PLANNING FOR NEW AND INTEGRATED DEMAND-RESPONSIVE SYSTEMS

Katherine O'Leary, Office of Research and Development Policy, U.S. Department of Transportation

The function of the Office of Research and Development Policy in the U.S. Department of Transportation is to provide guidance for the research and development programs conducted throughout the Department of Transportation (DOT). In support of this function, a year and a half ago we began to look at the concept of demand-responsive transportation (DRT).

At that time, the Urban Mass Transportation Administration (UMTA) was sponsoring 2 categories of activity in the area of DRT. One involved providing capital grants to organizations serving special groups such as the handicapped and elderly. The DRT concept suited this market well, for it could offer door-to-door transport in vehicles equipped, in many cases, to accommodate wheelchairs and to lower entry stairs for easier access by the elderly.

The second activity sponsored by UMTA was the experiment in Haddonfield, New Jersey. The purpose of the experiment was to develop, test, and demonstrate techniques for computer operation of a fleet of vehicles operating in a demand-responsive mode. With little knowledge of those activities and a long list of questions, I attended the Fourth Conference on Demand-Responsive Transportation in Rochester, New York, in September 1973. At that time, we predicted increased activity in implementation of DRT services throughout the country, and this has indeed been the case. My presentation deals with the history of DRT services in North America from the earliest to those newly in place since the Rochester conference.

To use the history of systems as a mechanism for understanding the DRT concept can be confusing before it is enlightening. No 2 systems are exactly alike. Many systems have a feature that no other system has and, to complicate things even more, 2 systems that serve similar markets can have completely different technical designs.

With this in mind, I have selected only a limited number of statistics to help me tell the story and will present these first. I will then briefly address the 3 main system characteristics that I think provide a context for viewing and understanding present as well as future systems.

Many people generally acknowledge the Atlantic City, New Jersey, jitney of 1916 to be the earliest forerunner to the demand-responsive transportation concept. It operates on a fixed route and picks up and discharges passengers on demand. It is still operating. (However, it could be said that the jitney is more like a fixed-route bus and that the taxi, with its door-to-door, on-demand, flexible-route operation, is the closest forerunner to DRT concepts in terms of overall operating strategies.)

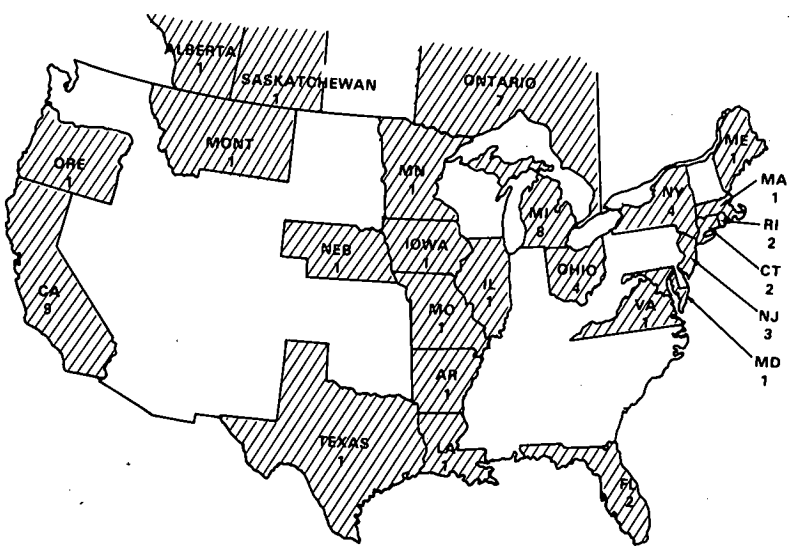
In Table 1, the Atlantic City jitney is the starting point of a listing of DRT service implementation. The most striking conclusion to be drawn from this chronology of DRT services is the accelerating activity in 1972, 1973, and 1974. Of the systems currently operating and those projected to operate by the end of 1974, 75 percent have been implemented during the past 3 years. This is significant for several reasons. For one, it is becoming difficult to keep track of the systems and thus to have a feel

Table 1. Chronology of demand-responsive transportation services in North America.

