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Demand-Responsive Transportation Systems and Other Paratransit Services

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Introduction

Papers in this Transportation Research Record were presented at the Sixth International Conference on Demand-Responsive Transportation Systems and Other Paratransit Services, which was held in Washington, D.C., March 15-17, 1976.

The conference was sponsored by the Transportation Research Board, the American Public Transit Association, the International Taxicab Association, the Massachusetts Institute of Technology, the Federal Energy Administration, and the Urban Mass Transportation Administration.

The first of these conferences on demand-responsive transportation was held in the summer of 1970 and was sponsored by the Massachusetts Institute of Technology. The Transportation Research Board has been one of the sponsors of the other four conferences and has published the proceedings in its special reports 124, 136, 147, and 154.

Part 1
Integrated Transportation Systems

Integrated Urban Transportation Systems: Challenge for the Future

Daniel Roos, Massachusetts Institute of Technology

Paratransit has been described as a bridge between the conventional automobile and conventional transit. Certain concepts, such as taxi and car pooling, have developed from the automobile side, and other concepts, such as subscription bus service and dial-a-ride, have developed from the transit side. As service concepts continue to develop and there is movement from both sides toward the center, certain conflicts are inevitable. Two major cultures, privately operated taxi companies and publicly operated transit companies, that have previously operated independently and differently must now learn to understand each other's environment and work together. However, to view the problem simply as taxi versus transit or public versus private is naive. As in all situations involving the assimilation of different cultures, patience, time, and understanding are required. Paratransit is a melting pot of different approaches, in which gradual assimilation will occur while fundamental differences remain. Paratransit provides the opportunity to increase available options with respect to both the service that is provided and the providers of service. Service can be successfully integrated—at one level by interfacing paratransit services with one another and at a higher level by interfacing paratransit with conventional fixed-route transit in a complementary manner.

In 1970 the Massachusetts Institute of Technology sponsored the first dial-a-bus conference. Two years later the conference name was changed from dial-a-bus to demand-responsive transportation, and the Transportation Research Board became the principal sponsor. The American Public Transit Association became a cosponsor of the fourth conference, and the fifth conference was cosponsored for the first time by the Urban Mass Transportation Administration. This year the International Taxicab Association is a cosponsor, and the name of the conference has changed to include other paratransit services.

We have evolved considerably during the past 6 years. It seems appropriate at this point to appraise what we have accomplished, where we are, where we should go in the future, and how we will get there. I will not restrict my remarks to demand-responsive transportation, but rather I will concentrate on paratransit and its potential role in concert with conventional transit—the concept of an integrated system consisting of numerous service options and numerous service providers.

DEMAND-RESPONSIVE TRANSPORTATION

What have we learned from implementing more than 100 new demand-responsive systems in the past 6 years? First-generation systems (those systems implemented since 1974) have demonstrated the following about markets and services.

1. The importance of a market and service orientation. Public transportation should respond to individual market needs that vary with respect to time, space, and quality of service. For example, the travel needs of the peak-hour worker are quite different from those of the off-peak shopper. They travel at different times of day, go to different destinations, and view the cost of a trip and the quality of service differently. Implemented demand-responsive systems have tapped new markets that were unserved by conventional transit systems.
2. The mix of different services. A spectrum of demand-responsive services varies from fixed-route systems at one end to exclusive-ride taxi service at the other end. As one moves from semi-fixed-route services, such as point deviation and route deviation, to more flexible systems, such as many-to-many dial-a-ride, both responsiveness and cost increase. The choice of the appropriate services for a particular urban area depends on the markets to be served, the physical characteristics of the service area, and the funds available to provide service.
3. The mix of different service providers. Demand-responsive services have been operated by both public organizations, including transportation authorities, transit operating companies, municipalities, and social service agencies, and private organizations, including taxi companies, limousine companies, and new organizational entities.

The following are some of the principal difficulties of the first-generation systems.

1. Poor system design and implementation. The flexibility and the ease of implementation have resulted in premature or inappropriate implementations. There is a dangerous tendency to minimize or eliminate any

planning and to merely implement a system and let it adjust to demand. I remember hearing people say, "Don't worry about planning. Just put it in. These systems are always successful." A number of failures attest to the dangers of this approach. Many implemented systems were overdesigned and are more responsive and flexible than they need be. This is unfortunate, since the more flexible a system is the more costly it is.

2. System reliability and service level. Customers were often provided with extremely poor service. The principal problems were vehicle reliability and manual dispatching limitations. These problems are real and have not been properly acknowledged. Unless we can ensure reasonable service reliability, the potential of demand-responsive services cannot be adequately accessed.

3. Cost of service. Concern has been expressed about how high the cost per trip is of many demand-responsive services and whether a community can afford to pay for the acknowledged benefits of those services. The cost per trip of the implemented systems varies considerably—from a low of about $0.60 to a high of more than $4.00 depending on the type of service provided, cost of labor, system efficiency, and productivity.

Basic differences exist between first- and second-generation systems. First-generation systems are small scale, manually dispatched, and implemented in small urban areas where there is little or no available public transportation. In contrast, second-generation systems are large scale, use some automated scheduling and dispatching, and are implemented in metropolitan areas where there is existing public transportation service. Second-generation systems have been implemented in Ann Arbor, Rochester, Santa Clara, Regina, and Toronto. These systems have been implemented as integrated systems having both demand-responsive and fixed-route components. The integrated system concept is my major concern in this paper.

PREARRANGED RIDE SHARING

At the same time that demand-responsive systems were evolving, the concept of car pooling was receiving increased attention and corporate-based van pooling was begun by the 3M Corporation. Many urban areas and several states have initiated areawide and statewide ride-sharing programs. The success of the 3M vanpooling program has caused more than 30 other industrial organizations to begin similar vanpooling programs. The following are some of the major conclusions of the car-pooling and van-pooling sharing programs.

1. Minor success can have major impact. Since so many commuters use automobiles compared with the relatively small number who use public transportation, even a slight increase in automobile occupancy is significant.

2. Car-pool and van-pool programs are self-supporting. At a time when transit deficits are increasing at an alarming rate, the ride-sharing programs produce sizable benefits without corresponding investments.

3. The most successful programs are organized with major employers. This provides the opportunity to identify people with common destinations and work times and to coordinate the organization of pools. Again, the importance of market segmentation is important.

4. Marketing, organizational, and coordination efforts are keys to successful ride-sharing programs. Barriers must be overcome with individuals who are oriented toward single-occupancy vehicles.

5. Incentives play an important role in encouraging ride sharing. These include preferential parking spaces, reduced parking and toll charges, and financial incentives to drivers who organize pools and provide service.

There are fundamental differences between prearranged ride-sharing services and demand-responsive services: Prearranged ride sharing is intended for the peak-hour work trip, uses volunteer drivers who provide in-kind services, and received initial government backing from the Federal Highway Administration. Demand-responsive services are primarily designed for the off-peak nonwork trip, use a paid driver, and received initial government backing primarily from the Urban Mass Transportation Administration.

PARATRANSIT DEVELOPMENT

Although many people viewed prearranged ride sharing and demand-responsive service as fundamentally different service concepts, others viewed them as having many underlying similarities. The term "paratransit" was therefore introduced to cover these and other similar service concepts.

Until recently, relatively few people were aware of paratransit. This was particularly true of decision makers responsible for urban transportation investments. A principal reason is that paratransit does not have well-organized vocal constituencies. Rather, the paratransit sector is fragmented, uncoordinated, and unorganized. Paratransit services often are provided by small-scale operators with limited capital resources and management expertise. Preoccupied with their own operations and short-term problems, these operators rarely concern themselves with influencing opinion or policy on a regional, state, or federal level. The taxicab and limousine industries have national trade organizations, but these organizations have only recently begun interacting with the federal government. Paratransit services such as car pooling and van pooling, which are not industries in the conventional sense, are seldom organized beyond a local or regional basis. The paratransit sector, lacking an organized constituency, has not undertaken lobbying efforts, and legislators and policy makers are largely unaware of the needs and potential of paratransit.

The awareness of and the interest in paratransit have changed dramatically during the past 3 years, primarily as a result of new government policies and new active roles of the taxi and transit industries. Government involvement in paratransit has come primarily from UMTA and to a lesser extent from FHWA and the Federal Energy Administration. Numerous UMTA policy statements have emphasized that paratransit services must be considered in an analysis of alternatives and that capital and operating assistance funds may be applied to paratransit services. UMTA's interest in paratransit is consistent with its emphasis on low-capital alternatives, incremental planning and implementation, involvement of private operators, and improved transportation management. Paratransit is an important component of the new transportation system management plan required of each urban area.

The energy shortages of 1973 were the primary reason for the increased involvement of FHWA and the entry of FEA into paratransit. The Emergency Highway Energy Act of 1973 provided funding for car-pool demonstrations. After examining many varied transportation strategies for energy conservation, FEA has placed high priority on van pooling.

Some of the most active interest in new paratransit services has come from the taxicab industry. Although taxicabs have played a vital role in providing public

transportation, only recently has that role been acknowledged and appreciated. The taxicab industry has concentrated on exclusive-ride taxi service and has not actively sought government funding. Four events changed this attitude.

1. Profits in the taxicab industry were squeezed by inflation and the escalation in gasoline prices. Taxi companies were unable to obtain corresponding rate increases.
2. Dial-a-ride services were initiated and subsidized by public transit organizations. Although these dial-a-ride operations represented only a miniscule portion of service provided by public transit companies, the taxi industry was concerned that a threat existed. They felt either that publicly subsidized companies should not provide taxi-like service or that the taxi industry should also be subsidized.
3. Operating assistance was introduced in the National Mass Transportation Assistance Act of 1974. Although the benefits of capital assistance to the taxi industry were debatable, the benefits of operating assistance were clear cut.
4. Several aggressive, innovative taxi operators rose to positions of leadership within the industry and argued convincingly that the industry should explore new shared-ride service opportunities.

The transit industry has generally been indifferent or opposed to paratransit services because of greater interest in expanding conventional bus and rail systems, concern about the reliability of small vehicles used for paratransit service, and fear that these new services would divert people from existing conventional transit. Recently, through the leadership of the American Public Transit Association (APTA), the industry has shown considerably more interest in paratransit. The APTA task force report on paratransit (1) concludes, "Our cities with their varied forms require a mixture of conventional transit and paratransit providing a family of services, services that can be designed or shaped to fit market needs of a particular portion of the community."

In late 1975, UMTA sponsored a paratransit conference that brought together 100 experts with different backgrounds to examine paratransit. The principal finding of the conference (2) was that "the ideal urban transportation system is a cooperative mix of paratransit and conventional transit with highly coordinated services, with the possibility of varied ownership of different modal components. Such a system would produce greater overall operating efficiency and increased transit patronage by allowing each mode to do what it does best."

PARATRANSIT ALTERNATIVES

A major step forward has been accomplished. Influential groups and organizations have recognized the potential role of paratransit when it is combined with conventional transit. However, recognition is only a first step. The step from recognition to realization is an extremely difficult one. Realization of the potential of integrated systems is the major challenge we now face. In examining integrated systems, we must distinguish among different purposes for implementing paratransit service. Paratransit can be used for the following objectives.

1. New service. In low- and medium-density areas with little or no transit service, paratransit can provide intraarea service and collection-distribution service to conventional fixed-route line-haul service. If successful, paratransit services can act as a "pump primer"; as demand develops, paratransit services would be replaced by more conventional fixed-route services along the corridors of the highest demand.
2. Additional higher quality service. Paratransit supplements conventional fixed-route service by providing higher quality service to specific market groups. The justification for these services is based on the premise that conventional mass transit satisfies mass needs rather than individual needs, serving all needs in an adequate manner instead of particular needs in an optimal manner. Before the major impact of the automobile, conventional transit was sufficient, for it was the primary or sole travel alternative. The combined effects of automobile availability, increased affluence, and more dispersed low-density urban development now dictate the need for additional personalized forms of urban transportation that provide higher levels of service.
3. Substitute service. Conventional transit services face a severe peaking problem; ridership during the peak periods is 4 to 10 times as great as during the off-peak periods. This peaking creates major economic problems for the transit industry. Paratransit can help decrease peaking in two ways. During off-peak periods, when demand is lightest, particularly late evenings and weekends, paratransit can be substituted for conventional transit. During peak periods, demand can be diverted to paratransit services, such as car pools and van pools. The combined efforts of this system balancing should be to lessen the peak loads and to increase the off-peak loads.

All of these applications appear to make sense. Why then has relatively little paratransit implementation been accomplished and have many concerns of potential conflict been raised? Four key issues are institutional considerations, funding allocation, competition, and coordination.

Institutional Considerations

Many existing paratransit services are illegal if obsolete regulations are enforced, and other paratransit services cannot be implemented because of regulatory constraints. Paratransit suffers from both overregulation and underregulation. Overregulation takes the form of restrictive statutes that may impede efficient provision of service or prevent innovative or integrated service. Underregulation takes the form of lack of precise legal definition resulting from statutes with anachronistic attributes that are not flexible enough to deal with innovative concepts. Local taxi industry regulations frequently embody the former problem, and the lack of regulations affecting van pools exemplifies the latter problem.

The existing regulatory framework in most urban areas is based on the provision of a limited number of service options by a limited number of providers. To satisfy the range of different transportation needs with varying levels of service, we should expand both the range of options and the manner in which services are provided. Regulation must be compatible with these goals. This has not been the case. Instead regulations have discouraged or prevented new services and thus encouraged existing operations to have monopolistic tendencies. Monopolies of any sort, be they public or private, are generally not in the public interest.

As paratransit services develop, much greater attention must be directed toward regulatory issues. Planning and transit officials in many urban areas are not totally aware of what regulations exist in their areas and how those regulations affect existing and potential services. The federal government has imposed certain

planning requirements to qualify for federal funding programs; however, no similar requirements exist with respect to regulation. In the same way that each urban area must develop a regionwide planning framework, each area should also be responsible for the development of a coordinated and integrated regionwide regulatory framework. At a minimum, each urban area should be required to develop process guidelines for regulatory reform. The emphasis would be on the regulatory process rather than on the content of specific regulations since each urban area has unique characteristics that affect its regulations. The federal government could assist urban areas by developing model ordinances to serve as the basis for the specific ordinances of each region.

Another major institutional consideration relates to labor. Since all paratransit services are labor intensive, the manner in which the service is provided and, in particular, the role of the driver have significant impacts on the cost of service. For some services, such as car pooling, van pooling, and car rental, the driver is one of the passengers who is providing an in-kind service. Services that use a for-hire driver vary considerably with respect to salary scale, method of compensation, and work rules. Transit companies have union drivers with base wage rates generally within the range of $5.00 to $7.00/hour, generous fringe benefits, and strict work rules that prohibit the use of part-time employees. Taxi companies may lease vehicles to drivers, use nonunion drivers on a commission basis, are usually not bound by strict work rules, and often make liberal use of part-time drivers.

As a result of these differences, paratransit services operated by transit companies generally cost considerably more than similar services operated by taxi companies; but taxi companies often suffer from poorly skilled drivers and high turnover rates.

The labor situation is extremely complex, often generating strong emotional reactions. Organized labor is viewed with suspicion and frequently blamed for preventing new paratransit services because of unrealistically high wages or unrealistic work rules. Considerable wage increases might make certain paratransit services infeasible. However, many of these services are currently operated in a substandard manner because of the low wages and the type of drivers being attracted at those wages.

Labor difficulties often arise from presupposing labor opposition and approaching labor unions with suspicion and mistrust. We tend to exaggerate labor problems and thus establish potential conflict situations between labor and management. Several recent experiences, such as the Rochester dial-a-ride project and Knoxville van-pooling project, demonstrate that, if a labor union is involved from the beginning and treated with respect, reasonable arrangements can be developed.

Labor problems do exist. The impact of section 13c of the Urban Mass Transportation Act on taxi operators has not yet been adequately determined. Escalation of wages is of concern not just to paratransit but to the entire transit industry. Work-rule arrangements for transit are often restrictive and pose major problems when applied to paratransit operations. Unions should realize that there are basic differences between providing transit and paratransit services. In the same way that there are different work rules for transit drivers and mechanics, there should be different work rules for transit and paratransit drivers.

Funding Allocation

Funding allocation decisions are becoming more difficult because the cost of providing existing transit services is increasing at a faster rate than available funds. In an effort to raise more funds, those at a local level are broadening the revenue base to include the county or region. Thus, more funds are being provided by outlying areas that have little or no public transportation. Funds allocated to provide new service in these areas are not available for existing conventional transit services in the higher density central city areas. Arguments are made that it is inequitable to fund high-cost paratransit services in rich suburban areas when the principal need is for low-cost conventional transit service in low-income areas. Although the argument is persuasive, should not those outlying areas be provided with some limited service? The issues are how much and what type of service should be provided in the outlying areas.

Although the cost per trip of paratransit service in suburban areas is generally high, the cost per capita is quite small. This point is often overlooked. Paratransit provides an areawide public transportation alternative that requires relatively few vehicles and drivers to offer extensive coverage for many potential users. Few people will use the service, but those who do generally have the greatest need. Although suburbanites tend to be more mobile and affluent than central city residents, many are poor and immobile. Provision of some public transportation option in suburban areas should also increase the opportunities of more people to settle in those areas.

The greatest potential for decreasing automobile ownership exists in the suburbs whose residents own more than one automobile. Provision of high-quality public transportation service should cause some families to eliminate a second, third, or fourth automobile. This has already happened in Reston, Virginia, and in Westport, Connecticut, two affluent suburban areas with high-quality public transportation service.

Although paratransit service in suburban areas might appear to have high costs compared with those of high-density service, it will probably be the least cost alternative. Several Michigan cities, disturbed by the high cost per trip of dial-a-ride, substituted conventional fixed-route service. The result was that demand declined, and the cost per trip was even higher for fixed-route service than for dial-a-ride service. The fixed-route service was dropped, and dial-a-ride was reinstituted.

Competition

Organizations view paratransit from their own perspectives. For example, the transit industry is interested in paratransit primarily to complement rather than to compete with conventional transit. The industry has expressed concern about paratransit whenever a potential threat of ridership loss exists. Memories of jitneys operating "cream-skimming" routes in the early 1900s cause great concern among transit operators whenever paratransit is discussed.

Does a new paratransit service divert people from existing transit or does it divert people from automobiles or does it create new trips? Taxi operators and other private providers share the same concerns. We have little evidence of what really happens, and that evidence is conflicting. In certain cases when new public transportation service was initiated, taxi patronage decreased; in other cases it remained constant; in still other cases, it increased. We need to understand better the ridership diversion impact of service concepts and pricing policies.

Few transit operators currently view diversion of peak ridership in a positive sense even if it can be shown to be economically desirable. They view their primary

measure of success to be ridership, and the greatest period of ridership potential is the peak. Although I disagree with the use of ridership as a primary measure of effectiveness, we must acknowledge that it exists. As deficits and public concern increase, cost effectiveness will no doubt become more important, and the attitude toward diversion of peak ridership might change. That is already occurring in certain areas, such as Sacramento, California, and Knoxville. The transit operators are discouraging additional peak-hour transit riders, encouraging the use of peak-hour car pools and van pools, and encouraging off-peak transit ridership.

In certain cases, conventional transit totally supports the use of overlapping paratransit service. The most obvious example is service for the elderly and handicapped. This market has such unique service requirements that the benefits of paratransit are obvious. In time I suspect that conventional transit operators will change their view regarding provision of overlapping paratransit service to specialized markets.

Potential conflicts do exist between conventional and paratransit alternatives. However, these can be grossly exaggerated and should not inhibit intelligent implementation of integrated systems. Existing conventional transit is serving an extremely limited market: the CBD-oriented work trip that generally comprises only 10 to 20 percent of travel in a metropolitan area. Why concern ourselves with conflicts over that limited market when the other 80 to 90 percent is unserved? For example, if new van-pool applications are to be initiated, they should be concentrated in outlying areas where no transit options exist rather than be placed in areas where they compete with existing transit service.

The federal government, through recent policy statements, has provided the opportunity to effectively use paratransit options. The question now is, How effectively will we use them? A major responsibility rests with the transit and taxi industries and their trade organizations to ensure that we take constructive initiatives. The first steps hold the key to working together to combine paratransit service with conventional transit and public and private operators. There are so many areas of potential cooperation that we should not focus on those areas of probable conflict. There is too much to be accomplished for us to divert major attention to nonessential issues.

I am not trying to suggest that everything is rosy. Significant areas of concern and conflict exist. This is understandable and healthy. I hope, however, that we do not create such significant conflict situations that paratransit concepts become infeasible. The two major industry trade organizations, the American Public Transit Association and the International Taxicab Association, should initiate cooperative projects to point us in the right direction and demonstrate what can be accomplished.

Coordination

The challenge is to develop combinations of services that are compatible with respect to service quality and complementary with respect to system use. System and service components should be integrated in a balanced manner that satisfies customer demands, provides for customer choice of different service levels at different costs, and uses the various system components in a highly efficient manner. The concept of an integrated system does not imply a single operating agency. Many different services should be offered by different transportation providers, both public and private, in a manner that achieves system coordination and integration while maintaining the independence of the various operators.

An example of how integrated services with different operators could function is the Allegheny Airlines commuter system. More than 10 small commuter operators contracted with Allegheny Airlines to augment line-haul service provided by Allegheny. Customers using one of the commuter lines perceive that they are flying with Allegheny; they use the Allegheny computer reservation system, flights are listed in the Official Airline Guide, and Allegheny personnel transfer luggage to connecting flights.

In many cases, Allegheny uses the commuter service technique as a way of replacing inefficient line-haul service. According to its report (3), "In nearly every city where Allegheny commuter service is introduced, flight frequencies double, triple, and even quadruple those previously provided by Allegheny Airlines with larger, 50-passenger aircraft." But Allegheny does not choose to operate the commuter lines. It recognizes that a carrier oriented toward medium-distance line-haul travel is not necessarily the best carrier to provide short-haul commuter service. Allegheny does, however, provide the coordination role: "Commuter flights are scheduled to connect with flights operated by Allegheny and other major airlines at hub terminals. Convenient, high-frequency connecting patterns have increased passenger boardings at commuter cities dramatically compared with traffic prior to replacement by Allegheny Commuter Service" (3).

Coordination of urban mass transit services is, of course, far more complex than the Allegheny example. Each of the urban transportation services (e.g., transit, taxi, limousine, and specialized services) has acted in the past as a separate culture with its own procedures and traditions. Thus, there is wide variation in how these industries are structured and function. The private sector operates in a competitive environment with profit maximization as a primary goal. Public-sector operations are typically based on a single service provider with social benefits as the primary concern.

It is important to differentiate between interest in providing paratransit services and ability to provide service. An existing provider may be totally committed to a new paratransit concept, but lack the organizational flexibility and management expertise to adjust to new service and operational requirements. This is true of both public and private providers. A more serious situation occurs when providers are asked to implement plans they do not fully comprehend and are not totally committed to. Some providers view paratransit as a vogue that will pass but is now diverting them from their major interest and true mission. Failure of new paratransit services becomes a self-fulfilling prophecy. This has already occurred in a few cases and is on the verge of happening elsewhere.

Recently, the brokerage concept has been proposed as a mechanism for service coordination. The idea of having a neutral organization matching those who need service with those who provide service has much merit. We should realize, however, that we are not dealing with a free market situation in urban transportation. Urban transportation is a public service. Although increasing the number of service options and providers is desirable, basing the choice of options and providers solely on economic criteria can be dangerous. Is it fair to deprive an existing public transit company of more favorable operations if another lower cost operator can provide a more cost-effective service and at the same time to require the public transit company to be the provider of last resort for important but unprofitable service?

