination points in the service area.

many-to-one (MTO)
Refers to demand responsive transportation service in which passengers are collected from multiple locations (origins) within the service area, for transportation to a common destination such as a transit terminal; also called "gather".

Maxi-cab
Name of demand responsive transportation service in Detroit, Michigan (Model Cities project).

Minibus
A small bus vehicle seating under 20 passengers, designed mainly for use in residential areas.

modal split
Analytic procedures used to estimate the proportions of the future intracity travel demand allocated to alternative modes of transportation.

Multiple-stop dispatching
Driver is assigned series of stops or "tour" which must be completed before next series is assigned.

one-to-many (OTM)
See "scatter." Reverse of many-to-one.

peak demand
The largest number of demands during a period. Typically one hour during the day.

PERT
PERsonal Transit. Name of demand responsive transportation service in Rochester, New York.

PT
Initialism for Personal Transport, the name of the Santa Clara, CA demand responsiye transportation service.

radio teleprinter
A device that converts digital communications to printed form.

route deviation
A demand responsive transportation service pattern in which a normally fixed route bus will leave the route upon request to serve patrons not on the fixed route.

scatter
Refers to the distribution of passengers to many destinations from a single origin such as a rail depot, typically involving prescheduled or regular service. Also known as one-to-many.

single-stop dispatching
Operating procedure whereby driver receives instructions for next route segment at each assigned stop.

software
The documentation and manuals of service operation such as: dispatchers guidelines, training and orientation manuals, computer programs, etc.

subscription bus service
The service provided by advance reservations of the same trip for a long period of time (typically AM and PM work trips).

Taxi-bus
Name of demand responsive transportation service in Menlo Park, California.

Telebus
Name of demand responsive transportation service in Regina, Saskatchewan.

Teletranspo
Name of demand responsive transportation service in Ottawa, Ontario.

Teletran
Name of demand responsive transportation in Ann Arbor, Michigan.

tour
The route plan and schedule for a vehicle to follow in serving a specified set of passenger requests.

traffic generator
A location in the service area that has a high concentration of patrons for a transportation service.

TransVan
Name of demand responsive transportation service in Cranston, Rhode Island.

travel time
The total amount of time taken to travel from beginning to the end of a trip.

vehicle density
The number of vehciles per unit area. The quotient of vehicle fleet and service area. Typically, vehicles per square mile (square kilometer).

vehicle fleet
The number of vehicles dedicated to transportation service in one service area.