Year	City
1916	Atlantic City, New Jersey
1934	Davenport, Iowa
1946	Little Rock, Arkansas[a]
1958	Ft. Leonard Wood, Missouri
1961	Hicksville, New York[a]
1964	Peoria, Illinois[b]
1968	Reston, Virginia
	Flint, Michigan[b]
1969	Menlo Park, California
	Mansfield, Ohio
1970	Bay Ridges, Ontario
	Merced, California
	Ft. Walton Beach, Florida[b]
	Buffalo, New York[a]
1971	Columbia, Maryland
	Kent, Ohio
	Scott-Carver Counties, Minnesota
	Ann Arbor, Michigan[a]
	Regina, Saskatchewan
	Batavia, New York
	Columbus, Ohio[a]
	Cranston, Rhode Island
1972	Willingboro, New Jersey
	Detroit, Michigan[a]
	Haddonfield, New Jersey[a]
	Franklin County, Maine
	Toledo, Ohio[a]
	Lincoln, Nebraska
	Medford, Oregon
	Klamath Falls, Oregon[b]
	Rhode Island State
	Dallas, Texas
	Stratford, Ontario
	West Palm Beach, Florida
	Kingston, Ontario[a]
	Sudbury, Ontario
1973	Kent, Ohio
	La Habra, California
	Lower Naugatuck Valley, Connecticut
	Davis, California
	La Mirada, California
	Helena, Montana[a]
	Grand Rapids, Michigan[a]
	Bramalea, Ontario
	Ottawa, Ontario
	Rochester, New York
	Los Angeles, California
	New Orleans, Louisiana
	St. Petersburg, Florida
	Toronto, Ontario
	Bensenville, Illinois
	Cleveland, Ohio
	Calgary, Alberta
	El Cajon, California
	Hartford, Connecticut
1974	Hemet, California
	Holland, Michigan
	Luddington, Michigan
	Mt. Pleasant, Michigan
	Sault Ste. Marie, Michigan
	La Mesa, California
	Cambridge, Ontario
	Merced, California
	Traverse City, Michigan
	Dover, Delaware
	Fairfax City, Virginia
	Midland, Michigan
	Isabella County, Michigan
	Alpena, Michigan
	Houghton-Hancock, Michigan
	Richmond, California
	Washington, D.C.
	Benton Harbor-St. Joseph, Michigan
	Cleveland, Ohio
	Santa Clara County, California
1975	Rockville, Maryland

[a]Subsequently expanded. [b]Terminated.

Figure 1. Geographical distribution of 57 operating systems in North America as of May 1974.



for the number of communities and markets being served by the service. Second, system operating data are incomplete when all services are not represented, and this weakens considerably the available information that planners and operators of future services need to assist them in their decision making. Third, although the technical expertise required to ensure the successful implementation of DRT services can be found in a number of highly qualified professional firms, this number is still small compared to a growth rate of 2 to 3 DRT implementations per month. I should like to return to this point later in this paper, for DOT, as a result of these observations, sponsored an activity in early 1974 on how to plan and implement a demand-responsive service.

As of May 1974, we were able to identify some 57 demand-responsive services operating in the United States and Canada (Fig. 1). Of particular note are the numbers of systems in Michigan, California, and Ontario. The availability of state and provincial funds is undoubtedly an important factor in the somewhat intense activity of DRT services in those areas.

The DRT services in the United States represent a small number compared to the American Transit Association (now the American Public Transit Association) figure of 1,006 motor bus transit systems in 1973 (Fig. 2). Some arithmetic will yield a comparison of passengers carried daily by these service categories—somewhat incomplete data on DRT services (only 53 of 57 services reporting) do not distort the picture much in that DRT has a very small market share. A caveat here is that although the DRT market is small it is growing, while the motor bus industry has been static until recently.

Figure 3 shows a summary of the 57 operating services by the size of their fleets. For example, 8 services have fleets of 1 vehicle, 4 services have fleets of 2 vehicles, 5 services have fleets of 3 vehicles, and so on to the largest service with 80 vehicles in its fleet. The line on the chart corresponds to the scale on the right and represents what percentage of the total number of 57 services are described by the bars to that point. For example, 8 services having fleets of 1 vehicle represent about 15 percent of the total services. Adding the 4 services of 2-vehicle fleets makes 12 services represented out of 57 or 21 percent accounted for, and so on. Of the 57 services operating in North America as of May 1974, 70 percent have fleets of 7 or fewer vehicles. The 3 largest fleets operate shared-ride service and taxicabs. Most of the smallest services operating a single vehicle provide service for the elderly.

Fleets are like much else about DRT services—few things are typical. Diversity in type of vehicles used to provide DRT services exists not only from one service to another but within services themselves. For example, Regina, Saskatchewan, uses six 14-passenger, four 22-passenger, and seven 42-passenger vehicles to provide service in the DRT area. Detroit uses school buses to augment its regular fleet for charter operations.