Another basic issue is whether we should use an

evolutionary or revolutionary process for change. An evolutionary process uses an existing organization to coordinate service; a revolutionary process introduces a new organization. Primary responsibility for coordination of transportation frequently resides in a regional transportation authority (RTA). The charters of RTAs are extremely broad and cover far more than conventional transit. However, the need to cover ever-increasing deficits has forced many RTAs to concentrate exclusively on existing transit operations. Often an RTA becomes defensive and adopts a protectionist attitude toward its transit operations. It ceases being an organization concerned with broad transportation responsibilities and becomes a transit operating company.

I hope that RTAs can broaden their roles, seek involvement with other transportation providers, and assume overall responsibility for coordination of transportation services. Many RTAs have already begun new activities, such as car-pool and van-pool programs and subsidization of private carriers for paratransit service. The federal government should encourage and reward transit authorities that take positive steps toward a broader base. This can be accomplished by providing incentives, such as considering car-pool and van-pool passengers gained as a result of transit authority coordination as increased ridership, that could be rewarded by increased federal funding.

If an RTA is unwilling or unable to assume a more neutral position, then we must either look to other existing organizations, such as metropolitan planning organizations or councils of government, or create some new organizational structures within metropolitan areas that can coordinate planning, regulation, funding allocation, and operations.

Is there any one best solution for coordination? I think not. In the same way that different service concepts are appropriate in different urban areas, so too organizational relations among providers will vary among urban areas. It is premature at this time to specify what is best. Rather, a variety of different approaches should be tried so that the benefits of different alternatives can be determined.

FUTURE DIRECTIONS

What are the appropriate directions for the future? I am troubled that a backlash toward public transportation might soon develop. Our credibility record is poor if promises are compared with results. Operating deficits are rising at an alarming rate at a time when public funding programs are being held constant or reduced, particularly at a local level.

We live in a constantly changing society. Technology continually opens new opportunities at the same time that resource limitations raise serious questions about future directions. Our goals and values change in response to a variety of factors.

What does the future hold? Two things appear to be certain. First, we must use existing capabilities and resources better rather than continue to build new facilities. Second, change is inevitable, but probably not predictable.

These directions have definite implications for urban transportation. We must be more concerned with cost-effective solutions, make better use of existing public transportation resources, and use flexible systems that can respond to change. In that context, paratransit can play a vital role in urban transportation systems of the future.

Paratransit services and integrated systems are still largely innovative, experimental concepts. The diffusion of any innovation is a complex, lengthy process. For more than a decade, the U.S. Department of Transportation has stressed the concept of balanced transportation planning. Urban areas are required to jointly consider highway and transit alternatives and investments. Today, in spite of numerous pressures, relatively little is being done. It took time to develop new planning approaches, reeducate people, and break down preconceptions and opposition. Realistically, one must expect a similar lengthy process to occur with respect to integrated public transportation systems. To ensure that we achieve our objectives, we should concentrate in the following three areas.

Research and Planning

We know little about the design, implementation, and evaluation of integrated systems. Two studies, which have been completed for the U.S. Department of Transportation, examine the concept and feasibility of major modal diversions to integrated public transportation systems. For the first time, issues of service choice and integration of paratransit and conventional transit service were explored. The results of those research efforts are quite encouraging. They demonstrate how, as mode split increases, integrated systems can yield economies of scale as high as 40 to 50 percent in the cost per passenger and how flexibly routed paratransit services play an important role in the transition from current low modal splits to more moderate modal splits. That work is only a first step and should be continued.

Many specific questions that have been raised in this paper can only be answered by undertaking research. What impact does paratransit have on conventional transit? To what extent are they competitive? What are the relative economies of operations during the peak and off-peak periods? Should transit systems try to divert existing peak ridership? What are the implications of section 13c of the Urban Mass Transportation Act on the provision of paratransit service? What regulatory reforms are required to allow implementation of new service options and greater flexibility of service providers while ensuring protection of the public and equitable treatment for existing operators? What impact will automation have on the coordination and operation of paratransit service? What are the potential roles of untested paratransit concepts, such as areawide short-term rental cars and legalized hitchhiking? What incentives should be provided to encourage paratransit and integrated systems? What alternative subsidy schemes can be used, such as direct subsidy to users rather than to transportation providers? What role can automobile disincentives play in encouraging the use of integrated systems?

Our traditional planning approaches geared toward unimodal fixed facilities are often not relevant for short-term, noncapital service. We must develop new tools that permit us to work intelligently with these service concepts. Paratransit has taught us to be much more concerned with individual markets, and our planning tools should reflect that orientation.

Experimental Implementations

We need to implement programs that explore new service concepts, new service providers, and coordinated service. The Service and Methods Demonstration Program has played a critical role in this experimentation. The funding for that program should be expanded so that more meaningful experiments can be undertaken. The experiments must be coordinated to try a variety of approaches that build on one another. Initially we should concentrate on sites and experiments with a high prob-

ability of success. Succeeding experiments would venture into successively higher risk areas. Existing transportation providers, particularly the transit industry and the taxi industry, should play active roles in proposing experiments with a potential for success. A closer tie between federal and state demonstration programs is appropriate.

Transfer Mechanisms

Mechanisms are needed to transfer successful results to other urban areas. Ignorance and misinformation are the greatest potential dangers facing paratransit. Relatively few decision makers at a regional or local level understand the implications of paratransit service. If these people are to intelligently choose among alternatives, they must become more knowledgeable about paratransit.

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Integrated Transit Service in Santa Clara County

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This paper describes the experience of an integrated transit system in Santa Clara County, California. Background information on the county and the origins of the system are presented, as well as a description of the services provided. After 4½ months of operating the full system, elements of the system were dismantled. Some of the reasons for this failure are discussed.

Many words and probably tons of paper have been generated as a result of the ambitious and forthright attempt by Santa Clara County to institute an integrated transit system suitable for the twentieth century. Words and paper notwithstanding, I can report that the attempt was a success. But it was success with a vengeance. In Santa Clara County, we did what others just talk about. The fact that part of our project failed because of a lack of resources does not detract from the importance of the concept to transit operations everywhere. Those who have been able to look past the hardware have recognized this importance and we find that gratifying.

The problem of integrating transit in an adaptive manner to respond to the changing goals and aspirations of the many conflicting trends in our society is only now beginning to be addressed. More commonly, the concept of integrated transit seems to confine itself to making devices work together in the transit business, rather than integrating transit with the infrastructural system.

In Santa Clara County, our design concepts were projected to integrate police, fire, and emergency vehicles as well as arterial, bus-pool, dial-a-ride, and light and heavy rail services. Provision was even made for the very necessary incorporation of private-sector services. Finally, we have started to provide the governmental and management structure to accommodate this total integration.

Happily, the concept of transportation as a functional system helping to link together the other functions of an urban society is still in effect in Santa Clara County, even though a portion of that integrated system has now been constrained by the decision not to proceed at this time with countywide demand-responsive services.

Some brief background information on Santa Clara County will be helpful in understanding the Santa Clara experience since it is only by understanding the nature of a community that strategies for transportation and transit can be properly understood. Meshing the community with transportation strategies is the first and most important integration.

Santa Clara County has a population of about 1.2 million people and an urbanized area of about 620 km^2 (240 $miles^2$) in a county whose overall area is about 3400 km^2 (1300 $miles^2$). There is a strong county government with 15 independent, and independent-minded, cities ranging in population from 3000 to 550 000. In the 1950 census, Santa Clara County had a population of fewer than 300 000 people. By 1960, that population had grown to 640 000. In 1970, the population was about 1.1 million, but many people strongly wish to slow the rate of growth for a broad variety of reasons. A large part of the population is highly educated and therefore well able to articulate a wide-ranging set of ideas for the future of the county.

The county has a large number of both established and experimental regional mechanisms for addressing some of the more comprehensive issues normally associated with large urbanized areas, one of which is the overall transportation issue. Transit, which is the responsibility of the Santa Clara County Transit District (SCCTD), is dealt with by a governing body that is also the Board of Supervisors of the County of Santa Clara, a unit of general-purpose local government. This political arrangement dictates that transit be considered in priority with other urban issues. To ensure that all cities and major interests have an appropriate influence on this governing body, there is also the County Transportation Commission composed of city council members from each of the 15 cities, along with 10 others, 3 of whom are supposed to have some special knowledge of transit.

ORIGINS OF THE INTEGRATED SYSTEM

The Arterial/Personalized Transit (APT) system in Santa Clara County has often been referred to as dial-a-ride. This is incorrect. APT is a system concept, independent of hardware, based on functional services to provide the opportunity of mobility to all the people in Santa Clara County. Dial-a-ride was merely part of APT.

APT was conceived in controversy. Transit has been a controversial issue in Santa Clara County since the first paper was written in 1964 advocating the pursuit of a comprehensive transit effort, during the time when the highway-building program was in its heyday. The controversy has continued among those who believe that the automobile mode should be terminated; those who believe that the automobile is the only way to go; those who believe that electrified, exclusive right-of-way transit is the only solution to long-term travel problems in the Santa Clara County metropolitan area; those who believe that, since fixed guideways take too much time and money to install, buses are the only solution; and those who believe that the public should be left alone, particularly insofar as additional taxation is concerned.

The transit controversy led inevitably to making a study. That study in 1969 recommended a system of fixed-route bus services covering about 70 percent of the 1980 population in the urbanized areas and using 325 buses. This recommended plan was a considerable improvement over the then-existing bus services provided by private operators, which served about 53 percent of the urbanized population with roughly 75 buses. The report was not greeted with favor by those who advocated an immediate rapid transit system.

When the SCCTD was created in June 1972, it became mandatory to deal effectively with the sharp divisions of opinion concerning the appropriate initial size of the bus fleet, particularly to ensure that the bus fleet should not be so large as to preclude productive efforts toward installing the electrified rapid transit system. Goals and programs were adopted. The decision was made to begin countywide transit services with about 200 buses. That decision was a compromise and offered a fleet of a size that could be operated within the financial limitations of the legislation that created the SCCTD, which at that time contained no local taxation capability.

As soon as the compromise decision was reached, a new controversy was created. Sharp disagreement surfaced over the deployment of such a limited number of vehicles for 1.2 million people in 620 km^2 (240 $miles^2$). Jurisdictions that had transit service from the private companies that had been purchased were insistent that service levels be improved. Jurisdictions that did not have transit service were equally insistent on receiving their fair share of transit service, preferably in proportion to population and certainly in proportion to tax revenues generated by a $0.0025 sales tax.

APT avoided the politics of the deployment controversy and focused on goals. Given 200 buses to serve more than one million people, it was quite apparent that a formula allocation of buses to jurisdictions would prevent achieving reasonable service levels. The concept of judging transit service levels by the opportunities for service, irrespective of jurisdiction, was introduced and called APT. Under this system, there would be a countywide network of arterial routes that would serve countywide travel. Since 54 percent of all trips are less than 8 km (5 miles) in length, the short trips would be handled by demand-responsive services. The number of vehicles needed to respond to demand in a given area would adjust to that demand. On this basis, if demand was low in a given area of the county but very high in another area, vehicles would simply move from the low-demand area to the high-demand area to equalize response time to a call for service. It would be very difficult then for any jurisdiction to argue that it was not receiving its fair share of transit service. The true integration of arterial services and demand-responsive services minimized the perennial problem of the transit operator concerning productive use of a fleet during the off-peak hours and made the best use of a grossly inadequate number of vehicles.

APT was born of these controversies in an effort to provide at least some transit service with the resources available. It was fundamentally an orderly expression and refinement of the transit desires of the community, including the needs of those who rated themselves transit dependent because of income level or physical handicap. It was intended to be a bridging operation between no transit service and adequate transit service, while both addressing social needs and avoiding the political controversies that were threatening to result in simple inaction. APT was a strategy for approaching the overall goals without complete revamping of service with each step. It was and is a hardware-independent service strategy that was also suitable as a feeder network (collection/distribution system) not only for heavily traveled arterial bus routes but for future fixed-rail facilities of any type.

SERVICES PROVIDED

The arterial portion of APT consisted of 99 to 132 vehicles on 19 routes forming a network over the entire county of 446 km (744 miles) of two-way routes with basic headways of 15 and 30 min.

The personalized transit (PT) portion of APT consisted of 39 to 75 vehicles (the original design called for about 100) in 18 zones within four control areas. Three of the control areas, in the more heavily urbanized northern part of the county, used computer-assisted reservations, scheduling, dispatch, and management. The average zone was 34.4 km^2 (13.3 $miles^2$) and had a population of 61 000. Address subzones were sized at about 2.6 km^2 (1 $mile^2$) for convenience.

In addition to these highly visible services, APT also envisioned coach facilities for the self-assisted wheelchair rider as a part of mainstream transit service in which both the handicapped and the able bodied would ride the same vehicle. Such an integration was not only adopted for social reasons, after discussion with handicapped people, but was also required to make effective use of scarce resources.

Commuter specials or bus pools were also instituted and continue to be a part of the transit service in Santa Clara County. The commuter special is the one piece of premium service for which a premium fare was agreed upon to permit recovery of operating costs.

In order to provide these services with a fleet of 212 buses, only 134 of which were new and truly operable, each vehicle ran in excess of 9300 km (5800 miles) per month despite shorter than normal operating hours, both on weekdays and on the weekends. The rate of 9300 km per month per coach in fleet is probably at least 60 percent higher than the rate for other major transit properties in California. This intensive fleet use compounded problems that were to have been avoided by rapid vehicle replacement. The replacements did not materialize.

Ridership jumped, nevertheless, during the 4 months and 17 days that APT was in operation, from fewer than 18 000 riders per average weekday to more than 32 000 riders per day. In the remaining PT service area, ridership in December 1974 was 150 per day with three vehicles. Today, that service carries up to 938 in one day with seven vehicles.

THE FAILURE

The demand-responsive element of APT began on November 24, 1974, and APT was fully installed on December 21, 1974. The PT element was discontinued in the northern part of the county on May 9, 1975. During that period, APT system ridership increased dramatically,

and PT ridership increased steadily from about 1200 on the first day to 6671 on Tuesday, May 6. The demands placed on the system were high and highly visible. Rapid adjustments within the severe fiscal constraints occurred during this 4½ months. The adjustments were ongoing, as was intended in the original concept, but they were inadequate to stem the tide of discontent.

Probably the primary trigger for failure was that the revised countywide arterial network was installed without sufficient consideration for problems of the rider who was displaced, despite the cooperative effort of all cities in designing the revised network. Controversy surrounding the efforts of displaced riders to recover these old fixed routes tended to discredit the entire APT system. Displaced riders both resisted exercising the alternative transit opportunity that existed and were unable to use the PT system because the general demand was so great. A measure of that demand is indicated by the problem of the telephone system. On the first day, more than 50 000 telephone calls for PT service were attempted. Not only was the SCCTD's telephone system on the brink of disaster, but the entire telephone system of the county incurred severe strain, and emergency measures were taken at the telephone company's switching stations.

The very nature of the APT strategy unleashed the dormant expectations of the public and revived old controversies. The problem of the rider displaced from fixed-route services became a rallying point to coalesce discontent with society in general and transit access in particular.

Legislative discontinuity was an important feature in the political failure of a technical and box-office success. APT began full service on December 21, 1974. By January 7, 1975, the complexion of the governing body had changed with the addition of two new members of the five-person Board of Supervisors. A new majority appeared to exist, with little allegiance to previous decisions and with the problem of coping with the highly activist demands of some community interest groups. The solution finally arrived at was virtually inevitable, given the rigid financial constraints and the legislative discontinuity.

There is no question that the demand for the new service, coupled with the scarcity of resources to satisfy this demand, contributed greatly to the demise of dial-a-ride. Under normal circumstances, given a high demand for service, a reasonable response would be to increase the resources needed to satisfy that demand. This was not possible. As demand levels continued to rise, any adjustments to service tactics could not really address the fundamental problem of undercapitalization. Service continued to attract more riders but greater feelings of discontent. The constituency in favor of the service could not enlarge itself rapidly enough because there were too few buses. It was never possible to devote the planned number of buses to demand-responsive service because of the increased peak-load demands in the arterial service, for which schedules and routes had already been published. Under such circumstances, fleet deployment gravitated toward arterial services, which further deteriorated the already inadequate PT service.

The willingness to compromise was gone by this time. Dial-a-ride was singled out as the culprit, despite the fact that ridership in the APT system per coach in fleet per day compared favorably with other major transit operations in California. The problem of the empty bus remained because of the uncompromising attitudes that prevailed during attempts to explain the concepts of APT. The concept of the integrated system was forgotten, and APT was regarded as a series of discrete transit services independent of other transit services that were being performed. Dial-a-ride was focused on by the community interest groups as the source of all inadequate transit services being provided by a fleet of 200 buses in an urbanized area of 620 km^2 (240 miles^2) and 1.2 million people.

When APT began, eight taxicab companies in Santa Clara County that owned approximately 150 taxis, half of which operated each day, became concerned over the potential loss of business, particularly to dial-a-ride. A lawsuit followed and the judgment was against the SCCTD. Apprehensions concerning the total compensation that would have to be paid to the taxi companies further aggravated the situation.

Attempts were made to reach some accommodation with the taxi companies, but these attempts were also frustrated by the district's inability to incur additional financial obligations. The SCCTD attempted, at various times, to treat the private taxi fleet as a part of the total public transportation system and offered centralized dispatching and scheduling. It also offered an aggressive referral service during periods when our own response times would be too long. It offered referral services for those who might not wish group travel and were willing to pay a premium for private travel. It offered to centralize marketing so that any member of the public wanting to make a trip by anything other than a private automobile would be able to make one telephone call. Unfortunately, these attempts at operational integrations failed. The taxi companies were unwilling to consider anything but the simple payment of dollars by the SCCTD. The lawsuit is still on appeal since the taxicab company owners want to be purchased anyway, rather than paid damages. A similar problem with ambulance companies is possible if demand-responsive services are proposed for only the elderly and handicapped.

Cost computations on dial-a-ride came from a variety of sources, but costs were assigned to dial-a-ride on a proportional-cost basis only and without a proper appreciation for the integrated nature of the system or the peculiarities of the union contract. Under the union contract, labor costs incurred during peak hours on fixed routes are proportionately higher because of restrictions on the total number of hours an employee can work and guarantees to the employee for a certain number of hours of pay if he or she reports for work. Sophisticated marginal-cost concepts were ineffective during this time of intensive and simplistic political battle. Realistic application of marginal-cost theories would have led to the conclusion that dial-a-ride cost virtually nothing compared with our overall rates of expenditure.

During the start-up period, inexperienced personnel were at a severe disadvantage under such high-pressure conditions. Despite intensive training, the learning curve was flatter than it should have been because of ad hoc attempts to respond to high levels of criticism. Service efforts were sharply diluted as panic spread.

LESSONS

Providing transit services in the context of overall transportation mobility for a metropolitan area is a complex problem. Proper provision of these services can best be discussed under the headings of price, product, packaging, promotion, and politics.

Price

The price of adequate transit services is high. The traditional public concept of transit service is that it is an entrepreneurial undertaking that should somehow be paid for entirely by the customer. The customer is usually

defined as the one who rides on transit. Only recently has the idea been introduced that transit services should be treated like any other governmental service and not like an entrepreneurial undertaking. With government operating transit, social values take on increasing importance and influence the conduct of transit service.

Dealing with transit in such a way requires a different pricing approach, but the viewpoint that transit should be paid for solely by the rider lingers on. To the extent that the customer is the beneficiary of the existence of a service or product, the transit customer is the population at large rather than merely the rider. The rider secures a direct, identifiable benefit for which he should pay. At the same time, however, the community at large receives an identifiable, although still intangible, benefit from the existence of transit, and the community should be expected to pay in proportion to that benefit. The transit customer is now everyone in the community who benefits from transit riding, from decreased congestion, from improved air quality, and from decreased consumption of land. The pricing of transit, however, does not yet recognize this new situation.

In addition, decisions on pricing policy by those in government who are inexperienced with pricing theory further complicate the situation. There is the mistaken concept that the price margin should be uniform over all elements of service. Pricing levels should be based on the attractiveness of the product and should provide a functional economic situation. In the APT system, the price for dial-a-ride was established at precisely the same level as that for traditional fixed-route service. The level of service for the two is different, however.

The use of pricing as a means of regulating demand on limited resources is not yet fully understood in government circles. The loss-leader concept has insufficient currency. In addition, fare levels have been established more on the basis of social goals than on economics. That attitude has curtailed the ability to achieve differential pricing by modes of service, except in the arena of bus pools, which are regarded as being primarily for the more affluent.

In addition, some complaints were received from senior citizens who objected to the need to make a telephone call to secure transit service. Many senior citizens view the telephone not as a utility but as a lifeline for emergency purposes only. They have telephones but use a limited-service rate. The need for the telephone call therefore added to the cost for transit service and virtually eliminated the benefit of lower fares for the elderly.

Product

The product offered by APT service was superior and was achieved at a premium of 7 percent or less over the alternative of 100 percent traditional fixed-route transit services. The premium to produce that product was perceived as being considerably higher because of the empty bus factor in the face of extraordinary demand. The product also required using advanced technology, such as computerized assistance for scheduling and dispatching. While the computer did its job superbly and was a minor part of the cost, it added to the perception that APT was a premium-cost service that could not be properly afforded given the financial constraints on the SCCTD.

Our use of computer technology does not have to be defended. We could not have operated demand-responsive service in the urban areas of the county without the computer. The scheduling and dispatching programs did exactly what they were designed to do and more. Reliability was excellent—90 min of hardware downtime in 10 000 h of operation. Furthermore, we are convinced that computer technology improved scheduling effectiveness over manual methods by 20 to 30 percent, as shown by a constantly rising vehicle productivity that reached 6.6 just before the PT service was terminated.

Incidentally, we have continued to use the computers for other transit-related purposes. We recently installed a low-cost automatic passenger information system, and we are beginning to develop a low-cost system for checking the adherence of vehicles to schedules on fixed routes.

Packaging

The packaging for the service was also superior. Graphics on the inside and the outside of the bus were designed for high visibility as well as nighttime safety, and they were designed to help the bus seem smaller in the street than it really is. Special attention was devoted to the selection of the power plant. Buses were going into areas of the county where large vehicles had never gone before. Transit was sold, in some measure, on the basis of environmentalism. After careful consideration, the diesel engine was discarded as a suitable power plant because of smoke, smell, and noise. A gasoline engine converted to propane fuel was selected after a protracted fight with those with more traditional viewpoints.

The interior of the vehicle was specifically designed for customer comfort, but with a view to adequate maintainability and cost considerations. Space between seats was increased for additional leg room. Floors were carpeted. Ceilings were vinyl covered. Incandescent rather than fluorescent lighting was used to provide pools of light at a seat. Interestingly enough, with the reduction in seating capacity the overall peak-hour loading capacity of the bus was increased. In addition, vandalism rates have been lower with the soft interior than with more standard interior bus treatment. Small individual NO SMOKING signs were glued to windows. These signs have been subjected to the only significant vandalism as members of the public have taken the stickers for souvenirs and for use in their own establishments. This packaging strategy continues to attract happy compliments from new riders.

The same vehicles were used for both arterial and demand-responsive service. This packaging decision resulted from the search for a universal vehicle and the need for dynamic balancing of fleet deployment during the course of the day. What actually occurred, however, was that while the bus was in PT service it was perceived as empty and therefore extravagant. In addition, all buses, however they were being used at a given moment, were perceived as being in PT service because of the timing of the start-up, since dial-a-ride was introduced in advance of arterial services. The problem was compounded by the administrative decision to use relatively clear glass in the new large-windowed buses. A better decision would have been to darken the windows of such large-windowed vehicles to enhance interior coziness and inhibit charges of extravagant emptiness directed even at buses that were out of service.

A large integrated transit system that includes demand-responsive services depends on packages of equipment and business systems that are not within the control of the transit operator. Demand-responsive service, for example, requires intensive use of the telephone if the system is to operate successfully. A very large demand-responsive service places intensive operational demands on the telephone system in the area. During the early stages of dial-a-ride, some 50 000 to 70 000 telephone calls were being attempted each day

within a 16-h period. This is a call rate of 45 to 65 requests per 1000 population rather than the rule of thumb of 10 to 26. Uncompleted calls were due not only to our inability to answer such a large number of requests, but also in some measure to the failure of the overall telephone system itself.

Promotion

The promotion of APT was probably superior. Advance information issued was colorful, informative, and, unfortunately, in some respects exhortatory. The placement of the Rider's Guide into virtually every household, before service was begun, excited expectations, and there was insufficient time to explain truly what was inside the package. As a result, it was pure promotion rather than instructive promotion. With a technologically innovative system such as APT, the educational effort should have received more emphasis during the promotional phase. This problem was compounded by informal commentary to civic groups and other interested organizations concerning the potentials of the APT system without adequate explanation as to its practical limitations in vehicles available. The formal and informal promotion of APT loosed unexpectedly high expectations. It is difficult to know precisely what was said in some of the informal promotion, but the suspicion is that there was too much implication of utopia unfettered by practical limitations.

Politics

Politics is not typically taken into account in transit marketing, but the provision of government transit services is political. Political accommodation is therefore inextricably bound up in the technical solutions that are sought. This fact was not properly recognized and the problem of political passions was too casually dismissed by technicians, professionals, and politicians alike, especially when dealing with technologically innovative management solutions for providing ubiquitous transit services. Nor did we recognize how volatile politics really is. The ever-present possibility of the new politician was not factored into design decisions.

In addition, politics governed the decision for a shotgun start of APT. Despite a preference for incremental and gradual beginnings, the policy of a shotgun start was made after a majority of cities volunteered to be first.

CONCLUSIONS

Dial-a-ride died, but there is still some integration of transit services within Santa Clara County, and normal arterial fixed-route bus transit services continue.

Commuter services, also known as bus pools and van pools, are being emphasized. A new van-pooling operation now under way is designed, once again, to maximize service opportunities in the SCCTD. Vans are used for a 6-month trial period to acquaint employers with the concept of van pooling without an investment in equipment or assumption of risk by the employer. After the 6 months, employers and employees have the option to end the project or continue with their own drivers and equipment, and the SCCTD takes its vans and goes on to another employer to aid in establishing private van-pooling efforts.

Ten off-peak local routes serving neighborhoods and major trip attractors have been established since the demise of dial-a-ride in the former PT service areas. Route configurations are based on a review of the 4½ months of operational data coming out of the dial-a-ride effort. Buses run at nominal 30-min intervals and cover the off-peak transit service time of roughly 9:00 a.m. to 3:00 p.m. These fixed routes on fixed schedules are intended to accommodate as well as possible the midday trips previously accommodated by dial-a-ride.

Full demand-responsive dial-a-ride services are being continued in the southern part of the county covering the cities of Morgan Hill and Gilroy, the community of San Martin, and the surrounding semirural area. This service carries more than 100 people per vehicle per day and is steadily growing. Waiting times exceed 1 h during the morning peak and all afternoon and early evening. Demand-responsive coach service for the handicapped has also been instituted. Interestingly enough, the daily proportion of ridership by self-assisted wheelchair riders exceeds the estimated percentage of people confined to wheelchairs in the population at large.

The consideration of successes or failures in a truly integrated transit system must delve very deeply into behavioral and infrastructural factors. The APT experience in Santa Clara County has led me, for example, to appreciate strongly the fact that there is a definite, albeit undefined, relationship between public perceptions and expectations and that both are highly volatile.

Integrated transit approaches require integrated governmental approaches to urban issues, complete with integrated hazards that are probably higher than those normally experienced by the traditional transit operators. Relationships between the public and private sectors become very important, and I suspect that they are unique to each area in this country. A simple discussion of modal integrations, in this context, becomes superficial and inadequate.

If there is to be truly integrated transit, including integration with the community, transit techniques will have to address problems larger than the simple interfacing of equipment or management techniques. When community goals are known, transit goals can be integrated in turn and appropriate management strategies can be devised. If such an approach is to be adopted elsewhere, I would urge the administrator of such an effort to be particularly sensitive to the realization that he or she can increase service linearly but must face the problem of dealing with geometrically rising public expectations and perceptions.

A final set of comments is required. This presentation has deliberately not been filled with statistics and operational data. Truly integrated transit resides in combining transit with community goals, and these are not statistical issues. Integrated APT in Santa Clara County was pursued with what, in my opinion, was a remarkable partnership that integrated the problem-solving capabilities of the public and private sectors.

We have the tools to integrate our transit services. We need now the will and the management and political structures to make those integrations possible. Management strategies must be based on the recognition that the public interest is not necessarily the interest of the public at any given moment in time. Only if we understand these behavioral considerations, both for individuals and for groups, can transit be truly integrated.

Demand-Responsive Transportation in Ann Arbor: Planning and Administration

William D. Drake,* University of Michigan

Since its formation in 1968, the Ann Arbor Transportation Authority (AATA) has made significant strides in shifting the emphasis from private automobiles to public transportation. This paper details the implementation of a system that has grown from ground zero in 1968 to 1 600 000 riders in fiscal year 1974-75. The attendant growth of AATA's capital equipment and annual operating budget is similarly impressive. Funding has been derived from federal and state grants and a local property tax adopted by the voters in 1973. The local funding support is important because it demonstrates a high level of community support for the transit system and furnishes the required matching funds for larger state and federal grants. The AATA system is truly demand responsive since it includes planning and service revisions as well as the dial-a-ride service. It is anticipated that the respective importance of dial-a-ride and line-haul service will shift as the system matures and ridership reaches a much higher level. Long-range growth can be ensured only because AATA continues to monitor public response to its service and to implement required changes.

Ann Arbor is a unique and exciting community in many ways. Concern for social justice and attention to the quality of our environment dominate many policies and programs. It is natural then that we are leaders in the development and implementation of a new public transportation system that is helping to shape our future.

A major advance toward this new public transportation system came with a 2.5-mill property tax earmarked for public transit that, when passed in 1973, amounted to $1.5 million. Since that time, the Ann Arbor Transportation Authority (AATA) has been progressing steadily toward high-quality personalized transit. AATA's 1975-76 operating budget of $3.8 million gives some idea of its growth.

HISTORY

The AATA is a young organization, chartered by the city of Ann Arbor in July 1968, under a public act of the state of Michigan. This act enabled municipal transit authorities to operate service within the city of incorporation and some distance beyond its boundaries. The original limit of 3.2 km (2 miles) was changed to 16.1 km (10 miles) in 1970 through special state legislation to allow the AATA service area to better conform to the service needs of the urbanized area.

The AATA was created when the city recognized that operation of a transit system could no longer be undertaken at a profit by private enterprise (the last of a series of private operators stopped service in May 1968). After several months with no bus service and a brief unsatisfactory experience with an outside contracting firm, publicly operated service commenced with four minibuses in Spring 1969. Later that year, used transit coaches were purchased and regular fixed-route service was restored with 30-min headways on three main routes.

The AATA purchased 16 new transit buses in 1970 with the assistance of the U.S. Department of Transportation Capital Grant Program. This enabled further expansion of line-haul service to six different routes covering most of the city. Half-hour service was offered during peak periods and hourly service at midday. The lines operated Monday through Friday, with a 35-cent cash (adult) fare and free transfers. This basic line-haul bus system restored public transit to Ann Arbor and provided the foundation for subsequent expansion and improvement of service.

PILOT DIAL-A-RIDE

The AATA wanted to go beyond providing bare bones transportation. In April 1971, the AATA adopted a far-reaching statement of goals and objectives that called for

1. A diversified, coordinated public transportation system for the urbanized area that permits any individual to make any desired trip quickly, safely, conveniently, and economically and
2. A public transportation system of a size and influence to reduce the automobile population of Ann Arbor to one car per family and to maintain that level.

To meet these goals, service improvements were mandatory. In September 1971, the dial-a-ride pilot program was launched with a demonstration grant of

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*Mr. Drake was chairman of the Ann Arbor Transportation Authority when this paper was written.

$56 000 from the Michigan Bureau of Transportation, technical services and a vehicle donated by the Ford Motor Company, and a special appropriation of $10 000 from the Ann Arbor City Council.

The objective was to field-test door-to-door public transportation, measuring both public response and operating feasibility, and to determine whether such demand-responsive service could help the AATA fulfill its stated goals. The program was small; it involved only three vehicles and served approximately 15 percent of the city's population. The one-year test period produced several important findings.

1. The total number of transit trips from the target neighborhood was more than double the previous line-haul bus ridership in the same area.
2. Dial-a-ride lured many passengers from their automobiles. According to surveys in January and June 1972, 50 percent of the users had been automobile drivers or passengers before dial-a-ride became available.
3. Dial-a-ride reached many people who did not use public transit regularly. In a typical month, approximately 70 percent of those who traveled on the test system rode less than once a week. Surveys verified that this was not due to dissatisfaction with the service but rather to the feeling that dial-a-ride was a backup or auxiliary transportation system. This suggested that occasional users might ride more regularly if door-to-door public transportation became permanent.
4. The service delivered was excellent. The average waiting time (telephone call to doorstep pickup) was 10 min and the average riding time (pickup to drop-off) was 13 min. All four surveys conducted during the project indicated that the public in the test service area was pleased with dial-a-ride. A home interview survey also showed widespread citizen support for expansion of the system, which would require a tax increase.
5. Dial-a-ride proved operationally feasible under Ann Arbor's conditions but relatively more costly than traditional line-haul service. Direct operating costs during the test year came to $1.74 per ride for the three-vehicle system. The cost per ride for a larger system could not be directly extrapolated from this figure, but it was likely to be somewhat lower.

These test findings confirmed the AATA's initial hope that the public would find dial-a-ride more attractive than conventional service and would therefore encourage use of public transit rather than automobile travel. The cost findings indicated that a new source of funding would be required if dial-a-ride service were to be made available to Ann Arbor's citizens citywide.

FROM PILOT TO COMMUNITY SERVICE

On the basis of the pilot program and the experiences of other communities, the AATA established that any significant switch from private automobiles to public transit would require a system with doorstep pickup and drop-off; an absolute minimum of transfer difficulty; telephone requests for service, with little or no requirement for public knowledge of schedules and route maps; fare at present levels or lower; and ability to shift the type of service according to the time of day and travel demand.

The final plan was developed in fall 1972, a combined effort of the AATA board, its consultants, and other interested citizens. Key decisions, such as levels of fares, were the result of direct input from citizens' groups that met to review and discuss the plans being prepared.

The system, which is largely based on the dial-a-ride experience, consists of

1. Neighborhood dial-a-ride services with doorstep pickup and drop-off by telephone request that provide point-to-point service within a given zone and also act as feeders to express buses that connect major trip attracters and other zones;
2. Express trunk-line services that connect major shopping centers, employment areas, all senior high schools, the University of Michigan, a community college, hospitals, and other major trip-generating points;
3. Coordinated no-wait transfers between neighborhood dial-a-ride vehicles and express buses; and
4. Regular subscription service for daily work and school trips, with doorstep pickup and drop-off at the same time every day, serving locations that have adequate demand to justify dedicating a bus to that run.

In early summer 1973, the AATA began to implement the system in incremental phases. An entirely new organization was built. A full-time professional management team was hired. The number of drivers and dispatchers increased from 25 to 125, the maintenance staff increased from 3 to 15, and the bus fleet grew from 21 to 78 vehicles.

As new services were implemented, ridership in fiscal year 1974-75 continued to grow at a rapid rate. On a typical day the AATA services transported more than 7000 passengers—4000 passengers on regular line-haul and express routes, 1500 passengers on school subscription service, 1300 passengers on daytime dial-a-ride, 500 passengers on citywide evening dial-a-ride, and 25 passengers on the service for the handicapped. This represents a level of more than 1.5 million passengers a year, up approximately 50 percent from the previous year and nearly three times the ridership in fiscal year 1971-72 (582 240). The projected ridership for fiscal year 1975-76 is 2 100 000. When the system was being planned in January 1973, the projected ridership for the first full year of operation under the new system was 1 300 000. That estimate was conservative and was easily surpassed while we were still phasing in the daytime demand-responsive service.

CAPITAL PROGRAMS

The AATA has been extremely successful during fiscal year 1974-75 in multiplying local dollars with state and federal grants for the purchase of capital equipment. With $288 060 raised locally, AATA attracted $807 645 from the state of Michigan and $3 606 576 from the U.S. Department of Transportation.

These allocations cover the transit fleet, buildings, automated coin-handling systems, maintenance items, and construction. Among the new hardware items are

1. A 46 700-m^2 (52 600-ft^2) building for administration and vehicle services located between heavy transit points in downtown Ann Arbor and Ypsilanti (cost: $1.3 million, equipment included);
2. Nine $8000 transfer-point shelters for passengers moving between dial-a-ride and fixed-route vehicles;
3. Three-channel communications gear that provides for all dial-a-ride vans automatic readout of passenger addresses, voice verification facilities, and silent-alarm devices, all coordinated by a new dispatching center (cost: $497 900); and
4. Eighty-three new automatic fare boxes to mesh with a vacuum-operated coin-handling system. The combination virtually eliminates security problems between the time a passenger puts his fare in the box and its ultimate delivery to the contracting commercial bank.

The armored strongbox feeds automatically into a massive

vault at AATA headquarters. Special equipment then takes the unopened box to the bank (cost of the system: $249 500).

RELATIONS BETWEEN AATA AND CITY GOVERNMENT

Because financial resources derived both from the special 2.5-mill transportation levy and from governmental funding sources outside the city permitted expansion of the AATA, complex and unique questions emerged concerning the relationship between AATA and the city. The fundamental issue was AATA's independence.

AATA has a number of the characteristics of an independent agency. Under the state enabling legislation, the AATA exercises full corporate powers as well as certain rights of eminent domain and bonding. Moreover, AATA has a financial base derived from the 2.5-mill property tax and is the designated agency for receiving state and federal financial assistance, both for capital programs and for operations. On the other hand, the mayor and City Council have power of appointment and removal over members of the AATA's board, and the transportation millage is collected by the city rather than by AATA.

After several months of discussions and negotiations, an agreement was ratified by the City Council and AATA's board that defined in detail the relationship between the two entities. The city recognized AATA as the operating agency to provide mass transportation service to the public and designated AATA as the contracting agency for the use of the 2.5-mill tax levy designated by the charter for transportation purposes. The AATA agreed to pay the city 1 percent of the annual transportation millage in recognition of provision by the city of certain essential services, such as tax assessment and collection, review of public transit plans, and the processing of AATA materials for review by the City Council. The AATA and the city further agreed to determine annually whether any additional city services will be provided to and paid for by AATA. The AATA agreed that its budget will be submitted to the City Council each year for recommendations and comments and that the council will be informed when major AATA policy decisions are to be reached so that it can provide advice.

The following paragraph of the agreement characterizes the manner in which the two agencies expect to resolve any further questions that may arise:

> Both the City and the AATA recognize and covenant their obligation as public bodies to exist harmoniously for the public good. Disputes or conflicting interpretations of this agreement are to be resolved amicably to the extent possible through discussions and negotiations by the two bodies with efficient and equitable service to the public being the uppermost objective of both.

The AATA is deeply concerned with long-range transportation planning for the entire urban area beyond the 16.1-km (10-mile) service radius that we are empowered to serve. Our current activities in planning include

1. Membership and active participation at all levels in the Ann Arbor-Ypsilanti Urban Area Transportation Study Committee (UATS), a regional entity charged with coordinating transportation planning in the area;
2. Participation in UATS's long-range regional transportation planning effort to determine how public transit fits into the region's overall development plans;
3. Participation in the comprehensive traffic study for Ann Arbor's central area;
4. Representation on the Transportation Task Force of the Southeast Michigan Council of Governments;
5. Participation in the study program now being conducted by the Southeastern Michigan Transportation Authority for rail service between Ann Arbor and Detroit; and
6. Representation on the Transportation Research Board.

The AATA staff recently completed a fiscal year 1976-77 plan for submission to the Michigan State Department of Highways and Transportation, and longer range (5-year) capital program development plans are being finalized. This work is funded by a $25 000 planning grant through the Urban Mass Transportation Administration.

It is only proper that such an extensive effort at planning is underway at AATA. Our belief is that public transit can help shape our future in significant ways if we wish it to. One of the most basic elements of the AATA system is its flexibility and consequent capacity to learn how to improve from previous performance.

AATA's learning should improve significantly under the terms of a new $100 000 federal-local program to monitor transit attitudes and behavior of households in the ridership areas. This survey will cover people who do not become customers, as well as those who do. It is hoped that this one-year renewable exercise will become an integral part of the system's development through building on its experience.

Ultimately, what is learned may have some surprising effects. Since AATA will be using dial-a-ride ridership data to chart new fixed routes (which, under heavy use, are more cost effective), there may be a partial de-emphasis of door-to-door dial-a-ride service in some areas. As dial-a-ride and the new survey point out more fixed-route bus runs, the number of dial-a-ride vans will probably remain constant, instead of growing, with their services being diverted to more specialized uses.

CUSTOMER RELATIONS

As a public entity, AATA must depend for support on its ridership constituency. The latest sampling reveals that, while there are some problems of the sort that can be expected in a highly innovative system, the majority of present users are satisfied with their service, and an encouraging growth potential seems to be built into the exercise.

In general, it has been established that AATA services reach all citizen groups in Ann Arbor—young, old, automobile owners and drivers, and those who do not own or drive an automobile. The most serious bias in our ridership is that, while the general population is about evenly divided between females and males, our user population is approximately 60 percent female (the proportion of females is typically even higher in other cities).

AATA riders usually make the same kind of trips that automobile users do. We provide for much more than just work and school trips. We find that dial-a-ride—including evening and weekend service—serves proportionately more shopping, personal business, and social or recreational trips than does line-haul bus service. For all AATA services, traveling to or from work is still the most important trip purpose—38 percent for line-haul bus and 30 percent for dial-a-ride (school trips account for approximately 15 percent, not including school subscription service; university or college, 13 percent; shopping, 12 percent; personal business, 12 percent; social-recreational, 9 percent; and other, 4 percent.

Most of our riders are regular customers who ride by choice or for convenience; more than half ride at least once a day. However, it is also significant that on a typical day approximately 7 percent of the riders on all

our services are riding for the first time. This indicates a good growth potential and the need for a comprehensive ongoing information program.

Overall, 76 percent of our riders seem to be satisfied with AATA service; the remainder of our customers have specific complaints. The most common specific complaints (30 percent) have to do with time-related variations and irregularities in service; these variations have been the target of a major quality-control program. The customer criticism that dial-a-ride telephones are too busy (about 8 percent of our dial-a-ride gripes had to do with telephones) has been largely addressed by the purchase of automatic telephone-answering equipment. An important finding is that riders feel safe aboard AATA vehicles and have little difficulty with each other or with AATA personnel.

Recently the Ann Arbor Planning Department commissioned a survey of the attitudes of a sample of the city's registered voters toward community services and issues. AATA's ratings proved highly satisfying. Sixty percent of those asked said that AATA's service had improved significantly in the preceding year. Even more encouraging—and basic—was the finding regarding the public's willingness to continue the experiment. The survey indicated that fully 80 percent would continue to support the special tax levy that makes the system possible. Since that is a considerably higher proportion than approved the original levy, it is a good harbinger for the future of the system.

Demand-Responsive Transportation in Ann Arbor: Operation

Karl W. Guenther, Ann Arbor Transportation Authority

Ann Arbor, Michigan, has had a dial-a-ride service operating since 1971. Since passage of a special property tax for transit in 1973, dial-a-ride has expanded its role and ridership. It is now totally integrated with line-haul bus service within the Ann Arbor Transportation Authority's operation. Weekday service provides for coordinated transfers between dial-a-ride collector-distributor vehicles and line-haul buses at several points within the system. Dial-a-ride has helped the Ann Arbor Transportation Authority secure a dramatic increase in ridership over the past two years. The transit system is operating within budget. Staged incremental implementation has allowed the introduction of dial-a-ride with a relatively high degree of reliability and minimal disruption. A great deal of operational fine tuning has been done within each small implementation. Satisfactory results are being obtained with dial-a-ride vans and with a semiautomated computer-assisted dispatching system. Cost and productivity data are provided.

The dial-a-ride program in Ann Arbor, Michigan, has once again become a subject of interest in North America. This interest appears to be based on Ann Arbor's success when contrasted with the highly publicized systems in Haddonfield, New Jersey, and Santa Clara, California, which are believed to have failed. One concludes that success is defined as ongoing operation and failure as shutdown. The Transportation Research Board, the Urban Mass Transportation Administration (UMTA), the Canada Transportation Development Agency, and many local agencies are now interested in an evaluation of the Ann Arbor system. In this paper, the basic elements of Ann Arbor's dial-a-ride service, its present role in a community public transportation system, and its probable future are presented in digest form.

Those responsible for public transit at a local level would probably judge Ann Arbor's dial-a-ride program a mixed success at best at the present time. Ridership has grown rapidly, indicating good public acceptance on the whole. The system (Ann Arbor's total public transit system) has run on budget; so far there are no serious cost overruns on financial crises. The physical system of vehicles and dispatching equipment is falling nicely into place. And there is certainly no immediate prospect of discontinuing dial-a-ride in Ann Arbor.

But dial-a-ride is definitely not universally accepted as successful on the local front. Uncertainty about vehicle arrival time, telephone problems, and circuitous routings are cited as unacceptable trade-offs for the door-to-door convenience of dial-a-ride. For a few citizens, dial-a-ride results in longer travel time for certain trips than the old line-haul bus system. Fiscal conservatives continue to categorize dial-a-ride as an expensive luxury and maintain that regular line-haul bus service could serve the public more efficiently. Pressures for more street maintenance funds could reduce the system's financial support in the future, particularly if the conservative point of view prevails.

In light of this mixed success, I will now summarize the present status of dial-a-ride service in Ann Arbor. I do not suggest that other communities should imitate Ann Arbor. Information is presented here without judgment, so that the individual reader can determine the applicability of this experience.

BACKGROUND

The Ann Arbor Transportation Authority (AATA) was formed as a public authority in 1968, when private carriers became unable to provide the community with acceptable transit service. Its service area includes the City of Ann Arbor, the urbanized area of Washtenaw County, including Ypsilanti, and the rural areas 16 km (10 miles) beyond the Ann Arbor city limits in all directions.

The transit service as it operated from 1969 to 1973 consisted of six fixed routes, radiating from the Ann Arbor central business district (CBD) using headways of 30 min in peak hours and 60 min in off-peak hours. Coverage was limited to the City of Ann Arbor only, with weekday-only operation from 6:30 a.m. to 6:15 p.m. Annual operating budgets during these years were typically $400 000 to $500 000 with half of the budget derived from fares and half from the city's general fund on the basis of an annual appropriation.