The 57 operators provide service at adult cash fares ranging from 10 cents to $1.75 (Fig. 4). Seven services are provided at no direct charge to the passenger. These are predominantly for senior citizens and are funded variously by a combination of federal, state, and local governments and private agencies. Roughly 84 percent of all systems charge fares of 50 cents and less, 13 charge fares of 50 cents, and 8 charge fares of more than 50 cents. Of the 57 services, 2 are jitney services, 7 are taxi-based operations, and 48 are bus-based operations.

Figure 5 shows the variety in size of area served by 44 DRT fleets. Fifty percent of the service areas are less than 10 miles^2 (26 km^2). Of the operators serving the largest areas, 5 have 7 or fewer vehicles (these are special group services for senior citizens or handicapped persons), 1 has 28 vehicles for statewide senior citizen services, and 1 is a taxi operator who has 75 vehicles. Nine areas are the result of expansion from initial, smaller areas, such as Ann Arbor, which expanded to 22 miles^2 (57 km^2) from an initial area of 1½ miles^2 (3.9 km^2).

The following profile of the services emerges from these data.

1. A relatively small market has been demonstrated to date, but it is a rapidly growing one in that systems are proliferating at a rate of 2 to 3 per month and indications

Figure 2. Demand-responsive transportation services and total motor bus services.

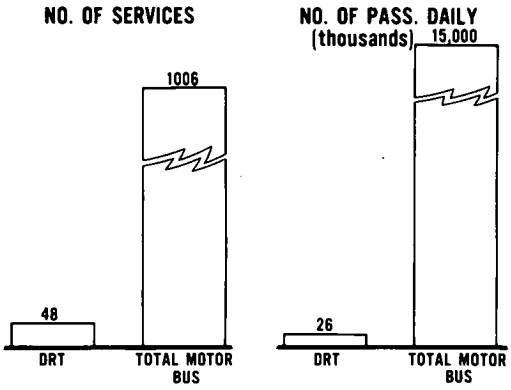


Figure 3. Fleet sizes of 57 operating systems as of May 1974.

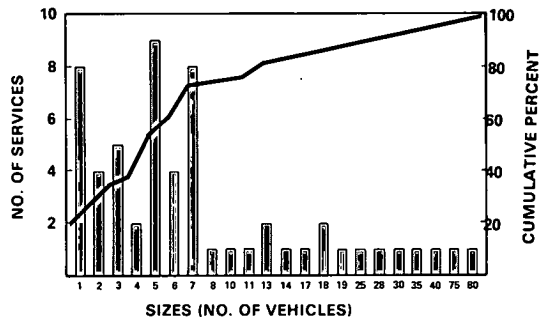


Figure 4. Fares of 57 operating systems as of May 1974.

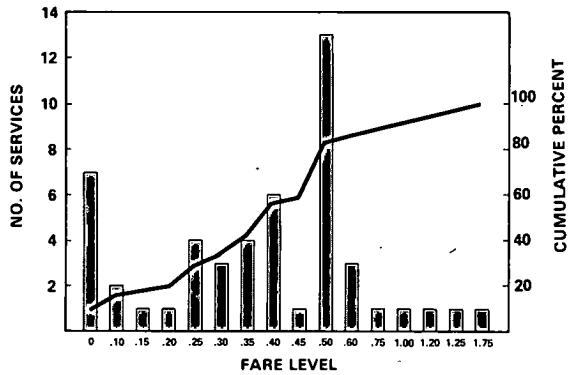


Figure 5. Service areas of 44 of 57 operating systems as of May 1974.

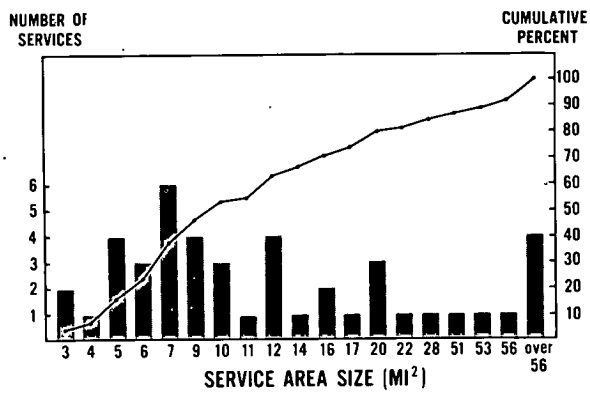
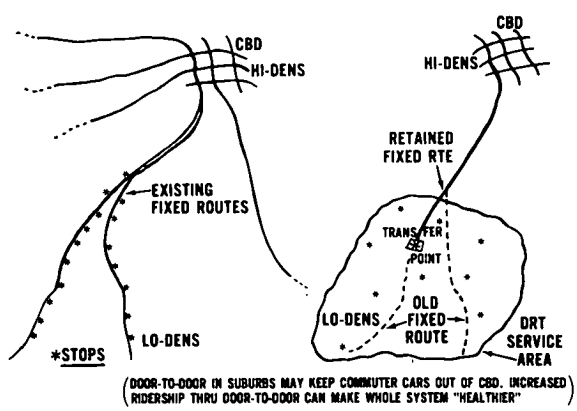