In September 1971, a small dial-a-ride pilot program was undertaken with state and local funds to demonstrate the applicability of demand-responsive service in Ann Arbor. The program was successful in increasing transit use and switching some travelers from private cars to transit. The demonstration program cost of $1.74 per ride (exclusive of capital) highlighted the fact that a greatly expanded funding source would be required to

undertake additions to the dial-a-ride system.

In April 1973, Ann Arbor voters (city only) approved a 2.5-mill property tax earmarked for public transit. The margin of passage was approximately 61 percent. The tax raises approximately $1.6 million annually; this is used for the local operating budget. Citizens' groups were extremely active in the campaign on the millage issue; no professional public relations firm was used.

The system described to the citizens in the 1973 election campaign consisted of dial-a-ride service in neighborhood zones coordinated with fixed-route service on major arterial routes. That basic plan has been followed in implementing the present system.

Since 1973, the AATA has hired a new management team, expanded from 30 to 150 employees, added 80 new vehicles to the existing fleet of 20, and embarked upon a substantial facility construction program. Ridership has grown from 677 000 in the fiscal year 1972-73 (just before the election) to 1 613 700 in fiscal year 1974-75.

DESCRIPTION OF PRESENT SERVICE

The basic format of the Ann Arbor system is a coordinated combination of dial-a-ride and line-haul bus service. The weekday operating system can best be described as a large circle, or main-gear line-haul route, with satellite-gear dial-a-ride operations restricted to specific zones and coordinated with the line-haul route schedule. Dial-a-ride buses meet every line-haul bus arrival at every transfer point.

Dial-a-ride zones are operated with one, two, or three vehicles on a fixed schedule dictated by the need to meet the line-haul bus at a transfer point. There are currently seven such weekday dial-a-ride zones feeding this loop route. The loop buses operate in both directions with headways of 15 min in peak hours and 30 min in off-peak hours. CBD routing serves the retail sectors, the University of Michigan main campus, and the hospital area.

The present weekday system also includes radial routes in Ann Arbor, each slightly different in nature. All operate at 15-min peak-hour headways and 30-min off-peak headways. All serve the CBD activities mentioned above. The Miller/Huron route is a combination of local stops and an express line with two dial-a-ride zones feeding a transfer point at its extremity. The Packard route has local stops only, serving an area that has traditionally generated high ridership to and from the main campus of the university. Dial-a-ride service overlaps with line-haul route coverage in this area, but there are no coordinated transfers between dial-a-ride and the line-haul buses.

The Washtenaw route is a radial route connecting the Ann Arbor and Ypsilanti CBDs in the city's most intensely developed corridor. Some local service is provided, and there are two dial-a-ride feeder points along this route. The University of Michigan operates a free shuttle service from its north campus to its main campus, providing a fourth radial route. This is in fact Ann Arbor's most heavily used transit corridor by virtue of the captive demand. AATA service interfaces with the university's service at a principal main campus bus stop.

With the radial routes, some dial-a-ride zones actually feed two transfer points, making the weekday system more complex. There are nine outlying zones. Each zone's boundaries and connection patterns are based on local trip generators (schools, shopping centers) and geographic constraints. For neighborhoods close to the CBD there is dial-a-ride service directly to the major generators in the Ann Arbor CBD, including retail stores, the main campus of the university, and the large medical complex. These same generators are served by the downtown routing of all line-haul buses. There are currently three such "close-in" zones, with one area remaining to be implemented. Thus the total number of weekday dial-a-ride zones is 13: 7 on the loop route, 2 on radial routes, and 4 close in.

The resulting weekday system provides doorstep pickup by dial-a-ride, connections to line-haul buses serving all parts of the community and major trip generators, and doorstep drop-off into neighborhood areas after a transfer is made from the line-haul bus at a transfer point. It is thus possible with this system to reach any point inside the city limits. While full access and complete connectivity are major steps forward in community public transit that are not provided by most fixed-route systems, there are drawbacks. Travel time for some trips can be four or five times the direct automobile driving time. Thus, transit is still not time-competitive for certain crosstown (or many-to-many) trips. In addition, the system is not transparent enough to some citizens, particularly people who value certainty in all aspects of routing and scheduling. The combination of riding two types of buses and transferring, even with coordinated transfers, is too confusing.

The first of these objections can be overcome by increasing service—adding more line-haul routes or adding a many-to-many dial-a-ride capability. Neither appears to be within our financial reach at this time. The second can be addressed by a well-designed information program, which is now being undertaken. With the passage of time, as both the operators and users gain experience, the system should become more acceptable to all elements of the community.

Weekday evenings after 5:45 p.m., most line-haul route operations cease. The city is then covered by citywide dial-a-ride service dispatched through seven radial zones, all converging on the CBD. Crosstown trips are served by a single transfer at the CBD. Tours are 1 h each, with two or more vehicles per zone and effective mean headways of 30 min in each zone and doorstep pickup and drop-off. Calls are accepted until 11:00 p.m.; the last trips are dispatched at midnight.

Weekend service is also provided by citywide dial-a-ride, with Saturday line-haul bus service connecting the CBD with two major shopping centers on the edge of town. Hours are 8:00 a.m. to 6:00 p.m.

The Ann Arbor system also includes specialized service to handicapped persons that uses wheelchair-lift-equipped vans. These are dispatched as citywide many-to-many dial-a-ride vehicles. The AATA is currently receiving demonstration funds from the Michigan State Department of Highways and Transportation to provide a rural dial-a-ride service for elderly or handicapped citizens and to build and operate a CBD shuttle system.

The Ypsilanti urbanized area is provided with fixed-route service on five routes that radiate from the Ypsilanti CBD and a connection to Ann Arbor via the Washtenaw route. These services operate Monday to Friday only, with 30-min peak-hour headways and 60-min off-peak headways. There is no dial-a-ride in Ypsilanti.

The AATA also operates subscription bus service within the city limits of Ann Arbor for groups of 20 or more persons traveling in the same direction at the same time. To date, this has been primarily a school-related service. The AATA has always included plans for home-to-work subscription service but has not had the resources available to implement that service so far.

Fares on all AATA services are basically 25 cents. All transfers are free. Individual unlimited-use monthly passes are sold for $10; household passes are sold for $15. All elderly and self-certified low-income persons qualify for half fare, which is administered by selling 10 tokens for $1.25 and passes as described

above for $5 or $7.50 per month.

IMPLEMENTATION STRATEGY

Unlike some of the more dramatic systems, the AATA has implemented its services slowly. Each new dial-a-ride zone has been phased in according to a plan adopted in 1973. While the coverage has been only slightly modified, the dates have been continually pushed back so that the full plan described at the time of the April 1973 election was not in place until almost three years later. Following is a brief rundown on service changes since the vote on the millage issue passed, starting with the system as it was in spring 1973, i.e., six line-haul routes and one pilot dial-a-ride zone.

July 1973
- Decrease in fares to 25-cent flat rate (from 35 cents on line-haul bus and 60 cents on dial-a-ride).

September 1973
- Expansion of school subscription service.

October 1973
- Withdrawal of fixed route in original dial-a-ride area and institution of a new fixed route to the Briarwood shopping center (this eventually became part of the loop routes).

November 1973
- Launching of citywide dial-a-ride for handicapped persons.

December 1973
- Launching of citywide evening and weekend dial-a-ride service.

March 1974
- Beginning of fixed-route service in Ypsilanti (not part of the plan funded by the Ann Arbor property tax).

January 1975
- Beginning of Northside weekday dial-a-ride zone (two vehicles).

March 1975
- Withdrawal of Northside local line-haul bus, extension of the loop route to Plymouth Mall, and institution of Northside coordinated transfer service and the original southwest dial-a-ride sectors.

June-July 1975
- Phasing in of southeast dial-a-ride in four incremental zones (eight vehicles) over a 6-week period, revision of the Washtenaw route to avoid duplication, and completion of the express loop route.

August 1975
- Addition of Plymouth (far-northeast) dial-a-ride zone (three vehicles) and withdrawal of local line-haul bus.

September 1975
- Addition of 15-min service on Packard and Washtenaw and a fifth local route in Ypsilanti.

November 1975
- Addition of far-northwest dial-a-ride zones (three vehicles) and increase in the frequency on the Miller/Huron route to 15 min during peak hours.

January 1976
- Addition of near-northwest dial-a-ride zones (six vehicles in two stages).

March 1976
- Completion of the weekday dial-a-ride with addition of the near-southeast zone (three vehicles).

The reason for such painstakingly slow implementation was to permit us to fine tune, correct, and modify each area before proceeding to the next. New staff members can only be hired and trained at the rate of three to four persons per week. Equipment deliveries (vehicles, radios, and telephones) have often governed implementation dates, particularly the long delays between March 1974 and January 1975. Even at this slow rate, there is criticism from within the organization that we are often not polished enough before proceeding to a new area. The operating staff and the union are usually interested in delaying each step in implementation as long as possible in the interest of quality control. Thus, the management of change and rapid expansion emerges as a major area of concern.

The disadvantages of staged implementation include inequitable service delivery: All citizens pay taxes from the outset but do not receive service at the same time. Another is the loss of enthusiasm and momentum from the high point of the April 1973 victory to the reality of delays. However, all things considered, it can be argued that the benefits of staged implementation have outweighed the costs. Certainly Ann Arbor's services, while not perfect, are operating at a better level of quality than some in other areas that had more dramatic all-at-once implementations.

OPERATING DATA

Ridership on the AATA system has grown as follows:

Year	Passengers	Year	Passengers
1971-1972	582 240	1974-1975	1 613 700
1972-1973	677 500	1975-1976	2 100 000
1973-1974	1 100 000		

A typical passenger count by category for fall 1975 follows:

Originating Fare Service	Passengers
Ann Arbor lines	4300
Ypsilanti lines	800
Ann Arbor dial-a-ride	1700
School subscription	400
Total	7200

There is a problem with an integrated system in apportioning ridership to line-haul or dial-a-ride, since many trips use both services. At the present time we do not count transfers and we count fares on the originating service. Thus, a trip with dial-a-ride pickup and transfer to an express bus is counted as a dial-a-ride trip, and a trip started on a line-haul bus with a transfer to dial-a-ride is counted as a line-haul bus trip. Approximate dial-a-ride volume at the present time (October 1975) is 3000 daily trips with 1700 booked through dispatch and the remainder as walk-ons or transfers from line-haul buses. The current modal split for AATA in Ann Arbor (city only) is approximately 2.5 percent of 24-h weekday trips.

On-board surveys conducted in February 1975, show that ridership on dial-a-ride approximated the community's age profile and had the following other characteristics:

Item	Percent
Regular riders (twice a week or more)	46
Riders by choice (have option for trip made)	50
Sex	
Female	64
Male	36
Trip purpose (typical weekday)	
Work	29
School (including university)	18
Shopping	24
Personal business	13
Social-recreational	11
Other	5
Dial-a-ride eliminated need for automobile trip (either driving or riding)	60

The AATA has not been able to measure the reliability of the overall system in any meaningful way. Field checks at transfer points show that more than 90 percent of the scheduled coordinated meetings are achieved according to timetable and more than 95 percent are accomplished by delaying vehicles through the use of two-way radios. Recent dial-a-ride dispatching accuracy is estimated at 98 percent; that is, fewer than 3 percent of the called-in orders fail to get dispatched properly.

However, these statistics are very crude and are not derived from a large sample base. There also remains a level of customer expectation that is difficult, if not impossible, to achieve with the dial-a-ride element of our service. People will accept a missed line-haul bus but not a missed dial-a-ride. The personal element in placing an order implies a contract that is broken if the dial-a-ride van fails to pick the customer up at the promised time. Our evidence suggests that, while fewer than 5 percent of the patrons missed by a line-haul bus will call or write in a complaint, more than 50 percent of the dial-a-ride patrons will. Thus, the achievement of high operating reliability becomes extremely important with dial-a-ride, and we are continually placing a great deal of emphasis on quality control in our management system. This places extra responsibility on drivers, dispatchers, and first-line supervisors.

For fiscal 1974-75 the AATA services operated at the following average productivity:

Service	Passengers per Vehicle-h
Ann Arbor	
Line-haul service	25.6
Daytime dial-a-ride service	9.5
Weeknight dial-a-ride	5.9
Saturday dial-a-ride	6.7
Sunday dial-a-ride	7.5
Ypsilanti line-haul service	5.5

FINANCIAL DATA

The total activity and budget levels for fiscal years 1973-74, 1974-75, and 1975-76 are shown in Table 1.

The projected operating income for fiscal year 1975-76 is as follows:

Source	Amount ($)	Percentage
Millage (city property tax)	1 660 000	47.2
Purchase of service agreements	69 000	2.0
Fare-box revenue	525 000	15.0
Cash surplus, interest, and miscellaneous income	199 000	5.7
State operating assistance	436 444	12.4
Federal operating assistance	438 424	12.5
Demonstration and other grants	184 000	5.2
Total	3 511 868	

The projected operating expenses for fiscal year 1975-76, including projected demonstration services, are as follows:

Item	Amount ($)	Percentage
Operation, wages, and fringe benefits for drivers, dispatchers, and supervisors	2 135 216	60.8
Equipment, including wages and fringe benefits for service employees, mechanics, and supervisors	407 377	11.6
Vehicle operations (fuel, parts, supplies)	460 055	13.1
Management and administration, including wages and fringe benefits	217 736	6.2
Consulting and planning (not staff)	10 536	0.3
Services, supplies, overhead	280 948	8.0
Total	3 511 868	

Since passage of the property tax in April 1973, the AATA has been very successful in obtaining federal and state capital grants (in proportions of approximately 4 to 1 respectively). Without this support, the AATA could not be undertaking its present program. Less than $500 000 in local funds has been expended on capital improvements since 1973. The state and federal grants received total approximately $5 153 000. Not all equipment has been delivered and installed at the time of this writing, nor is the total construction program complete.

Items purchased on grants from UMTA and the Michigan State Department of Highways and Transportation include 14 new transit coaches, 5 used transit coaches (100 percent state funding), 48 dial-a-ride vans, and 12 dial-a-ride vans with wheelchair lift (seven with 100 percent state funding); fare collection and processing equipment for 94 vehicles; communications and dispatching equipment; land, garage, offices, and design and construction of new storage and repair facilities; shop tools and equipment; and service vehicles.

HARDWARE

The 110 vehicles (including those on order) in the AATA system include several sizes and types.

Vehicle Type	Capacity	Number	In Use Now
Dial-a-ride van	12 to 14	64	36
With wheelchair lift		12	
9-m (30-ft) transit coach	28 to 33	12	
10.5-m (35-ft) transit coach	40 to 45	20	17
12-m (40-ft) transit coach	53	3	
Conventional school bus	42 to 66 (children)	11	

The AATA has decided to standardize on two sizes of vehicles in future purchases: 12- to 14-passenger vans for dial-a-ride work, and 10.5-m (35-ft) 40-passenger transit coaches for line-haul and subscription work. As older equipment is replaced, the fleet makeup will reflect this standardization.

A review of other demand-responsive transportation systems suggests that operators have not been totally satisfied with the vehicles used. Ann Arbor has been successful in developing a procurement procedure and maintenance program that makes our dial-a-ride vehicles reliable in operation, comfortable and safe for passengers, and low in maintenance costs.

Ann Arbor has operated vans in dial-a-ride service since 1971. The oldest units (1969 model year) accumulated close to 320 000 km (200 000 miles) before retirement. The vans in the present fleet date from 1973 to 1975. They are top-line compact vans, with a high-quality conversion that provides higher roof placement for adult standing headroom, a driver-operated passenger door with a very low step, and a high-quality interior trim and seating arrangement. The base van is the heaviest available with all possible options to make the van better suited to stop-start duty cycles (highest capacity suspension, over-sized cooling capacity, and largest

brakes). The conversion itself strengthens the base structure of the vehicle.

The first step in achieving the objectives of reliable, safe, and economical vehicles is writing the proper specifications. The current AATA specification is an extremely detailed, precise document that has been developed through four procurement cycles. Each time the AATA issues a vehicle specification, it is a reflection of the operating experience with past vehicles and with the bids received in the past cycle. All recent AATA vehicle procurements have been with UMTA capital grant and state grant funding, which requires approval of the specification by UMTA and competitive bidding. On the average, three bids have been received. When the low bidder has been nonresponsive, UMTA has concurred in the AATA's decision to award the contract to a higher bidder.

Once a vehicle is delivered, routine maintenance and servicing become the important determinants in reliability, safety, comfort, and operating economy. The AATA's maintenance operation is geared to provide high operating availability and low cost per kilometer or per operating hour. Little emphasis is placed on the life of components per se, since the important thing is to anticipate problems and replace or repair components at the lowest cost and down time.

It is necessary to recognize at the outset that the philosophy of van maintenance is vastly different from that found in most transit organizations. One must overcome the natural resistance to automobile-quality components and frequent minor repairs. If a good preventive maintenance check can be developed, and if the maintenance employees can be motivated to perform minor repairs and adjustments at that time, good in-service reliability can be achieved. Proof of the value of this approach is found in the statistics on comparative operating costs produced by our computerized fleet-analysis program and shown in Table 2.

Table 1. Activity and budget levels.

Item	Fiscal Year 1973-1974[a]	1974-1975[a]	1975-1976[b]
Total operating cost, $	1 232 746	2 157 000	3 511 868
Fare-box revenues, $	272 000	398 000	525 000
Cost per service hour, $	17.61	19.97	18.76
Cost per passenger, $	1.12	1.34	1.67
Cost per kilometer, $	1.00	0.83	0.83
Ridership, all services except demonstration programs	1 100 000	1 614 000	2 100 000
Kilometers traveled, all services	1 230 700	2 612 800	4 211 200
Service hours	70 000[c]	108 000	187 000
Buses	35	78	110
Total staff	100	137.5	235.5
Drivers[d]	59	82	150
Dispatchers[d]	6	18	30
Bus counselors	12	14	13
Maintenance	10	18	25
Administration/management[d]	13	15.5	17.5

Note: 1 km = 0.6 mile.
[a]Actual. [b]Projected. [c]Estimated. [d]Stated in numbers of full-time equivalent employees.

Contrary to conventional wisdom, the Ann Arbor experience suggests that vans are more economical to operate than regular diesel coaches and are no more prone to repairs or heavy investment of maintenance time. However, these results cannot be achieved by purchasing any random vehicle on a low first-cost basis or by trying to add a few small vehicles to a predominantly transit-coach-oriented maintenance program.

The dial-a-ride dispatching system is based on the zone structure and tour timetable described earlier. Any incoming request for service can be filed according to a zone name and tour time. The orders so filed constitute a tour roster that can then be dispatched to the vehicle. The electronic hardware employed to assist dispatchers with taking orders, filing, and organizing the communications to the vehicles consists of a processor, storage, peripheral equipment, and the interface units connected to the radio channels. The processor is a 16-bit word-length minicomputer with 48K work-core storage and 1-million-word disc-cartridge backup storage. Cathode ray tube (CRT) terminals with keyboards provide the means of local input of information to the system, and local printers provide various hard-copy logs of the daily transactions handled by the system.

The basic functions of the system are the automatic assistance in order taking and the associated dispatcher functions. In addition, there is provision for supervisory facilities with respect to start-up, organization, and off-line procedures. Order takers use the CRT terminals to write either regular (immediate) orders, advance orders (later pickup), or standing orders (regular pickup on a repetitive basis). Dispatchers can perform all order-taking functions, as well as editing, sequencing, organizing, and dispatching tours. This includes the ability to move an order to another tour and to delete orders. A master tour display is used to check rosters of tours that remain to be dispatched. The dispatching CRT terminals also display digital status messages sent from vehicles. The supervisory console can perform all of the above functions, as well as check system status, reassign buses to tours, and amend the master tour files.

The radio system uses two-way base and mobile radio equipment operating on three channels in the ultra high frequency spectrum. This system includes mobile fixed-message reporting equipment, mobile selective calling, and mobile data display equipment, as well as two-way voice equipment. This combination in each vehicle permits information to be entered directly from the buses into the central system, identifying vehicles and displaying their status on the CRT for the dispatcher's attention. In the other direction, address lists (tours) are transmitted under computer control and displayed in the buses on the light emission diode display for the driver's attention.

THE FUTURE

Dial-a-ride service has a definite ongoing role in the AATA program. Our 1990 plan, just completed this year, calls for an extension of the coordinated dial-a-

Table 2. Comparison of operating costs.

Type of Vehicle	Number	Operating Time (mo)	Costs ($/km) Fuel and Oil	Maintenance and Repair	Total	Avg km/ Vehicle	Repairs/ Vehicle	Mechanic h/ Vehicle/yr	Fuel Consumption (km/liter)
1973 van	4	12	0.0760	0.0823	0.1583	121 000	74	780	3.1
1974 van	10	10	0.0763	0.0283	0.1046	56 000	38	660	3.0
1970 45-passenger coach	4	12	0.1245	0.2227	0.3462	225 000	84	934	1.9
1975 45-passenger coach	11	6	0.1293	0.1307	0.2600	32 000	30	798	1.8

Note: 1 km = 0.6 mile; 1 km/liter = 2.4 miles/gal.

ride/line-haul bus concept to all parts of the urbanized area. This will of course require additional sources of local funding, either similar to the City of Ann Arbor property tax or a regional replacement of that tax. There is a feeling among those responsible for formulating the 1990 plan, including elected officials, that the doorstep service provided by dial-a-ride is an important part of an increasing emphasis on public transit (and away from private vehicles). There is also a role envisioned for dial-a-ride in providing rural transportation for people with limited mobility in AATA's service area.

However, in the matter of relative emphasis, Ann Arbor follows quite closely the thesis presented by Ward (1). If dial-a-ride is successful in increasing the level of demand, new fixed-route services will be justified and the relative importance of dial-a-ride, in terms of number of riders and number of dollars allocated, will decrease in comparison with line-haul service. There are now plans for adding fixed-route service in established dial-a-ride areas during 1976-77, as well as to add five major new regional fixed routes over the next five years.

For the short term, the emphasis in expansion will be on fixed-route services, with dial-a-ride expansion depending very much on the commitment of additional local funds by other government units (or their citizens) than the City of Ann Arbor.

In keeping with current UMTA planning guidelines, AATA is also emphasizing increases in capacity through other means, such as bus-priority programs, that do not require capital expenditures.

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Dial-A-Ride in the Context of Demand-Responsive Transportation: A Critical Appraisal

William F. Hoey, Wilbur Smith and Associates, New Haven, Conn.

Dial-a-ride service has become one of a number of possible demand-responsive small-bus transportation systems. A comparison of several systems suggests that a well-marketed fixed-route bus system can be far more cost effective than dial-a-ride in low-density areas. The concept of demand-responsive public transportation should be broadened to include well-planned fixed-route transit. Dial-a-ride appears to have greater value for special-need groups (e.g., elderly, handicapped) and at times when fixed-route transit would be uneconomical. Better integration with fixed-route elements is essential.

Demand-responsive transportation began in the late 1960s as an early-action transit improvement that used available technology. It was thought that transit access time and operating costs could be reduced, particularly in low-density residential areas, by substituting demand-actuated vehicles for conventional vehicles on fixed routes and fixed headways. Early studies suggested that dial-a-ride could be efficiently substituted for any bus service on which it was only economical to operate at headways of more than 20 min (1, Vol. 1, pp. 60-64, Vol. 3, pp. 84-143). Computer-assisted on-line monitoring and dispatching were expected to minimize waiting time and ensure efficient use of vehicles.

OPERATING EXPERIENCE

In operation, demand-responsive transit has compiled an impressive record of public service and continued growth. Pioneering successes in Ann Arbor, Michigan, and Batavia, New York, were expanded and copied. Canadian cities such as Regina, Saskatchewan, and Bay Ridges, Ontario, found dial-a-ride to be more successful than fixed-route buses.

These successes were achieved in communities that were able to pay relatively high subsidy costs. (The "profitable" Batavia B-Line was, until recently, cross-subsidized by a school-bus contract.) Tables 1 and 2 compare seven typical dial-a-ride services. The most cost effective of these require a subsidy of about $1.25 per passenger. Lower subsidies are reported for some dial-a-ride operations in Michigan (6, 7), all of which are small-scale operations with manual dispatching and van-type vehicles.

Weekday ridership ranges from 1 to 3 percent of the population of the service area. Dial-a-ride service conducted by large franchised transit operators has proved extremely expensive because of long-established work rules. The Haddonfield, New Jersey, demonstration was costing $3.50 per passenger after two years of operation by Transport of New Jersey (8). A dial-a-ride bus service in Richmond, California (operated by the well-managed Alameda-Contra Costa Transit District), required about $3.45 per ride in subsidy. The Santa Clara County experimental dial-a-ride, now abandoned, was costing $2.92 per passenger in subsidies from the transit district. Free taxi service to needy persons would be less costly to the public than these high-cost operations.

Few dial-a-ride users have selected the service in preference to a personal automobile. In Haddonfield, rider surveys (9) found the following characteristics:

Characteristic	Percent
No driving license	56
No personal automobile	68
No automobile available for trip	83
Age of passenger	
65 or over	13
45 to 64	30
25 to 44	22
15 to 24	27
14 or under	9
Alternative travel mode	
Drive automobile	11
Ride in automobile	15
Taxi	15
Bus (fixed-route)	20
Walk	10
Other	5
Would not make trip	12
Energy crisis (long lines at gas stations) influenced trip	17

Senior citizens and handicapped people benefit from the door-to-door feature of dial-a-ride. Members of one-car families use the service when the family car is required for getting to work. Analysis of the early ridership on the Haddonfield dial-a-ride established that households with no automobile were the most likely sources of riders. Haddonfield ridership increased

when a fixed-route shuttle service was inaugurated late in 1973 and decreased when the shuttle was transferred to operation by Transport of New Jersey to make more buses available for the dial-a-ride operation.

The many-to-may dial-a-ride van is inherently a low-occupancy vehicle. Of the systems cited in Table 1, only the Batavia B-Line exceeds 10 passengers/h, and that figure includes peak-hour subscription service. The Haddonfield demonstration averaged 6.2 passengers/h (6). However, peak-hour productivity was only about 8 passengers/h. In contrast, the Westport Minnybus fixed-route bus system, operating on 35-min headways in a community with only 463 people/km^2 (1200 people/mile^2), averages 19 rides/bus-hour. In Haddonfield, the fixed-route shuttle was the most productive element in the dial-a-ride system. The many-to-many operation, even with fairly long runs, seems to preclude high productivity.

One of the major problems with the Haddonfield and Santa Clara dial-a-ride services was response time.

Table 1. Comparison of general features of seven dial-a-ride systems.

System	Population	Area (km^2)	Gross Density (people/km^2)	Type of Service	Vehicles		Average Weekday Rides					
					Active (peak)	Spare	All	Per Vehicle	Per Vehicle-Hour			Per 100 Persons Served
									Base	Peak	Both	
Ann Arbor initial (2)	6 500	3.6	1800	Many to few	3	0	214	70	—	—	8	3.2
Batavia B-Line (2)	18 000	14.1	1300	Many to many[a]	0	0	340	49	9	14	13	2.0
Dover Senior Surrey (2)[b]	27 000	54.0	500	Many to many	4	0	210	43	—	—	7	12.4
Haddonfield dial-a-ride (3)	40 000	28.0	1400	Many to many[c]	18	1	925	51	5.2	6.0	5.4	2.3
La Habra dial-a-bus (2)	47 000	18.0	2600	Many to many	6	1	450	75	—	—	5 to 7	1.0
La Mirada dial-a-ride (4)	32 000	15.4	2100	Many to many	5	2	350	70	—	—	6	1.1
Westport Minnybus (5)	27 000	56.5	500	Fixed route	8	1	2000	222	10 to 30	20 to 40	19	7.4

Note: 1 km^2 = 0.39 mile^2.

[a]Subscription service in peak hours.
[b]Information derived in part from telephone conversation with Don Hodge, Assistant City Manager, Dover, Del., June 2, 1972. Only senior citizens (over age 65) can use the service, which covers the city's corporate limits only; there are approximately 1700 eligible users.
[c]Many-to-one service in peak hours.

Table 2. Comparison of financial features of seven dial-a-ride systems.

System	Fare ($)		Avg Revenue per Ride ($)	Driver's Wage/h ($)	Estimated Operating Cost/h ($)	Estimated Annual Financial Data ($)			Annual Rides	
	Basic	Senior				Operating Cost	Revenues	Deficit	Total	Per $1000 Deficit
Ann Arbor initial (2)	0.60	—	0.34	4.40	14.60	100 000	20 000	80 000	53 000	600
Batavia B-Line (2)	0.60[a]	—	0.50	3.50	10.00	225 000	53 000	172 000	106 000	620
Dover Senior Surrey (2)[b]	—	Free	—	3.00 to 3.80	8.40	63 000	0	63 000	52 500	833
Haddonfield dial-a-ride (3)	0.80	0.40	0.68	6.00[c]	21.66	1 200 000	150 000	1 050 000	300 000	285
La Habra dial-a-bus (2)	0.50	0.25	0.39	3.12[d]	10.00	225 000	50 000	175 000	140 000	800
La Mirada dial-a-ride (4)	0.25[e]	—	0.22	3.00[c]	8.00	150 000	24 000	126 000	110 000	873
Westport Minnybus (5)	0.50[f]	15.00/yr	0.15	4.20	12.00	350 000	100 000	250 000	600 000	2400

[a]Fare is 40 cents on a subscription basis. [b]See footnote b to Table 1. [c]1974. [d]1973. [e]Free service to shopping center. [f]Reduced rates with purchase of pass.

Table 3. Outline of a general concept of demand-responsive transportation.

Population	Typical Attractions	Time of Operation	Type of Service
Persons in low-income or high-density areas	Hospitals, transportation centers	10 p.m. to 6 a.m. and Sundays	Dial-a-ride, many to few
	Restaurants, shopping centers, professional offices	6 a.m. to 10 p.m. (fixed headway)	Fixed route
	Public buildings	6 p.m. to midnight and Sundays	Dial-a-ride, few to many
	Industrial areas	Shift changes only	Fixed route (subscriber)
	High-income homes (for domestic jobs)	8 to 10 a.m. and 2 to 4 p.m.	Fixed route
Senior citizens	Senior centers, downtown	10 a.m. to noon	Dial-a-ride prebooked
	Shopping centers, movies, theaters, hospitals, medical offices	Noon to midnight and Sundays (fixed headways)	Dial-a-ride, many to few, few to many
Children 7 to 17	Schools, movies, theaters, shopping centers, playfields	1 to 6 p.m. (fixed headway)	Fixed route
Commuters to CBD jobs	Downtown, railroad station, express bus terminal, rapid transit station	7 to 9 a.m. and 5 to 7 p.m. (to fit train schedules or work hours)	Fixed route (subscriber)
Employees at large establishments	Large employers	a.m. and p.m. peaks	Fixed route
Spouses of people driving to work, one-car families	Shopping centers, movies, theaters, public buildings, offices	8 a.m. to 6 p.m. (fixed headway)	Fixed route
	Hospitals, universities and colleges	6 a.m. to 8 p.m. (fixed headway)	Fixed route
Handicapped (wheelchair or other mobility problem)	All accessible places (i.e., without architectural barriers)	24 hours	Dial-a-ride, many to many
Workers and visitors at major trip generators	Shopping, restaurants, public buildings, transportation terminals, offices, exhibitions or events within CBD or activity center	All hours of activity center (fixed headway)	Fixed route
All others	All others	24 hours	Taxi (individual or shared)

Although waiting time can be brought down to 20 to 30 min by good management and adequate telephone answering capacity and dispatching staff, there remains an irreducible uncertainty in predicted pickup time for the potential passenger. In Haddonfield, the response time ranged from 6.9 min early to 17.5 min late. About 32 percent of the pickups were outside these limits. This variability is less the fault of the driver than that of the passengers themselves.

Some passengers are waiting at the curb when the bus arrives. The bus is stopped only 10 or 15 s and may therefore arrive early to pick up a subsequent passenger. At the other end of the scale, an elderly person waiting in a high-rise apartment may have to wait for an elevator to get down to ground level and may need driver assistance in boarding the vehicle. Stop time can range from 2 to 5 min. Family groups using the dial-a-ride may have to get themselves together while the bus is waiting, with similar delaying effects. Walk-on passengers (those who hail the bus) cause delays because the driver has to relay the ride request to the control room and confirm that he can fit the desired journey into his tour before accepting the passenger. In Haddonfield, 15 percent of the passengers were walk-ons.

These uncertainties are built into the concept of dial-a-ride and cannot be removed by better computer algorithms. (A good dispatcher in a small community, however, can compensate if he gets to know his regular customers' patterns of punctuality.) In short, dial-a-ride buses are second in choice to private automobiles, serve only the captive portion of the traveling public, are inherently less reliable in keeping schedules than fixed-route buses, and require higher subsidies than fixed-route (or shared-taxi) transit services. Most of these weaknesses were predicted in the initial analysis of the concept for the U.S. Department of Housing and Urban Development in 1968 (1, Vol. 1, pp. 60-64, Vol. 3, pp. 84-143).

REDEFINING DEMAND-RESPONSIVE TRANSPORTATION

Dial-a-ride buses, which have received most of the publicity, are logically only one aspect of demand-responsive transportation. Shuttle service, subscription buses, and even well-planned fixed-route transit services should be considered demand responsive. The main requirements for demand-responsive transit should be as follows.

1. A demand-responsive transit system should take people where they want to go, when they want to go there, unconstrained by historic street-car franchises or utility-commission running rights.
2. Small buses should be used when necessary to penetrate residential areas and minimize walking distances. Large buses should be used as needed for complementary high-volume trunk-line services or bus pools.
3. Different kinds of routes should be operated, varying as required from hour to hour and day to day.
4. Continuing market research should be employed to find out what potential passengers want in the way of service.
5. Fixed, easily memorized headways should be used only if these are consistent with passengers' needs. For example, it is usually more important to dovetail with the working hours of employers, beginning and ending times of after-school activities, commuter railroad timetables than to run a bus every 20 or 30 min.

In this respect, demand-responsive transportation is not just dial-a-ride service or even a taxi. It is a philosophy of managing and operating a bus system to serve consumer and social needs. Within this broad concept, the emphasis should be on predictable fixed-route services with good public information (maps, schedules, route identifications). Dial-a-ride service can be an important supplement to fixed-route operations, although in many communities taxicabs rather than bus operators should supply the dial-a-ride service.

The needs of different population groups should be identified and distinguished. A tentative classification of groups and needs is presented in Table 3.

The demand-responsive concept outlined in Table 3 has the following characteristics.

1. It focuses on concentrated centers of activity and high-density or low-income residential areas.
2. It distinguishes people who can walk and wait from people who usually can't (the elderly, the handicapped, or those who live in high-crime neighborhoods).
3. It uses the taxicab to fill gaps in the fixed-route and dial-a-ride bus services, such as the need for low-density many-to-many travel.
4. It uses dial-a-ride when personal door-to-door service is important and time is not critical (the elderly, the handicapped, and owl service).
5. It runs fixed-route services to meet high-volume travel needs (e.g., to meet the shift changes at a large industrial plant).
6. It provides some sort of public transportation (fixed route, dial-a-ride, or taxi) at any time of day to all parts of its service area.

In the past few years a great deal has been written in the transit trade press about free transit or fare reductions. Yet impartial studies (7) have shown that quality and reliability of service are more important than fares. Effective demand-responsive transportation service can charge patrons a dollar a ride and yet allow them to travel for less than the annual cost of insuring a second or third family car. Discount fares have a place in promotion or to make service accessible for the elderly or for economically disadvantaged people. Family passes can attract groups of people away from the private automobile, as they have in Westport. However, the rider who uses public transit only when his car is being tuned should pay full value for the service. Selling public transportation at too cheap a price leads to overcrowding and deterioration of service. The successful Davenport-Moline and Little Rock dial-a-rides charge a $1.00 fare (8, p. 21). The failed Santa Clara County service charged 25 cents.

More important than the price of the fare is the way it is collected. A pass system like that used in Westport or a credit card system like that developed for Valley Transit District in Connecticut is far more desirable than cash fares, which increase overhead and necessitate a choice between exact fares and the risk of driver cheating and fare-box robberies. Regular bus users should have prepaid discount fares, and fare boxes should be for occasional use only.

The type of vehicle needed by demand-responsive transportation varies. However, if the vehicles are to be running all day, every day, the economies in fuel, maintenance, and service life of the diesel engine will usually outweigh the lower initial costs of gasoline-powered vehicles. There is no diesel-powered taxi manufactured in the United States, and small diesel-powered buses are only now beginning to be offered by domestic manufacturers. Problems with vehicle maintenance and unreliability have plagued the Haddonfield

and Valley Transit District demonstration projects (among others). For example, on one day in March 1973, only one of seven Valley Transit District buses was operational. While awaiting the delivery of new Grumman vehicles, that district is operating some of its dial-a-ride routes with standard four-door sedans.

ROLE OF DIAL-A-RIDE

Dial-a-ride began life as an innovative theoretical concept intended to solve the problem of efficiently providing public transport in low-density suburbs. In the past decade, the mechanics of operating dial-a-ride service have developed. Computer dispatching programs have been field tested. Experience has been gained. Dial-a-ride has proved a feasible transportation alternative.

Simultaneously with developing the practical technology of dial-a-ride, we have learned—or should have learned—its limitations. It is a low-capacity, labor-intensive, personal-service travel mode. It works best on a small scale—either in a small community or when limited to small areas or selected needy population groups. Fixed-route service with a longer headway than the average dial-a-ride waiting time can be more attractive to passengers if it is more reliable.

Fixed tour times and prebooking of dial-a-ride services (at least one hour in advance) tend to improve reliability. In Canada, they have not been a handicap to development of patronage. For homeward journeys, regular-interval scatter or zone services from a shopping center or hospital may be preferable to requiring a telephone booking for each trip. In the context of small-area personal dial-a-ride services, computer dispatching technology may best be applied to fairly large taxi systems.

In short, we now know that dial-a-ride will work (with good planning and good management). The problem we now face is in using it effectively in the developing broader context of demand-responsive transportation.

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Part 2
Demand-Responsive Transportation Systems

Transit Planning in a Small Community: A Case Study

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This paper describes strategies for estimating potential markets for transit or paratransit service, developing a potential set of transit system concepts, estimating demand for each of a selected subset of concepts, developing an evaluation process, and selecting an implementation strategy. The case study has shown that there is considerable value in conducting limited, small-scale surveys of specific market segments as well as in developing a wide variety of system concepts in order to permit an effective choice among possible systems. An extensive educational effort is needed for the community participants in the process as well as broad-based community representation throughout the process.

This paper records the experience of a transit planning team in its attempt to apply recent research developments and operational concepts to an actual situation. The current emphasis on low-capital highly flexible market-oriented systems and the development of paratransit concepts have created a need for new approaches to planning, new techniques to carry them out, and consideration of alternatives to fixed-route systems. The classical approach no longer suffices.

Methods for estimating the potential demand for a proposed transit service have not adequately reflected service factors that differentiate among the alternative modes available. Generation of alternative systems and their evaluation have often failed to include active, structured community participation. The management concepts that are needed to handle these more complex systems while meeting a variety of related community goals are just beginning to gain consideration.

This project had as its primary objective to define for a community of 70 000 people a public transportation system that could provide the level of service required to meet physical, social, and economic goals. The study framework is shown in Figure 1. The tasks were designed and arranged to maximize participation by the community and to assure complete consideration of a wide variety of potential transit services in alternative forms of system integration.

The study was conducted for the villages of Schaumburg and Hoffman Estates, Illinois, two adjacent and intertwined suburban communities located about 40 km (25 miles) northwest of the Chicago central business district (CBD). In 1975 the study area encompassed a population of 69 000 and had an employment level of 26 000 jobs. Projections to 1985 show a population of 135 000 and employment of 71 000. The area is characterized by a scattering of trip attractors. There is no CBD for either village, nor is it intended that one be developed. In addition, two railroad commuter lines (the Chicago and North Western Railway Company to the north and the Milwaukee Road to the south) are used by the residents, primarily to get to and from work in the Chicago CBD. Neither of these lines has stations in the villages. A major junior college is adjacent to the study area.

Present public transportation within the study area is extremely limited. Taxi companies serve several of the suburban communities in the area. A school-bus company also provides limited peak-period service on a fixed-route basis to one of the commuter railroad stations. Demand-responsive transportation is available to handicapped persons through a program administered by the office of the township supervisor.

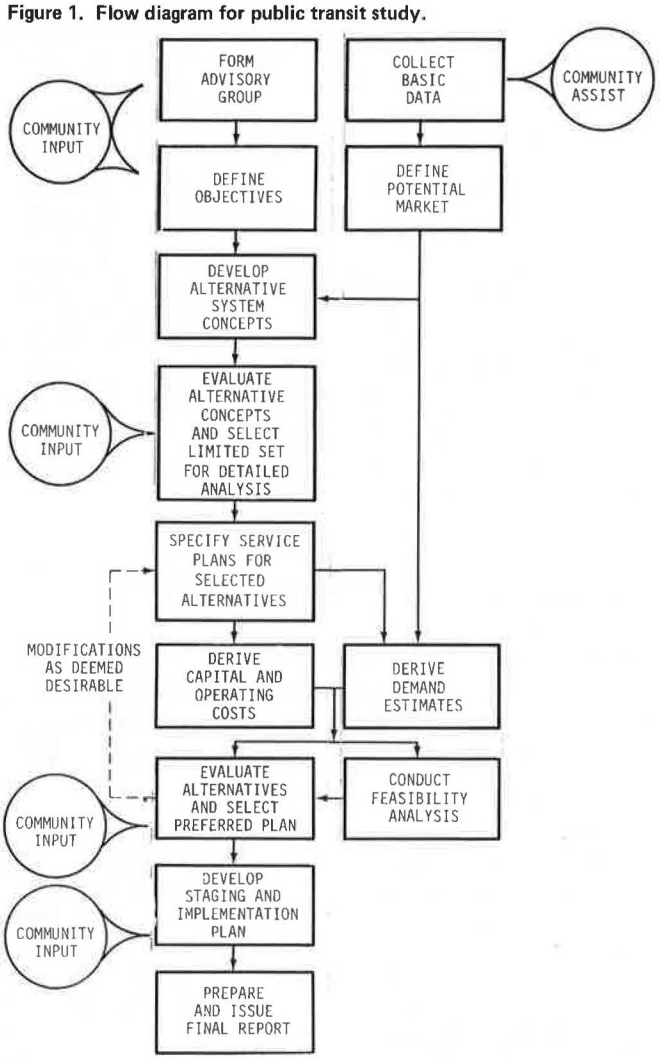
Housing consists primarily of single-family dwelling units. Most growth, however, will be in the form of high-density apartment complexes. According to the 1970 census, there were about 16 600 households in the study area. The average household income at that time was $15 600. More than 25 percent of the population was under age 15, and 2 percent was over age 65. There are a large number of multiple-car families (only 3 percent of the households had no automobile available and half owned two automobiles) and an even larger number of licensed drivers (45 percent of the households had more drivers than automobiles). Consequently, trip patterns are generally dispersed both in space and time over the area of approximately 11.3 by 9.7 km (7 by 6 miles).

MARKET ESTIMATION

Surveys were performed to assist in identifying the sizes and characteristics of the various markets to be served

*Mr. Pfefer was a staff member and Mr. Stopher was a consultant of Jack E. Leisch and Associates, Evanston, Illinois, when this research was performed.

Figure 1. Flow diagram for public transit study.



in the community. The primary market segments surveyed were rail commuters (those who work in the Chicago CBD), internal commuters (those who live and work in the community), and shoppers (residents shopping in the community). A number of other market segments were also identified but were not considered appropriate for the survey work. Hand-out, mail-back questionnaires were designed and distributed for each of the three markets. A sample survey is shown in Figure 2.

The rail commuter survey resulted in 1891 returns, 639 of which were from residents of the study area. The internal commuter survey produced 3355 returns, with 1377 from study-area residents. The shopper survey resulted in 1579 returns, 958 of which were from residents. Table 1 summarizes the general findings of the three surveys.

The surveys showed that the internal commuters and shoppers, neither of whom have any bus service currently available, had a low level of interest in using a bus. In contrast, rail commuters, for whom limited bus service is already provided, showed a higher willingness to use the bus under any conditions. Also, walking distance was found to be more important than in-vehicle time. Most respondents who would use a bus even if it took longer would be willing to take it even if it took almost twice as long as the car (10 to 14 min longer compared with the average travel time of 13 to 17 min).

Table 1. Summary of survey findings.

Item	Rail Commuter	Internal Commuter	Shopper
Mode of travel, percent			
Automobile driver	71	86	83.0
Automobile passenger	18	11	0.6
Shared automobile ride			
One passenger	44	23	31.0
Two or more passengers	13	1	17.0
Bus	10	–	0.2
Peak period, percent of trips			
6:15 to 7:30 a.m.	84		
6:30 to 9:00 a.m.		77	
5:30 to 6:30 p.m.	74		
3:00 to 5:00 p.m.		64	
Average travel time, minutes	15	17	13
Estimated cost of trip by present mode, cents	43	44	37
Maximum bus fare traveler will pay, cents	44	39	38
Trip frequency of five times a week, percent	88	80	–
Licensed drivers, percent	96	96	93
Households with automobiles, percent	98	99	99
Average number of drivers in household	2.20	2.38	2.44
Average number of automobiles in household	1.62	1.82	1.88

In general, the survey identified a fairly typical suburban community with high dependence on the automobile, high automobile competition (i.e., a high ratio of licensed drivers to automobiles in the household), and generally relatively short travel times within the village. It was clear that a transit service will have a relatively difficult time competing with the current levels of service offered by the automobile.

The next step was to develop estimates of the total market for transit service within the communities. The primary sources for estimating the sizes of the various market segments were census data and local data collected by the villages. It should be noted, however, that the villages under study are among the fastest growing in the country, and the market estimation process was being conducted nearly five years after the completion of the last decennial census. Special census data gave up-to-date population values but no updating of characteristics.

In addition to the three groups surveyed, four further market segments were considered to be likely to generate reasonable levels of transit use. The figures derived for all market segments in 1975 are summarized below.

Market Segment	Market Size (trips/avg weekday)	Market Segment	Market Size (trips/avg weekday)
Rail commuter	3 000	Personal business traveler	12 600
Internal commuter	9 300	Social-recreational traveler	8 400
Shopper	21 000	Total	57 200
Elderly	2 600		
Handicapped	300		

It should be recognized that the total market estimated here (approximately 19 000 trips per year) does not cover all segments of the population, nor does it provide for all types of trips that might be undertaken.