Figure 6. Feeder service to fixed-route transit.



are that this proliferation will continue;

2. Except for taxi operations, fleets usually have fewer than 10 vehicles;
3. Fares are typically 50 cents or lower; and
4. Size of area served is usually smaller than 13 miles^2 (34 km^2).

The demand-responsive services implemented to date differ from each other in basically 3 ways: technical design of the system in response to the market needs, markets served by the service, and funding sources for the service. Other papers in this Special Report discuss the design aspects of the currently operating demand-responsive services. My focus is on the markets served and the funding sources.

MARKETS SERVED

A major market served by a number of existing DRT services is the commuter market (Fig. 6). Where fixed-route transit existed in a region, DRT services have been substituted for unprofitable fixed routes in low-density areas and serve as feeders to the remaining fixed-route portion. Regina, Saskatchewan, actually was able to increase its ridership on the fixed bus routes to the center city through this process, referred to as route rationalization. When DRT serves as a feeder to rail rapid systems, the transfer point becomes one of the rail stations, as in the case of Bay Ridges, Ontario. One of the markets for which the Richmond, California, system is designed is the commuter market using the BART system. It acts as a feeder to the BART Richmond Station.

Commuting patterns, however, have been changing in character during the past decade. Although the CBD continues to be a dominant destination for a large number of work trips, industrial parks are developing as parts of new activity centers located in the lower density suburbs. In these areas, fixed routes can be uneconomic because of the low densities and thus low load factors. These commuter markets can also be served by DRT. The activity center (an industrial park or a large factory or a government center) operationally serves the same drop-off and pickup function as the transfer point of the previous applications. Increased vehicle productivity and thus improved economics can result by developing the commuter market as a subscription service because of the time and location certainties this gives the operator. In large metropolitan areas, the commuter market is best served by DRT in low-density suburbs. In middle-sized and small cities, commuter markets may be served by DRT in partial or entire areas of the cities themselves. This is in large part determined by trip origin and destination patterns, other site-specific variables, and density of demand.

A second market served by DRT services is that made up of groups having special mobility needs. Typically, these are handicapped persons and the elderly and, in some cases, the economically disadvantaged. Of the 57 services, some 24 provide service exclusively to these groups. These markets are also those for whom the UMTA demonstration grants for handicapped and elderly services are targeted.

A third market, distinguishable from the commuter and the special needs groups, is hard to describe in a single word. It is that group of people within a given area who need to get around in the area. The service that meets these market needs is areawide and provides the population in a given area with door-to-door transportation wherever their origins and destinations. Typically, patrons of this local transportation service are shoppers, bank patrons, school children, dental and medical outpatients, airport users, restaurant patrons—all of whom depend on the activities within the DRT service area itself. Such areawide DRT service is provided in Batavia by the B-Line Dial-a-Bus, which operates citywide service from 6 a.m. to 6 p.m. Monday through Friday. In addition to carrying people, other areawide service markets can be captured and can provide additional revenue. Batavia's system carries not only people but packages. DRT service in Batavia also transfers bank printouts (not money) from one bank to another.

The principal advantage in operating a fleet of vehicles in a flexible manner is that

it can serve all, some, or one of the above markets depending on the needs of the area. The most important consideration in implementing successful DRT services is tailoring the service offered to the market to be served. The success of a system is defined in different ways by different people. An operator in business to make money would judge a system that does not as unsuccessful. If, however, the operator's objective is to provide mobility to a market segment, making money would not be a basis for judging the system's success.

FUNDING

A recent survey of operating systems revealed that of 22 reporting services all but 3 required subsidy to cover costs. Whether subsidy is required depends on the level of service offered and the markets served. The requirement for fare-box viability restricts the market served and the level of service to be offered to that market. If DRT service is striving for broad markets (for example, to get a substantial share of the commuter market away from private automobiles) and for high levels of service (for example, round-the-clock operators on an areawide basis), some form of subsidy most likely will be required. The key factor here is the breadth and type of market the service is designed to serve.