TRANSIT SYSTEM CONCEPTS

Once a satisfactory definition of the size and characteristics of the potential markets in the community has been established, the appropriate systems can be considered.

The development of system concepts represents a first pass at a definition of alternatives for the markets that have been identified and characterized. The work at this point was conducted at a conceptual level, both in terms of definition and evaluation. This is the point at which the planner has the greatest freedom of expression and can consider the broadest variety of modal alternatives (1) and the most unorthodox of ideas. It is necessary, however, to conduct such conceptual work within a structure that encourages efficiency. Guidelines were established with community representatives. A broad-based taxonomy of services was developed. Evaluation of the concepts and the selection of some for further analysis were based on the identified goals and guidelines.

Objectives and Guidelines

The study involved a strong emphasis on community participation in the planning process. An advisory group that consisted of representatives of the community at large, elected officials, professional employees of the village, and regional transportation agency representatives was formed. The initial role of this group was to formulate goals and guidelines for this study.

We devised sets of questions to get the advisory group started in their thinking, comments, and recommendations concerning basic objectives, levels of service, and system characteristics. The group resolved questions and conflicts around the table with these sets of questions as a frame of reference. It was understood that the result would be a tentative finding of the group, subject to change as work proceeded and as issues gained clarity.

It is important to note that the initial meeting at which tentative objectives and guidelines were established was preceded by two sessions at which presentations were made to educate the group about the planning process, the potential range of transit service available, and the variety of markets to be considered.

The elements that were most important to the advisory group are summarized below.

Figure 2. Sample questionnaire distributed to railroad commuters.

1. WHEN DID YOU LEAVE HOME FOR THIS STATION TODAY? . . . . . [:] am

2. HOW DID YOU TRAVEL TO THIS STATION TODAY?

[ ] Car & parked at station (how many with you in the car? ___)

If so, was parking . . . [ ] Free [ ] Daily or Metered [ ] Monthly ?

[ ] Car & dropped off [ ] Bus [ ] Walk (all the way) [ ] Bike/Motorcycle

[ ] Other _____ (please specify)

3. WHEN DID YOU ARRIVE AT THIS STATION TODAY? . . [:] am

4. WHAT IS THE SCHEDULED TIME OF YOUR TRAIN TODAY?[:] am

5. WHAT IS THE PURPOSE OF YOU TRIP? [ ] To work or work related [ ] Shopping

[ ] Personal business (visit doctor, bank, lawyer, etc.) [ ] Social/Recreational

[ ] Going home [ ] Other _____ (please specify)

6. HOW MANY TIMES PER WEEK DO YOU MAKE THIS TRIP TO THE STATION? [ ] Less than 1 day a week

[ ] 1 to 4 days a week [ ] 5 days a week [ ] More than 5 days a week

7. HOW MUCH DO YOU ESTIMATE THAT IT COSTS YOU, ON THE AVERAGE, FOR TRANSPORTATION TO THIS STATION? *(DO NOT INCLUDE PARKING COSTS - ONE-WAY ONLY)* _____

8. WHEN DO YOU EXPECT TO ARRIVE AT THIS STATION ON YOUR RETURN TRIP TODAY? . . . . . .[:] [ ] am [ ] pm

9. WHERE DID YOUR TRIP TO THIS STATION BEGIN?

a.) Nearest Intersection or address: _____ (example: Acorn & Beech)

b.) Municipality: [ ] Schaumburg [ ] Hoffman Estates [ ] Other _____ (please specify)

10. a.) DO YOU HAVE A DRIVER'S LICENSE? [ ] Yes [ ] No

	None	One	Two	3 or More
b.) HOW MANY OTHER LICENSED DRIVERS ARE THERE IN YOUR HOUSEHOLD?	[ ]	[ ]	[ ]	[ ]
C.) HOW MANY CARS (TOTAL) ARE AVAILABLE TO YOUR HOUSEHOLD?	[ ]	[ ]	[ ]	[ ]

11. WOULD YOU RIDE A BUS TO AND FROM THE TRAIN STATION IF . . . . *(PLEASE CHECK EACH QUESTION)*

	Yes	No		Yes	No
a.) ...you waited inside your home for front door pick-up?	[ ]	[ ]	d.) ...it took less time than your present trip?	[ ]	[ ]
b.) ...you waited at the nearest intersection?	[ ]	[ ]	e.) ...it took the same time as your present trip?	[ ]	[ ]
c.) ...you walked 4 blocks to the bus stop?	[ ]	[ ]	f.) ...it took longer than your present trip? If yes, how many minutes longer? ____	[ ]	[ ]

12. IF YOU WERE PROVIDED WITH THE TYPE OF SERVICE DESCRIBED IN 11 a) AND e) ABOVE, WHAT MAXIMUM ONE-WAY FARE WOULD YOU BE WILLING TO PAY? . . . . . _____

13. ARE THERE OTHER TRIPS FOR WHICH YOU WOULD USE A BUS SERVICE? [ ] Yes [ ] No

IF YES, PLEASE SPECIFY_____

WE WOULD APPRECIATE YOUR IDEAS ON BUS SERVICE IN THIS AREA: _____

1. General objectives: service for transit captives and those with high levels of automobile competition in the household, coordination with regional systems, flexibility, strong positive image, reasonable subsidy levels, and ability to attract people away from automobiles.
2. Service objectives: on-time arrival at destination, elimination of need to change vehicles, consistency in travel times, assurance of getting a seat, fare discounts for the elderly, handicapped, and children, credit-card or ticket option for paying fares, use of small vehicles (12 to 25 seats), ability to take a direct route, requirement of exact fare, and availability of telephones in public places to call for service or information.
3. Specific guidelines: maximum walking distance of three to four blocks (less for shoppers and almost none for handicapped), maximum waiting times from 20 min (for rail commuters and shoppers) to less than 10 min (for internal commuters and special groups), maximum riding times of 30 to 45 min for internal commuters and 30 min or less for others, and maximum fares of 50 cents.

As work progressed toward more detailed system selection and design considerations, some minor shifts in emphasis were voiced by the group.

Concepts

A significant amount of time was spent reviewing with the advisory group the variety of conventional and paratransit services that were available to meet the identified needs of each of the market segments. The characteristics and greatest potential for application of each were discussed. Generally, discussions centered on conventional fixed-route service, dial-a-ride (including shared-taxi service), subscription services, pooling programs, and jitney operations. Potential service integration was also emphasized.

The conclusions were tabulated in a format that facilitated development of integrated service concepts. The early project work had identified the interest in providing a system tailored to the community to be competitive with the automobile. This, combined with the relatively low population density and lack of a CBD, was taken to indicate the desirability of a dial-a-ride operation to serve off-peak demands. Fixed-route, subscription, and pooling options were considered worthy of further consideration as peak-period services. Twenty alternative system concepts were listed. For each alternative concept, special tabular summaries were prepared that described the service provided to each market segment with maps, where appropriate, showing routings or service areas. This, combined with a review of the goals and guidelines established, provided a basis for narrowing the selection. Selected concepts were analyzed in further detail through derivation of several operational factors regarding the user and the operator. This provided more quantification with respect to walking, waiting, and travel times; number of vehicles required, by type; and cost considerations. The final set of evaluations was then made.

The advisory group determined that detailed testing should concentrate on defining an off-peak dial-a-ride service and studying as alternative peak-hour services (a) dial-a-ride only, (b) dial-a-ride and subscription service, and (c) fixed-route only.

Comparing Costs of Alternatives

A key element in the evaluation of alternative systems is the comparison of expected costs. Of interest here is the comparison between the more conventional service and demand-activated systems. Although dial-a-ride service is often considered more expensive than a conventional system, some of the more thoughtful studies (1, 2) have shown us that one must be careful to define the conditions of comparison carefully. Further pursuit of that discussion is included here in order to extend the philosophy that has been developed (1) and to place it in the perspective of the process of transit planning and design.

First, one must ask on what basis the systems are being compared. More theoretical analyses (2) have assumed a level of demand, hypothesized a service sufficient to handle the assumed demands, and proceeded to cost and evaluate them. Another approach is to define a level of service (1), hypothesize alternative modal operations that meet that standard, and compare costs at a given level of demand. This is often difficult to do to everyone's satisfaction since it is difficult to arrive at a satisfactory definition of level of service and to agree on the relative weighting of the elements that produce the level of service (e.g., waiting time versus riding time).

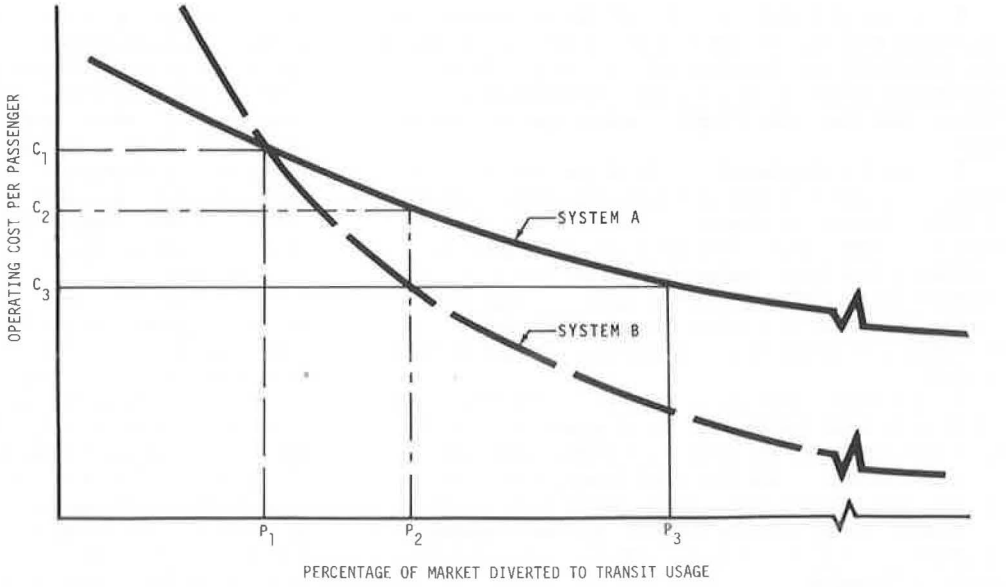
In the case of the transit planner, it is not usually possible to compare systems with equal levels of service. Similarly, it is not likely that the alternative systems being evaluated will have equal attractiveness in a given market setting. It is therefore necessary to develop an effective gauge of potential demand that takes into account market dynamics.

Figure 3 presents a simplified picture of the relationship between market diversion and cost per passenger for two alternatives. The curves are schematic representations and would more accurately appear as step functions. It is assumed that diversion is from a total set of markets spread more or less ubiquitously about the area. Assuming that system A is the more attractive service in this market context, there are two potential conditions under which cost per passenger is less for system A than for system B.

The first is the point at which demand density is so low that system B is apparently inefficient, i.e., demand densities lower than P_1. This has been demonstrated (2) to be the case when comparing demand-activated (system A) with fixed-route (system B) services. It is a result of reaching a base operating condition at which buses are running at extremely low load factors. The same level of ridership (or greater, for the more attractive system) can be serviced with flexible routing and scheduling, using fewer vehicles, and at a lower cost.

More to the point, however, is the second condition in which system A might be near, at, or below the cost per passenger of system B. With a demand density of P_2, system B costs C_3 and system A costs C_2; the difference represents the additional fare or subsidy that would be required to supply demand-activated service. But, considering the market dynamics for system A, its share of the market could easily become P_3, at which point its cost per passenger would be C_3, the same as for system B at P_2. Such a condition might occur, for instance, with door-to-door dial-a-ride service in certain market contexts when the unique service attributes of such a system have a major impact on trip-making and mode-choice decisions. Clearly, it is necessary that the dynamic effects of differences in market attractiveness be considered before making snap evaluations.

Figure 3. Schematic representation of relationship between market diversion and cost per passenger.



DEMAND ESTIMATION

Model Description

It is necessary to arrive at estimates of ridership for each alternative being considered in order to arrive at estimates of system size and costs that can be used in the overall evaluation process. Many studies on the design of paratransit facilities have used only judgmental estimates of the likely ridership for a proposed system. In contrast, the present study undertook the development of disaggregate behavioral choice-modeling techniques, from which estimates of the potential ridership for a number of alternative systems were generated. The basis of this technique has been described in other documents (3, 4, chap. 16). It offers two important benefits for the type of estimation needed in this study. It can be applied to very small data bases, and the models are simple enough in operation, once calibrated, to handle fairly efficiently a rather large number of alternative systems.

Principally, the technique is structured around a calibration of models to the revealed preferences of individual travelers. The resulting model indicates the probability that an individual will choose a particular course of action, e.g., a specific mode of travel for a specific trip. The probabilities that are produced by most of the models are conditional probabilities, i.e., that a particular mode of travel will be chosen for a particular trip, given the origin, destination, and purpose of the trip and given that a decision has already been made that the trip will be undertaken.

The model was developed to be responsive to a set of attributes that describe the alternatives open to an individual. This is the sense in which the model is termed behavioral. On the basis of both current theory and ease of use, the most common form of model is the multinomial logit model.

$$p_k^i = \exp[G^i(X_k)] \Big/ \sum_M \exp[G^i(X_m)] \qquad (1)$$

where

p_k^i = the probability that individual i chooses alternative k from the set 1, 2, . . . , k, . . . , m, . . . , M;
G^i = an individual-specific (or homogeneous group-specific) function of alternatives of the alternatives; and
X_k = a vector of attributes of alternative k.

In the case under study, the binary logit model was selected since the primary current mode of travel is the automobile and the alternative would be some form of transit or paratransit. While a number of previous research projects have shown that other attributes besides cost and time are important in the decision-making process, the research has also shown that cost and time alone determine a large measure of the choice. We therefore decided to develop a model for the case study in terms of these two parameters alone.

$$p_b^i = \exp[\alpha_0^i + \alpha_1^i (c_a^i - c_b^i) + \alpha_2^i (t_a^i - t_b^i)] / 1 + \exp[\alpha_0^i + \alpha_1^i (c_a^i - c_b^i) + \alpha_2^i (t_a^i - t_b^i)] \qquad (2)$$

where

p_b^i = the probability that individual i will choose the bus;
t_a^i, c_a^i = the time and cost, respectively, by automobile for individual i;
t_b^i, c_b^i = the time and cost, respectively, by bus for individual i; and
α_0^i, α_1^i, α_2^i = coefficients to be determined from observed choice behavior.

Calibration of the Model

The calibration of a model in the form of equation 2 required data on the choices made by individuals between at least two alternative modes. Two procedures were possible. First, if transit service existed within the area, the model could be calibrated on data for the choices made in relation to that system. Alternatively, a model could be transferred from some other area that is geographically and socioeconomically similar to the one under study. In this case, it was possible to collect data on present bus use and to develop from this a calibration procedure.

Calibration of the model required a data set that specified the travel times and travel costs for each individual by automobile and by bus. The questionnaire

had only ascertained travel times and travel costs for the trip actually undertaken. As a result, it was necessary to construct the data on the alternative mode for each traveler to the station by using bus operation data, simulated vehicle runs, estimates that used routings on maps, and other assumptions based on survey responses. A logit model was then fitted for a choice between bus and automobile.

$$p_b^i = \exp(-1.37 + 0.054\Delta t^i + 0.0021\Delta c^i)/1 + \exp(-1.37 + 0.054\Delta t^i + 0.0021\Delta c^i) \quad (3)$$

where

$\Delta t^i = t_a^i - t_b^i$ and
$\Delta c^i = c_a^i - c_b^i$.

This model was found to be statistically significant at better than the 99.9 percent level, and each of the coefficients of travel time and travel cost was significant beyond the 99 percent level and had the right signs. The model also indicated, as would be expected, a bias against bus use, as shown by the minus sign on the constant. The model was therefore accepted as being an appropriate one for estimating ridership for any fixed-route option, which is what the existing bus service provides. It should be noted, however, that the sophistication suggested in equation 2 was not carried through in practice, since a single model was calibrated for the choices of all individuals. The individual-specific element in the model is simply the specific difference in cost and time that each individual experiences.

As noted above, the constant α_0 indicates a bias for or against a mode of travel, based on other characteristics than those specified in the mode, such as the differences between the automobile and bus in comfort and convenience. Since the purpose of the model was to estimate ridership for options other than a conventional bus, it was considered that some adjustment might be needed for the value of the constant term to reflect the differences in other attributes offered by certain paratransit alternatives. After investigating other studies and service implementations, we reduced the constant term by one-quarter of its value for predicting such paratransit options as dial-a-ride or subscription service. The refined model is

$$p_{pt}^i = \exp(-0.913 + 0.054\Delta t^i + 0.0021\Delta c^i)/1 + \exp(-0.913 + 0.054\Delta t^i + 0.0021\Delta c^i) \quad (4)$$

where p_{pt}^i = the probability that individual i will choose a paratransit alternative given a choice between paratransit and automobile. The two models shown in equations 3 and 4 were then applied to current and future peak market segments to provide ridership estimates for the alternative service configurations tested in the study.

Development of Model Predictions

The models developed can be applied only to work trips in the communities. No data existed for calibration of a modal-split model for off-peak trips since no such bus service was offered in the village. We assumed that the relationship between responses to the survey item on the work trips would hold for nonwork trips, thus permitting us to estimate the modal split for nonwork trips on the basis of the responses to those questions.

Ideally, predicting potential ridership would require the estimation of differences in time and cost for each individual who might be traveling to either a railroad station or a workplace within the communities. Since this is clearly not feasible, a procedure is required for estimating the probabilities for some subsample of individuals and aggregating this to represent the total population, a problem typically handled by the use of a disaggregate model (5, 6).

The specific strategy we selected was somewhat different from most of those examined before. The communities were divided into 40 zones established on the basis of census tracts and census block groups. A random sample of 75 for each of the three market segments was then chosen from the completed questionnaires, and the respondents' home addresses and workplaces or rail stations were located on maps of the communities. We recorded the characteristics of the reported trip to the rail station or to work for each of the respondents, computed the service characteristics for each transit service option, and estimated the travel time and travel cost for each system. The models were then applied to produce a set of probabilities for each person in the three random samples. We estimated the number of automobile users and transit users for each zone by summing the probabilities for our respondents within the zone (the number of people in each market segment within each zone had been estimated previously). To obtain the final volumes of travel on each system, the proportion of transit trips estimated from the random sample was multiplied by the total population of the market segment within the appropriate zone. This provided a set of forecast ridership estimates for each of the alternatives considered.

Critique of Process

The procedure was found to be reasonably responsive, but it would have been better to have had a model that was able to separately specify walking and waiting times, particularly since demand-responsive and subscription services are significantly different in these regards from conventional bus systems. Unfortunately, data limitations did not permit a model of this form to be calibrated. It would also have been desirable to include differences in comfort and convenience. Furthermore, analysis is needed on the extent to which the aggregation procedure used introduces error into the estimation process. However, the estimates of ridership obtained appear to be in reasonable conformance with operating experience in the various locations in which demand-responsive or fixed-route, fixed-schedule service has been implemented. There is therefore no reason to reject the results of the application of this model.

In the application of the procedure, estimates were made of the likely growth of patronage, with the assumption that full patronage would only be reached after 3 years. Figure 4 shows the type of growth pattern that was forecast, with high and low estimates for each market segment.

EVALUATION AND REFINEMENT OF THE PLAN

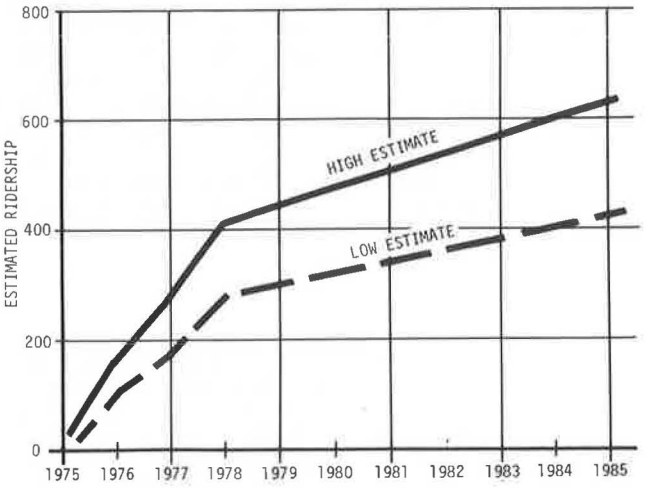
Once estimates of ridership had been derived, it was possible to generate the data required for an adequate evaluation of the alternatives. The evaluation of the detailed plans involved a return to the goals and objectives established early in the planning process. As was expected, new objectives were derived. Two of particular interest were that the system permit a management structure that used local private entrepreneurs to the maximum extent deemed advisable and that compliance with federal and state requirements be ensured to qualify for capital and operating assistance. As a result, the

Table 2. Summary of the analysis of alternatives.

Alternative[a]	Fare ($)			Annual Ridership	Annual Operating Cost ($)	Annual Revenue ($)	Annual Subsidy ($)		Ratio of Revenue to Costs	Cost per Ride ($)	Maximum Fleet Size
	Peak	Off-Peak	Both				Total	Per Capita			
DAR only	1.00	0.40									
Low estimate				990 000	1 270 000	528 000	742 000	11	0.42	1.28	31
High estimate				1 625 000	1 905 000	846 000	1 059 000	15	0.44	1.17	50
Sub/DAR A	1.00 (DAR)	0.40 (DAR)	0.40 (Sub)								
Low estimate				970 000	1 100 000	385 000	715 000	10	0.35	1.13	24
High estimate				1 595 000	1 610 000	595 000	1 015 000	14	0.37	1.01	36
F-R/DAR	1.00 (DAR)	0.40 (DAR)	0.40 (F-R)								
Low estimate				785 000	1 775 000	275 000	1 500 000	21	0.15	2.26	24
High estimate				1 215 000	2 286 000	475 000	1 811 000	26	0.21	1.88	28
Sub/DAR B			1.00								
Low estimate				585 000	715 000	495 000	220 000	3.40	0.69	1.22	24
High estimate				870 000	955 000	715 000	240 000	3.45	0.75	1.10	36

Note: Total market from which transit trips are diverted = 19 000 000 trips per year.
[a]Abbreviations: DAR = dial-a-ride, Sub = subscription service, F-R = fixed-route buses.

Figure 4. Dial-a-ride ridership estimates for railroad commuters.



final evaluation and selection were based on a synthesis of the quantitative, semiquantitative, and qualitative measures of effectiveness.

Costs and Revenues

In order to arrive at operating costs, an estimate of fleet sizes was necessary. Although simulation programs have been developed for limited sets of transit modes, they do not cover the spectrum. Also, the lack of operating experience with paratransit services in the Chicago area would make it difficult to arrive at accurate inputs for the models that did exist. A manual approach was adopted. The diversion estimates, along with assumed routings, headways, and typical productivity estimates (7, 8, 9, 10), were used to determine the expected loading and number of vehicles required for each period to maintain the service specified in deriving demand estimates. The weekday was divided into four periods for analysis: morning peak, midday, afternoon peak, and evening. The same design volumes were assumed for these periods on Monday through Friday. Saturday was dealt with separately. Analyses for Sunday were not differentiated by period. The number of vehicle-hours by period was estimated. The operating costs for each plan were calculated by using average vehicle-hour costs as derived from local operating experience and supplemented by experience with paratransit services in comparable areas.