Of 49 operating services for which data on funding are available, more than half were funded from a single source (Table 2). These are mostly the U.S. privately funded systems such as taxi-based operations, jitneys, and commuter bus systems. (The U.S. Department of Housing and Urban Development has funded systems 100 percent.) Some examples drawn from the operating systems illustrate the range of options available for funding DRT services.

1. Recent expansion of the Ann Arbor transit operations including the expansion of DRT service was funded entirely from an increase in local taxes voted by the citizens.
2. The service in Batavia, New York, is funded 100 percent locally from fares, receipts from package delivery, sale of marketing space. There the system is breaking even without any form of subsidy.
3. Canada's systems are eligible for federal subsidies to cover planning studies and portions of operating and capital costs. The Regina, Saskatchewan, system has drawn on funds from federal, provincial, and local sources.
4. The St. Petersburg DRT service for elderly and handicapped persons uses local sources for one-third of its funds and an UTMA grant for the remaining two-thirds.

The sources are varied and depend on local circumstances to a large extent. Where private sources do not cover all costs, funding is usually from multiple sources.

Table 2. Funding of 49 operating systems.

Fund Sources	Systems Funded by a Single Source	Systems Funded From a Combination of Sources
Public funds in United States		
Federal	4	19
State	4	
Local	6	
Private funds in United States	10	
Public funds in Canada		
Federal	–	3
Provincial	1	
Local	2	
Total	27	22

INFORMATION ON DRT

At DOT we felt that the existing technical expertise would get stretched thin if it tried to keep up with the rapid pace of DRT implementation activity. We wanted to ensure that failures resulting from bad or, even worse, no information would be kept to a minimum. To avert a large number of failures and to avoid condemning a promising concept to an early demise as a result of bad publicity, we set about to test whether we could devise a method to get some basic information out to the large number of planners

and operators making decisions daily on whether to try DRT services in their areas.

The method we devised was to synthesize the substantial array of available literature on DRT services into a state-of-the-art document and to validate the document prior to its dissemination at a workshop where experts (operators of DRT services) and local transit operators and planners would comment (page by page) on the accuracy and relevancy of the material to their needs. The workshop was jointly sponsored by DOT's UMTA and Technology Sharing Program, which is a part of the Office of Research and Development Policy. The report and its revisions were prepared by the Technology Sharing Office at the Transportation Systems Center in Cambridge, Massachusetts. The response both to the workshop validation method and to the document was positive. I mention the document for 2 reasons: (a) The document provided a source for many of the statistics that I used to profile the operating DRT services, and (b), and more important, many will undoubtedly find the document a useful tool in developing a feel for the DRT concept and its status as an operating service. We are currently preparing a supplement to this overview document dealing with vehicles and their operation in DRT services. Copies are free and available on request.

SUMMARY

Many DRT systems are operating, and many systems are being implemented every year. Those who plan and implement systems should understand the markets DRT can serve, tailor system design to those markets, and understand the funding consequences of the level-of-service and market decisions. At the Department of Transportation, we must ensure that the best and latest information is available for people to use in making decisions and that they know where to get that information.

REFERENCES

1. State-of-the-Art Overview of Demand Responsive Transportation. Transportation Systems Center, U.S. Department of Transportation, Cambridge, Mass., Aug. 1974.
2. Suburbanization and Its Implications for Urban Transportation Systems. Office of Research and Development Policy, U.S. Department of Transportation, April 1974.
3. '73-'74 Transit Fact Book. American Transit Association, Washington, D.C.

R. J. Wilson and Anthony U. Simpson, DAVE Systems, Inc.

Every successful DRT program starts with an effective planning effort. DRT systems that have had serious difficulties started with planning deficiencies such as inaccurate demand forecasting or absence of a long-range economic plan. This paper discusses some of the key elements of DRT planning and identifies some common pitfalls.

APPROACH TO PLANNING

For planning to have the necessary depth and quality, management must make a commitment to it. This means that the people who do the planning must realize that planning is vitally important and that the plans they produce will receive proper attention, including a detailed review and personal critique by management. A degree of formality, at least to the point of full documentation of the plans, is essential for both communication to management and later assignment of implementation responsibilities. For a new DRT system, the planning is from the ground up and covers initial concept through routine operations. There are 3 fundamental items for achieving this.