Capital costs were determined by using the fleet requirements determined above, including those for standby vehicles, and applying up-to-date unit costs quoted by various manufacturers. Related capital equipment (e.g., for communications) and facility costs (e.g., office space) were also estimated. Revenues were estimated, using the assumed fare structure, by applying the established fares to each market segment. The demand estimates previously described were used to determine the number of riders in each market. Revenue estimates were made for each plan or variation being tested. Annual costs and revenues were analyzed, along with the other measures, in selecting a plan for recommendation. An example of the results of this revenue and cost analysis at the point of initiation of service is shown in Table 2.

Selection and Refinement

After considering the detailed analysis of costs, revenues, subsidies, service levels, management alternatives, and so on, the advisory group decided to recommend the implementation of a peak-hour operation consisting of a combination of subscription service for commuters and dial-a-ride for noncommuters, with dial-a-ride service continued for off-peak periods. In addition, recommendations were made for a program to encourage car- and van-pooling plans, primarily through local employers. The subscription service and pooling programs were to be oriented toward two basically different commuter patterns—feeders to regional line-haul systems and service to local employment. Both of these were considered important, and the different characteristics of each had to be recognized in order to provide the proper service.

The plan required refinement in many areas. Ridership estimates were retested and alternative fare levels were considered. System management concepts were made more specific and problems of service coordination were addressed. Projections of system operating levels were made for 5-year and 10-year periods. Staging and implementation programs and concepts were developed, including a step-by-step process toward inauguration of service. Of specific interest here is the analysis of alternative fare levels and system management plans.

For any type of service offered, the fare charged would have an effect on the use of the system and revenues and, thus, an effect on operating costs, as well as profit or subsidy levels. Commuter trips had been found to have little sensitivity to fare levels below 75 cents according to available data in this community. The noncommuter market, however, exhibited greater sensitivity to fare variations. As a result, an analysis of the recommended plan was conducted at four fare levels. An average fare was used to represent a more complex

schedule of charges that varied according to the market group. Average fares of 40 cents, 60 cents, 75 cents, and $1 were tested. Estimates of ridership and system size were made by using the analysis procedures described above. A typical mix of vehicles, using 25-passenger buses, 12-passenger vans, and specially equipped passenger automobiles, was derived for each. Costs, fares, and revenues were calculated as described above. The results were tabulated and plotted. Figure 5 presents a typical relationship, showing projected values for the first stage of operation with a mixed fleet ranging from 20 vehicles (at a $1 average fare) to 30 vehicles (at a 40-cent average fare). Resulting costs per ride were about $1.10. The annual subsidies required for each level were:

Average Fare ($)	Annual Subsidy ($)	Subsidy per Capita ($)
0.40	840 000	11.20
0.60	420 000	5.60
0.75	335 000	4.45
1.00	110 000	1.50

The decrease in subsidy levels from the average fare of 40 cents to the average fare of $1 is about $730 000 but there is an associated decrease in ridership of about 485 000 rides per year. The decision on which fare policy to follow clearly involves a trade-off between maximizing attractiveness to the community (and resulting use of the system) and minimizing the amount of public support required to operate the system.

These estimates of revenues are based solely on expected fares. Additional sources of revenue or support may be found to further reduce the operating subsidies required.

Management Concepts

The recommended combination of subscription, pooling, and dial-a-ride service will require a management system that can appropriately coordinate the financial and physical resources to meet transportation needs as they are identified. In addition, if federal funding is to be made available, it requires that existing jobs not be eliminated and operating businesses not be harmed because of this service.

The villages have a range of alternatives available for managing a transit system. At one extreme, all functions can be carried out by a local (village) or regional governmental unit. This would include marketing, dispatching, vehicle maintenance, vehicle operation, and storage, as well as the hiring and managing of all required personnel. At the other extreme, the villages can license a private operator to perform all these functions. A given community has a set of conditions that will allow a tailored system to be developed somewhere within this range of possibilities, at a level that will provide the best overall results for the community.

In considering the various possible arrangements, a management and operation concept has been developed for the Schaumburg/Hoffman Estates transit system, shown diagrammatically in Figure 6. It was proposed that a central public transportation agency be formed to manage and operate the system. This could be the responsibility of the two villages, a regional agency, or Chicago's Regional Transportation Authority. The management functions would include the initial steps of implementing the service as well as the ongoing tasks of marketing and monitoring. A basic feature of the concept proposed here is that the agency does not operate, maintain, or store its vehicles (except, possibly, a limited fleet as explained below) but contracts for these services through local entrepreneurs. The agency's responsibility, therefore, is to establish service standards and contract requirements for bidding and to negotiate the final service agreements.

The agency's operational responsibilities would be primarily those of a broker or coordinator of public transport service. This would include the acquisition of vehicles and related capital equipment (thus allowing for federal and state subsidy support). In order to maintain central control over the vehicles in operation and to assure the proper level of service, the agency would also develop the dispatching system, as well as take in all revenues and pay out on its contracts. Since other local or regional transit systems either border on or pass through the service area, it would be desirable for the agency to coordinate with these other systems to create a unified transit-service area. Finally, it is possible that the agency could operate and maintain its own small fleet of vehicles in order to gain first-hand experience and knowledge that would enable it to better monitor its outside contracts. This would also give the agency flexibility to take a larger share in actively operating the system, should it become necessary or desirable.

Since the transportation agency would act primarily as a broker in the system, the role of the other parties should be explained briefly. It was assumed that a local bus company would be contracted to operate, maintain, and store the required medium-sized and, possibly, small-sized buses. It was also assumed that a local taxi company would be contracted with to operate, maintain, and store the required passenger-car units and, possibly, small-sized buses. The vehicles could be provided through the agency or through the local company. If the latter, the vehicles would have to meet the agency's standards, which would include the use of the agency's vehicle colors and logo. Drivers provided for the vehicle by the local company would have to be tested and certified by the agency. Should the vehicle be owned by the local company and used for its own purposes when not plugged into the system, it would be necessary, to protect the system's image, to require that only drivers certified by the agency be allowed to operate the vehicle.

In addition to working with the local transportation companies, the agency might make direct arrangements with individuals or firms. Thus a pooling arrangement could be made in which one of the commuters also becomes the pool driver, which would significantly lower operating costs. The person selected to drive might be given free fare as well as other incentives. If a van-pool vehicle is needed for off-peak service, arrangements could be made for a professional driver to pick up the vehicle at the van-pool driver's place of employment and return it before his or her scheduled departure at the end of the day. The agency could work through an employer, who might also be willing to subsidize the program. In addition, car-pool matching services could be provided.

In summary, the proposed concept has the advantages of minimum capital investment in facilities, minimum agency personnel requirements, maximum use of local entrepreneurs, and flexibility to meet varying needs.

CONCLUSIONS

It has become clear that there are a number of sensitive issues in providing plans for transit and paratransit in any community, particularly small communities. In particular, it is very important to be able to produce accurate but inexpensive demand estimates for low-cost,

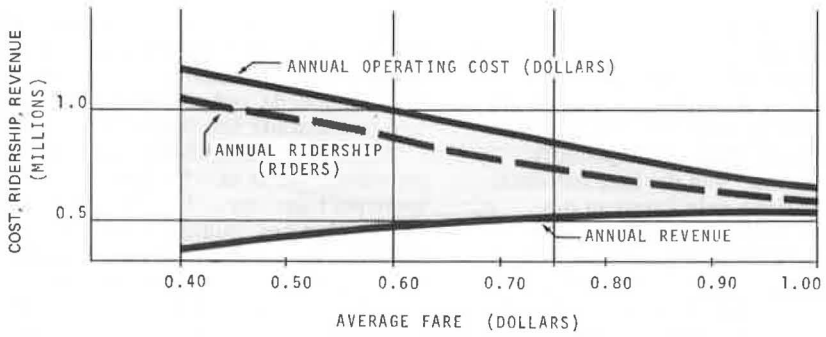


Figure 5. Results of feasibility analysis for the first stage of operation.

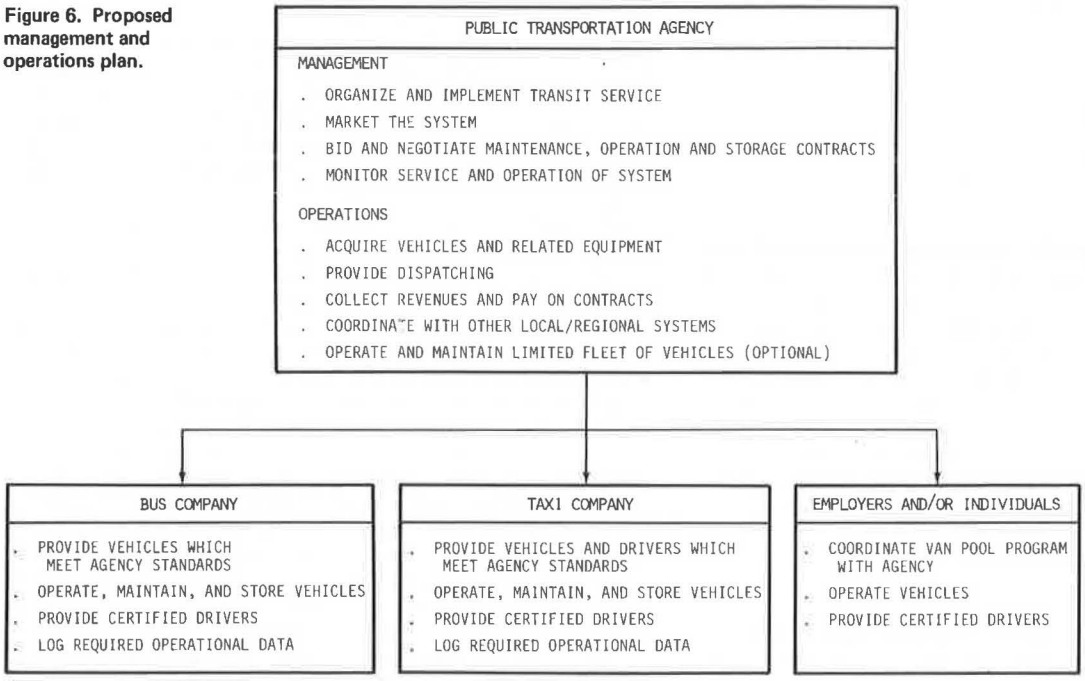


Figure 6. Proposed management and operations plan.

highly flexible systems. It is also of considerable importance to develop an operating strategy that will not alienate existing transportation firms (e.g., taxi companies) but that retains sufficient control of any system in the hands of the community.

In this paper, strategies have been described for estimating potential markets for transit or paratransit service, developing a potential set of transit system concepts, estimating demand for each of a selected subset of concepts, developing an evaluation process, and selecting an implementation strategy. In all cases, these strategies represent an initial trial of a particular method, from which a number of lessons can be drawn. The case study has shown that there is considerable value in conducting limited small-scale surveys of specific market segments. While our self-administered questionnaire lacks controlled response and may produce biased results, it can be checked against census data and its biases may be small. In developing estimates of the size of various markets, research is needed into the trip-making rates of a number of segments of the population, particularly those that are not subjected to surveys.

The development of a wide variety of system concepts that facilitate the generation of an optimal system or systems was also important. A qualitative analysis was found to be appropriate and sufficient to lead to an effective choice among candidate systems. Two inputs that should be provided at the system-concept stage are the various system costs and some reporting of operational experience with new transit concepts in other communities. The latter should include demonstrations of various types of vehicles and field visits to operating systems.

The demand-estimating process used a low-cost policy-sensitive method that was capable of responding to most of the needs of this study. Further use of the technique, with better data and before-and-after testing, will provide many of the improvements deemed desirable for greater responsiveness to new system concepts. Specifically, data are needed on the access and egress travel times and on the factors relating to comfort, waiting time, and waiting location that may distinguish levels of patronage among new transit-system concepts. Research is needed to determine the accuracy of the aggregation procedure as a function of sample size.

The emphasis in this study was on deriving a plan for immediate and near-future service. The high degree of flexibility within the systems being proposed and the dynamic development potential in the community make long-range transit planning an unnecessary academic exercise at any but a conceptual level. This approach can be taken with a high level of confidence and least likelihood of service retraction, assuming that the in-

dicated level of service and an effective marketing procedure can be maintained.

ACKNOWLEDGMENTS

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Evaluation of DRT Systems in Richmond and Santa Barbara

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This study evaluated system performance and the economics of a publicly operated demand-responsive transportation system in Richmond, California, and a privately owned and operated demand-responsive transit service in Santa Barbara, California. The systems were evaluated from the viewpoint of users, nonusers, and system operators. The major conclusion from the research was that ownership and operation of demand-responsive transit by the private sector demonstrate significant potential and should be given serious consideration by policy makers. By subsidizing a private operator at approximately $1.00 per passenger-trip, it should be possible for a local government to provide increased mobility to transit-disadvantaged sectors of the population with a greater degree of efficiency and equity than would be possible if the service were operated by a transit district.

This paper reports on a study of demand-responsive transportation (DRT) systems in Richmond and Santa Barbara, California. Since this research was performed, both systems have gone out of operation. This study should be seen as an attempt to analyze the reasons underlying the failure of the two systems. I hope it will provide some insight into the pitfalls that must be avoided in planning new DRT service.

SYSTEM STRUCTURE

Dial-a-ride was initiated in Richmond on September 16, 1974. The system was sponsored, operated, and managed by the Alameda-Contra Costa (AC) Transit District and was coordinated with Bay Area Rapid Transit (BART). The Board of Control for the AC/BART Coordination Project authorized the Richmond DRT experiment (1) in order to

1. Develop information from the pilot project that would be useful in implementing similar service elsewhere in the Bay area,
2. Acquire experience in coordinating DRT service, AC Transit, and BART services, and
3. Obtain guidance in terms of technology, personnel, and facilities requirements for expanding DRT service beyond the boundaries of the initial service area.

In contrast to Richmond's DRT, Santa Barbara's dial-a-ride operation was privately owned and operated. The system was initiated on September 1, 1973, and was operated as a service of the Yellow Cab Company, the only taxi firm in Santa Barbara. Ernie Parks, the system operator, said his objectives were "to prove that we could operate it cheaper than if it were operated by a city or transit district" and "to salvage the taxi business so the transit district couldn't put us out of business.... We hoped it would help the cab industry.... We looked at the Haddonfield system and figured that, if we could operate a dial-a-ride service and show that it fulfilled community needs, it would be worthwhile."

Although, like AC Transit, the owner of the Santa Barbara dial-a-ride service did not formulate any set of criteria by which to judge the success or failure of the system, he wanted to break even. The original goal was to carry 500 passengers a day by the end of the first 8 to 12 weeks, although the service was never aimed toward any particular market sector. The operator was quoted in a newspaper interview as saying that the system would be the first one to be put into operation without a federal subsidy and that it would be "learn and go" (2).

Area Served

Richmond is located about 16 km (10 miles) north of Oakland on the northeast shore of the San Francisco Bay. The site selected for the dial-a-ride demonstration project was an area of 12.7 km^2 (4.9 miles^2) covering the center of the city. The total population of the service area is 44 000, and the population density is 3542 persons/km^2 (9173 persons/mile^2).

The city of Santa Barbara is located on the southeast coastal plain of Santa Barbara County, approximately 161 km (100 miles) northwest of Los Angeles. Nearly 28 km^2 (11 miles^2) are contained within the service area with a total population of 54 605 and a population density of 1974 persons/km^2 (5112 persons/mile^2).

While the Santa Barbara service area was about twice the size of Richmond's, the population was half as dense. Thus, on the basis of physical characteristics alone, the Santa Barbara system began with a double handicap compared with Richmond's system.

The median income in Richmond's initial service area was approximately $10 000 (3). The racial composition

was 39 percent black, 56 percent Caucasian, and 5 percent other. Automobile ownership in the service area was generally high. One-third of the population was under 18 years of age. The elderly, another major group the DRT system was designed to serve, constituted only 14 percent of the population.

The median income for the Santa Barbara service area was $9247. Its racial composition was 24 percent Chicano, 72 percent Caucasian, and 4 percent black. As in Richmond, automobile ownership was high. The percentage of young, middle-aged, and elderly was fairly even. Those 18 and under made up 25 percent of the population, while those over 60 made up 23 percent.

Size of System

Since AC Transit officials believed there was no small vehicle available that could meet their stringent reliability criteria, they shortened 13 of the 10.5-m (35-ft) transit coaches that normally seat 45 passengers so that they contained 18 seats.

The vehicle used for Santa Barbara's dial-a-ride operation was a B200 Dodge Sportsman Maxiwagon. The operator decided to use vans rather than taxis for Dial-a-Ride because it was feared that, if taxis were used at the cheaper dial-a-ride fares, too many taxi customers would switch to Dial-a-Ride. There were originally two vans in service, but when ridership dropped, one van was taken out of service.

The average distance traveled per day in Richmond's dial-a-ride operation was 164 km (102 miles) per bus per day (4). Santa Barbara's van system covered approximately 200 km (125 miles) per day.

During the initial months of operation, Richmond's dial-a-ride system employed 26 drivers, 12 control-room operators, and 2 control supervisors. In February 1975, in an effort to reduce the cost of operation, 2 controllers and 6 drivers were laid off. The personnel cutbacks, however, resulted in increased waiting times, a drop in patronage, and complaints concerning reliability of the service. For these reasons, the employees laid off in February returned to their jobs in March.

During its initial period of operation, Santa Barbara's dial-a-ride staff consisted of two drivers. Apart from the drivers, the only other employees who spent time on Dial-a-Ride were the dispatchers who were employed by the taxi operation. No more than 8 to 9 percent of a dispatcher's time was spent on Dial-a-Ride.

Financing

AC Transit relied on five sources of revenue to finance the dial-a-ride operation: a two-thirds capital grant from the Urban Mass Transportation Administration (UMTA) to redesign the transit coaches, a one-time allocation from the Metropolitan Transportation Commission (MTC) to be applied to net operating loss, a federal subsidy for operating costs, fare-box revenues, and a property-tax assessment (the normal means of financing all AC Transit operations). The percentage of the total cost of operation (including capital costs) supplied by each revenue source is shown below.

Revenue Source	Percentage
UMTA grant	9
MTC funds	14
Fare-box revenue	5
Property-tax assessment	72

Unlike Richmond's system, Santa Barbara's dial-a-ride system receives no outside subsidies. The cost of operation depends wholly on fare-box revenues and cross-subsidy from the Yellow Cab operation. Package delivery and night charter operations also bring in additional revenue.

Marketing

A wide range of advertising techniques was used to inform Richmond residents of the existence of Dial-a-Ride, e.g., mapboards, brochures, posters, directional signs, decals, bus cards, telephone stickers, and plastic bags. In addition, community consultants from the Model Cities program canvassed the service area distributing free tokens, and the service was advertised on local radio and television stations and in the local newspaper.

Santa Barbara's dial-a-ride operation was much less publicized. Prior to start-up of service, only one short news article and one full-page ad appeared in the local newspaper. Following this initial period, small ads were run occasionally. The last ad appeared in September or October of 1974. In addition to these advertisements, the News-Press printed one or two stories about dial-a-ride service, and the local television station provided some coverage of the operation. The operator's reluctance to advertise more heavily was a source of discouragement to dial-a-ride employees and passengers.

SYSTEMS PERFORMANCE

Opinions about the performance of the two dial-a-ride systems were gathered from users, nonusers, and system owners. The method used for each group was: (a) users—surveys conducted on board the vehicles, (b) nonusers—random telephone surveys of the general population in each service area, and (c) system owners—individual interviews.

The Richmond dial-a-ride users were surveyed by questionnaires handed out on three different days during October 1974 (3). From the 110 riders approached, 102 completed surveys were obtained (93 percent response rate). Additional information was gathered by means of simple observation.

Original data on Santa Barbara dial-a-ride users were obtained through an on-board survey conducted during January and February 1975. During the periods the interviewer rode the van, there were 81 dial-a-ride users. Although a goal of 100 surveys had been set, only 32 could be completed, largely due to two factors. First, more than 40 percent of the passenger-trips were made by regular passengers who rode more than once during the survey period; although information was recorded separately each time a passenger rode, each passenger was asked to complete a survey only once. Second, many of the passengers were mentally retarded and could not be interviewed.

Ridership Characteristics

The percentage of riders in each age group and the age structure of the total population in each service area are compared below.

	Richmond		Santa Barbara	
Age Group	Percent of Riders	Percent of Total Population	Percent of Riders	Percent of Total Population
Under 18	29	33	0	25
18 to 24	30	12	9	13
25 to 44	17	22	13	22
45 to 59	13	19	25	17
60 and over	10	14	53	23

As with so many other features of the systems, Richmond and Santa Barbara were at opposite ends of the spectrum. Whereas there was a predominance of younger riders in Richmond, the majority of Santa Barbara users were elderly. In addition, 75 percent of the users in Richmond and 65 percent of the users in Santa Barbara were female.

The most frequent type of trip in Richmond was work trips; shopping was the second most frequent type. In Santa Barbara medical visits were responsible for the greatest number of trips.

No information is available on frequency of use for Richmond dial-a-ride users. In Santa Barbara there appeared to be a fairly even split between occasional customers and regular passengers.

Although the door-to-door feature of dial-a-ride service should have made transportation more accessible to people with some types of disabilities, the fact that the buses used in Richmond did not differ significantly from the vehicles used in fixed-route service suggests that Dial-a-Ride served few categories of disabled people who could not have ridden the regular AC Transit buses. Nineteen percent of the households in Richmond were without automobiles. In comparison, 72 percent of all dial-a-ride users did not have a car available.

Several aspects of the dial-a-ride operation in Santa Barbara made it more accessible to the handicapped, notably the low step on the van, which facilitated boarding by the elderly and handicapped, and the personal interest taken by the driver in each dial-a-ride passenger, as demonstrated by his calling out directions to the blind passengers to aid them in entering the building at their destination. In the hours the interviewers rode the van, 36 percent of the 81 passenger-trips were made by handicapped people. The types of disabilities represented were mental retardation, blindness, and problems with balance and walking. In addition to these more obvious handicaps, approximately 34 percent of the riders indicated that they have health problems that make it difficult for them to walk more than a block or two. Only 12 percent of 32 riders surveyed had a driver's license.

User Evaluation

Fare

The fare on the Richmond dial-a-ride system was 25 cents. There were no transfer privileges to BART or regular AC Transit buses. Two children under five years of age rode free with a fare-paying adult.

The fare on the Santa Barbara system changed several times. From September 1, 1973, to September 30, 1974, the fare was 60 cents for a one-way trip. On October 1, 1974, this fare was doubled to $1.20. The increase was deemed necessary to offset a 19 percent decline in the taxi business, which resulted primarily from the Metropolitan Transit District's move to place eight new minibuses in service. Shortly after the fare was increased, dial-a-ride patronage dropped from between 110 and 120 riders per day to approximately 60 to 70 per day. On January 6, 1975, the fare was changed again—this time to $1.00 per ride.

Most of the Santa Barbara dial-a-ride users were very appreciative of the service. Two-thirds of the riders indicated that they would continue using the system even if the fare were increased to $1.50. For most of the passengers, the choice was between taxi or Dial-a-Ride. As long as the dial-a-ride fare remained less than $2.00, it was still cheaper than a taxi for most trips within the city. At a fare that almost covered the cost of the service (assuming a fare of $1.50 and a cost per trip of $1.60), between 70 and 90 percent of the weekly ridership would still have used the system.

It is fair to say that, despite the fact that the cost per trip in Santa Barbara was higher than that for most other dial-a-ride systems, the passengers were not considerably dissatisfied with that aspect of the service. Although the satisfaction expressed with the fare in Santa Barbara should not be taken as wholly representative of all system users, since the passengers surveyed were the residue of the 110 to 120 riders who used the system daily before the fare increase, the passenger ratings do have some degree of validity and might be used as an example for the Richmond system. Since the passengers were very well satisfied with the fare in Richmond, it is reasonable to believe that riders would still have been willing to use the service if the cost per trip in Richmond were increased to 45 or 50 cents. One of the drivers in the Richmond operation indicated that neither he nor his passengers would have been opposed to a 50-cent fare.

Trip Destinations

Lack of major activity centers in the Richmond service area had a detrimental impact on the dial-a-ride operation. Analysis of trip tickets indicated that there was no major origin-destination point. The major trip generators included Brookside Hospital, Kaiser Hospital, Montgomery Ward, K-Mart Shopping Center, the Richmond BART station, Hacienda Senior Citizens' Center, the welfare department, Contra Costa County Building, the library, city hall, and the art center. Because there was no major employer in the service area, only a small percentage of dial-a-ride trips were commuter oriented. In particular, trips to BART were far below expectations. Although school trips constituted a significant part of the ridership, these trips were discouraged since student demand overwhelmed the system when the service was first initiated.

In contrast, the Santa Barbara service area, which encompassed most of the city of Santa Barbara, had no lack of trip destinations. Medical offices were the major attractors for dial-a-ride trips. The main work destination was Work, Inc., a rehabilitation center on lower State Street where handicapped persons are taught employment skills. The school trips made by Dial-a-Ride were limited to transportation of the mentally retarded students between the Montecito area and Alpha School.

Speed of Service

During the first quarter of operation, waiting time in Richmond averaged 26.5 min, while riding time averaged 14 min.

Passengers who called for dial-a-ride service in Santa Barbara were told that they would be picked up within 30 min. This was the average waiting time for the system. When the patronage levels fluctuated around 110 to 120, however, this 30-min promise often could not be fulfilled. With such heavy demands on a two-vehicle system and so large an area to traverse, there were times when a vehicle did not show at all. Waiting time was the major complaint against the service.

Nonuser Survey

To determine how the general population—in particular, nonusers—viewed dial-a-ride service, a telephone survey was conducted in each service area. The primary purpose of the Richmond survey (5) was to discover how people in Richmond became aware of Dial-a-Ride and to determine whether any advertising medium had particular effectiveness with any one group of people. Although the Santa Barbara survey asked many of the same ques-

tions, it was broader in scope. Its objectives were: (a) to test the researcher's suspicion that few residents in Santa Barbara were aware of the existence of Dial-a-Ride because of its sparse publicity, (b) to discover what percentage of those surveyed were currently using the service or had used it at any time in the past, and (c) to determine which aspects of Dial-a-Ride inhibited people from using the system.

Most respondents in Richmond were well aware of Dial-a-Ride. Of the 91 percent of those interviewed who had heard of the service, the largest number had found out about Dial-a-Ride by seeing the bus or reading about it in the newspaper. Changes suggested by those who had used the system fell into four categories: extension of the service area, improvements in the system, improvements in the equipment, and driver practices. Almost $^2/_3$ of the suggestions were recommendations to expand the service area. Only 10 percent of those interviewed said that riders should have to wait less.

In Santa Barbara 73 percent of the respondents had heard of Dial-a-Ride. Newspapers and personal conversations far surpassed all other sources of information about the service. Of the 27 percent of the respondents who had not heard of Dial-a-Ride, 75 percent indicated that they would be interested in such a service and 83 percent of this group stated that they would be interested if they could travel anywhere within the city limits for a fare of $1.00.

The age groups that showed the greatest degree of interest were those 25 to 44 (41.6 percent of the respondents) and those 65 and over (33.3 percent of the respondents). This point is significant since the bulk of the ridership was composed of elderly riders; people 25 to 44 constituted only 12.5 percent of the ridership. Thus, there may have been a latent demand for such a service among people of this age.

The other major finding was that 75 percent of the respondents who expressed interest in dial-a-ride service lived on the east side of town, where the greatest proportion of low-income and minority persons are clustered. It may be that, although these transit-disadvantaged persons had great latent demand for DRT, they had difficulty in obtaining information about Dial-a-Ride (perhaps because of a language barrier) or in knowing how to use the system.

None of the respondents who had used the service indicated use within the previous week and, from the comments and desired changes mentioned, it can be assumed that they were all former users. Among these former users, 85 percent were female, and 71 percent were 65 or older, while the remaining 29 percent were between 45 and 59 years of age. Also, newspaper items and personal conversations were the only two sources by which they had found out about the dial-a-ride service. While the suggestions for change in Richmond dealt mainly with expansion of the service area, the Santa Barbara respondents were concerned with three more basic factors: waiting time, cost of service, and reliability.

Operator Evaluation

From the point of view of the operator, patronage figures and the operating deficit are the main indicators of system performance. In both Richmond and Santa Barbara, patronage figures were below the original goals of the system operators.

In Richmond, the highest number of riders to use the system on any single day was 1103 on April 16, 1975 (a Wednesday), and the lowest number was 385 on September 22, 1974 (a Sunday). The consultants projected patronage at a level of 1000 per day by the end of the first 6 months of operation and 2000 per day after 18 months (6, p. 4-1). The control supervisor had his own goal—3500 per day by the end of the first year. After Christmas 1974, dial-a-ride patronage began to drop and in January 1975 it leveled off at about 850 per day.

On August 26, 1973, the Santa Barbara News-Press featured a story (2) that quoted Ernie Parks, the system operator, as saying "the La Habra system was carrying 500 customers a day within 8 to 12 weeks, and that's the goal in Santa Barbara." The hoped-for patronage of 500 per day never materialized. When the system first started, there were some Fridays when ridership reached 200, but on the average patronage fluctuated around 110 to 120 from September 1, 1973, to September 30, 1974.

In October 1974, the fare was increased from 60 cents to $1.20, with a subsequent decline in patronage to half the former level. Between October 1, 1974, and December 25, 1974, ridership averaged 60 to 70 passengers per day. It is interesting to note that the industry's rule of thumb is a decline of 3 percent in passengers for an increase of 10 percent in fares (7). Santa Barbara's fare increase of 200 percent should therefore have produced a 60 percent decline in patronage (66 to 72 passengers per day). As in Richmond, there was a further decline after Christmas that brought the average patronage to 20 per day.

A sizable operating deficit posed the greatest threat to the continued existence of Richmond's dial-a-ride operation. The estimated net operating loss for 1975 was $1 018 062 (4). This was equivalent to a net operating loss per passenger of $3.73, assuming 272 711 passengers per year (747 passengers per day).

Santa Barbara's dial-a-ride system was also a deficit operation, but the size of the deficit was minuscule compared with that for Richmond's system. The operation usually managed to break even by means of fare increases. It finally had an annual net operating deficit of $3000 and a deficit per passenger-trip of 60 to 65 cents at a patronage level of 20 passengers per day.

OVERALL EVALUATION

Efficiency

To determine the efficiency of the two systems, I have looked at two performance measures—operating cost, expressed as cost per kilometer and cost per passenger, balanced against the increase in mobility afforded by the services, and vehicle productivity.

Although any increase in mobility and the associated value of this increase are difficult to measure, it is possible to suggest some criteria for judging how well the systems are satisfying the needs of transit-disadvantaged people.

Criterion 1: Number of Created Trips

Only 16 percent of the total users in Richmond (714 passenger-trips per day) indicated they would not have made the trip if Dial-a-Ride did not exist. Of these created trips, 31 percent were shopping trips, 25 percent were for medical purposes, 19 percent were social-recreational, 13 percent were to work, 6 percent were to school, and 6 percent were for personal business. Of those riders who did not have a car available, 21 percent would not have made their trips if Dial-a-Ride had not existed, while 20 percent of the nondrivers would not have made their trips without Dial-a-Ride. Projecting the 16 percent figure over an entire day yielded 112 created trips per day.

In Santa Barbara, induced demand was responsible for only 10 percent of the total trips (three riders)—one medical trip, one trip for personal business, and one

shopping trip. If mobility was created for only three out of 32 passengers surveyed and there were usually 20 passengers per day, this would suggest that less than two trips per day were created trips.

Criterion 2: Number of Passengers Substituting From an Inferior Mode

Inferior modes include taxicab (because it provides nearly the same service at a higher price), fixed-route bus (which lacks the door-to-door feature), walking (which is not safe and exposes people to the weather), and other (hitchhiking, motorcycle, bicycle, and so on) (3, p. 54).

In Richmond, 42 percent of the passengers substituted from fixed-route bus, 13 percent would have walked, 6 percent would have taken a taxi, and 3 percent would have used another means of transportation. Thus, 64 percent of the total passengers surveyed (448 riders/day) were benefiting from improved mobility.

In Santa Barbara, 50 percent of the passengers substituted from taxi, 25 percent from fixed-route bus, and 5 percent from cab or bus; no passengers indicated that they would have walked or used another mode not listed. Thus, 80 percent of the passengers (16 riders/day) were benefiting from improved mobility.

Criterion 3: Number of Passengers From Areas Not Well Served by Fixed-Route Transit

Although exact numbers were not available, analysis of the trip tickets in Richmond showed that most of the riders were from the census tracts in the southwestern portion of the service area (6, p. 4-8), which is poorly served by transit lines. Although there are several lines in the area, many of the residents live more than 0.4 km (0.25 mile) from the nearest bus stop. The rest of the service area appears to be adequately covered.

In Santa Barbara, the origins and destinations of all 81 passenger-trips recorded by the interviewers were mapped to determine which trips had either their origin or destination in an area poorly served by buses. Excluding those trips made outside of the service-area boundaries, only five of the passenger-trips had their origin or destination in an area not well served by a bus line. No attempt was made to determine the exact distance each origin and destination was located from the nearest bus stop. A more thorough analysis would also have considered the number of transfers required as an indicator of transit coverage.

Criterion 4: Number of Passengers Who Have Difficulty Walking More Than a Block or Two

No information was collected for Richmond on the number of passengers who had health problems that made walking difficult. In Santa Barbara, 1/3 of the passengers surveyed (7 riders/day) indicated that they had health problems that made it difficult for them to walk more than a block or two.

Criterion 5: Number of Riders Who Would Have Been Automobile Passengers

Some people would have had to impose on another person to drive them if it were not for dial-a-ride service. In Richmond, 15 percent of the riders surveyed (105 people) indicated they were in this situation, as were 3 persons in Santa Barbara (approximately 10 percent of the total riders).

Two cost measures commonly used in the transit industry are operating cost per vehicle-kilometer and operating cost per passenger-trip. These measures are shown below.

Item	Richmond	Santa Barbara
Operating cost/vehicle-kilometer, $	3.89	0.43
Operating deficit/vehicle-kilometer, $	3.65	0.16
Operating cost/passenger, $	3.98	1.60
Operating deficit/passenger, $	3.73	0.60

It is apparent that the operating cost per passenger of the Santa Barbara service is less than half the cost of the Richmond system (and the cost per vehicle-kilometer is one-ninth the cost in Richmond). Richmond's operating deficit per passenger-trip is more than six times that of the Santa Barbara operation. Since the average revenue per taxi trip in Richmond is $1.95, the gap between the operating deficit and taxi fare makes the problem even more apparent.

The tremendous difference in cost between the two systems is primarily attributable to the high transit wages prevailing in the Bay area. An AC Transit bus driver receives an average wage of $6.85 per hour. Controllers are paid between $5.42 and $6.84 as an hourly base wage. In addition to labor, the overhead costs of the control center are a major expense.

Vehicle productivity—the key indicator of economic performance—was defined earlier as the average number of passengers per vehicle per hour. Based on experience from other DRT systems, vehicle productivity in the many-to-many mode generally averages 7.0 (8). Maximum achievable productivity to date is 15 to 20.

The goal in Richmond was to achieve a vehicle productivity of 10 passengers per vehicle-hour. As of April 23, 1974, the average productivity was 6 to 7 riders per vehicle-hour.

In Santa Barbara, vehicle productivity was extremely low—approximately 2 passengers per vehicle-hour. When patronage levels were 110 to 120 passengers per day and two vans were in service, productivity was probably about 6 passengers per vehicle-hour.

Thus, the number of passengers carried per vehicle-hour in each system was low, indicating an inefficient use of the vehicles.

Equity

A case has been made to show that approximately 1 out of every 44 residents in the Richmond service area (or 1 out of 88, if each passenger made a round trip) benefited from Dial-a-Ride each day, while the burden of operating costs was borne by a much wider range of individuals. The 25-cent fare paid by the user represented only 5 percent of the total cost of operation. The remaining 95 percent was paid by six different entities.

1. AC Transit (ultimately the taxpayers of the district)—It suffered loss of revenue on fixed-route lines, since 42 percent of the dial-a-ride users had switched from regular buses.
2. Taxpayers at all levels—The taxpayers of the AC Transit District shouldered the greatest portion of costs, $925 000 worth of operating costs for the year. In addition, the $200 000 supplied by MTC was derived from state sales-tax funds. Finally, the capital cost of refurbishing the buses was financed by means of a $125 482 federal grant, money that was acquired through federal income taxes.
3. The city of Richmond—Some expenses for pro-

moting subscription service were financed out of the city budget.

4. Veteran's Yellow Cab Company—Switching of passengers from taxi to Dial-a-Ride cost the taxi company between $500 to $700 in revenue each day, and 12 jobs were displaced by the dial-a-ride operation.

The financial burdens of the dial-a-ride operation must be weighed against the benefits. Four different categories of beneficiaries can be identified.

1. The transit disadvantaged, in particular, the nondrivers and members of households without automobiles, residents of low-income areas, and young people;
2. AC Transit personnel employed specifically for the operation;
3. Richmond residents, since they received extra police service as a result of Dial-a-Ride; and
4. All Bay area residents, since Dial-a-Ride was used as a model for the rest of the Bay area.

In Santa Barbara, the major cost of the service was borne by the users themselves, while the small operating deficit was covered by Yellow Cab. There were no nonuser impacts or financial burdens.

The primary beneficiaries of the service were the senior citizens and the handicapped, although other categories of transit-dependent people also used the service less frequently.

CONCLUSIONS

The main conclusion to be drawn is that the Richmond operation was a public investment that was not worth the cost. Although almost 1000 people used the service daily, the transportation needs of these transit-dependent people were not being met in the most efficient manner possible, as witness the fact that it would have been cheaper to subsidize them to ride taxis.

On the basis of the evidence presented in this study, it seems fair to suggest that the advantages of privately provided dial-a-ride services outweigh the benefits of publicly provided DRT systems at this point. Not only is there a greater opportunity for equity inherent in this approach, but the gains in efficiency resulting from lower labor and fixed costs are notable. If taxi drivers were to unionize, however, the wide gap between labor costs in the private and public sectors would diminish.

A need for some type of personalized transportation exists, and DRT will become even more important in the future. There are still too many travel needs that cannot be met by conventional fixed-route systems. The major issue is not whether Dial-a-Ride should exist, but rather to find the right institutional structure for providing it.

When the Richmond and Santa Clara County dial-a-ride operations were first initiated, some people speculated that Dial-a-Ride would eventually put the taxi systems out of business. This seems not to have been the case. It appears, instead, that the role of the taxi industry may be changing. It is not yet clear just what form this evolution will take, but spokesmen for the taxi industry have already acknowledged their interest in meeting the challenge of providing shared-ride services. It is now time for decision makers to give the private sector an opportunity to prove itself.

Some of the lessons that can be learned from the Richmond and Santa Barbara dial-a-ride experiments and applied to future systems are listed below.

1. If a privately owned DRT system is to accomplish social objectives, three elements will be required: continuous advertising and promotion, perhaps publicly subsidized; widespread community support, especially the backing of local government officials and other transit operators in the area; and some means of guaranteeing a minimum level of service.
2. Transportation provided by the private sector need not entail discourteous, irresponsible drivers and low service standards.
3. Higher rates of vehicle use can be achieved by providing demand-responsive service only during periods when fixed-route headways are longest in areas that already have good arterial systems, conducting package-delivery service during slow periods of the day, and using the DRT system to replace or integrate paratransit services now provided by individual social agencies or organizations with volunteer drivers.
4. A 25-cent fare is too low for demand-responsive service. A fare of 50 cents would not be unreasonable.
5. In assessing quality of service, passengers appear to be more concerned with waiting time than with attractiveness of the vehicle.
6. Only a community that contains a significant number of major activity centers should be chosen for operation of a DRT system.

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Dial-a-Ride Service in Santa Clara County

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Late in 1974 and early in 1975 the Santa Clara County Transit District initiated, operated, and then discontinued a demand-responsive dial-a-ride system within a span of 5½ months. This system's failure was primarily the result of poor systems planning. Specifically, four major mistakes led to the death of the system: an inadequate customer communication system, starting the entire system at once, an inadequate number of vehicles, and taxicab buyout. Each of these four mistakes is discussed in detail, and recommendations are made for instituting dial-a-ride systems. Getting through the difficulties of the start-up period is emphasized. Costs are discussed, and some relevant cost data are presented.

In January 1973, the Santa Clara County Transit District (SCCTD) took over the ownership and operation of all bus systems in the county, which has a population of approximately 1 150 000 and covers a service area of 518 km^2 (200 $miles^2$). The fleet size was 50 buses at that time. The vaguely stated goals of the SCCTD included serving all the people, providing high-quality service, and providing a transit opportunity for 97 percent of the population. Clearly such goals could not be simultaneously met with a fleet of 50 buses, especially in view of the other goals, which included reliability and reasonable speed and trip time. In fact, it has recently been estimated that a fleet of 680 vehicles would be required to accomplish the goals of the SCCTD, assuming the current level of demand (1).

In an attempt to overcome these difficulties, the Transit District Board, acting on the staff's recommendation, decided to institute a countywide demand-responsive transit system to augment a relatively meager fixed-route arterial system. This new Arterial/Personal Transit (APT) system began operation in November 1974, when the fleet size was expanded to 212 buses. Since, even with 212 buses, the goals of the SCCTD could not be met with a single or an integrated series of arterial systems, it was hoped that a dial-a-ride (DAR) system could be established that would provide all county residents, rural as well as urban, with the same opportunity for low-cost transit. Ironically, this reasoning proved to be correct. However, the level of service of the resulting transit opportunity was so bad by any measure and the cost of providing DAR service was so high that the demand-responsive portion of APT was discontinued in May 1975, except in the sparsely populated extreme southern portion of the county, where DAR was continued with 6 vehicles.

Thus in the short span of 5½ months, the SCCTD initiated, operated, and finally dismantled the largest demand-responsive system ever attempted in the United States. The costs of this brief attempt were significant both in terms of dollars and in terms of other less quantifiable but certainly no less real costs. Officials of the SCCTD have called the adventure a technical success, which is rather like saying that the surgery was successful but the patient died. In fact, little in the way of new technology was employed in the DAR system, Most of the original 75 vehicles used on DAR were new, air-conditioned, and propane powered, but they certainly were not of a new untested technology. Likewise the computer-assisted scheduling and routing system was nearly identical to, and in fact was an outgrowth of, the system in operation in Haddonfield, New Jersey. Finally, the telephone reservation system was using the most tested technology of all. Hence, there was no reason to expect anything other than a technical success.

This is not to say that all of these technological subsystems were integrated in such a way as to achieve a systems success. It is clear that they were not. But it is important to note that the systems failure resulted not from the technological components of the system failing to perform up to expectation but from a poor job of systems planning. This is not to say that the difficult things were done well and the easy things were overlooked. Systems planning is not easy. It consists of integrating all of the subsystems into a workable and efficient overall system, and it involves the consideration in detail of the effects that each subsystem has on all other subsystems. Unfortunately the systems planning function is often assumed to be easy, to involve only the application of common sense, and to be secondary in importance to the optimal design of subsystems. These assumptions inevitably lead to suboptimization and only by chance to an efficient and successful overall system design. While it is true that common sense plays a vital role in systems planning, this in no way diminishes the importance of, difficulty of, and time required for good systems planning.

While the systems planning function was badly handled,

if not ignored, in the design of the APT system, the purpose here is not to place blame but to point out some mistakes—specific omissions in the systems planning process—that were costly and that led eventually to the demise of DAR in Santa Clara County. The hope is that the discussion of these mistakes will reduce the probability of their being repeated in other DAR systems.

Post mortems are rarely performed on systems that have failed, since those with the greatest knowledge of the system have often played key roles in its failure and are not anxious to have the results any more widely publicized than is necessary. This lack of documentation unfortunately leads to the repetition of the same mistakes in other systems. In the field of public transportation, this results in placing high values on professionals who have operating experience and have been exposed to mistakes and failures. The experienced professional knows what does not work and is less likely to make mistakes. This is of the utmost importance since the costs of mistakes in public transportation systems can be gargantuan.

It may be of greater importance to discuss a systems failure in a DAR operation than in other operations in the transportation field because of the relative attractiveness of the demand-responsive concept. DAR has a significant initial cost advantage over other innovative transportation systems. The vehicle cost is relatively low, no fixed-guideway construction costs are required, the technology is available, and growth can be staged. Thus many, and especially smaller, communities can initiate such systems in a short amount of time and without an enormous initial capital outlay. This favorably low ratio of fixed costs to variable costs also provides flexibility; the system can be abandoned without a total economic disaster. With these attractions, it is expected that a large number of communities and transit properties will at least experiment with DAR in the near future. The following discussion will point out several factors that led the SCCTD to a systems failure so that others might not stumble over the same hazards.

FOUR FATAL MISTAKES

In the design of any system, it is inevitable that mistakes will be made. Most will have only minor effects on the eventual success of the system in question. Certainly this was the case in the DAR system in Santa Clara County. These mistakes, while regrettable, are of no concern here. Our interest here will be directed toward four major mistakes that together led to the death of the DAR system. Even though each was a serious error, the system probably could have survived any one of them; together they were fatal. They will be referred to as follows:

1. Inadequate customer communication system,
2. Starting the entire system at once,
3. Inadequate number of vehicles, and
4. Taxicab buyout.

Although the second and third are closely related in this instance, they represent different pitfalls and thus will be discussed independently.

Inadequate Customer Communication System

DAR began operation in the SCCTD on a Sunday; by the following Wednesday virtually everyone in the county had a horror story to tell regarding the telephone communication system. Typical reports had complaints in one (or more) of the following three categories:

1. Number of attempts resulting in busy signals,
2. Holding time once a call was completed, and
3. Service time once a reservationist was reached.

During the first few weeks it was not at all uncommon for a potential customer to place calls over a 2- to 5-hour period before completing one. Many people gave up on DAR very early in its life because they were unable to even complete a call. Once a call was completed, the caller was placed on hold, where he or she often stayed for 45 min or more before ever even speaking to a human being. At the end of this agonizing process, the reservationist took up to 20 min to complete the reservation procedure and communicate the information to the caller. Worse yet, the reservationist sometimes told the caller that it was too early to make this particular reservation and that the caller would have to try again later.

Several poorly solved or unanticipated problems led to the situation just described. First, and probably most importantly, the time the customer and reservationist needed to complete their communication was grossly underestimated—particularly for the start-up period—at 30 s per call. This seems to be an unrealistically low estimate even for a mature system in which both the customer and reservationist are knowledgeable about the information that must be transmitted and the procedures to be used. For example, Alameda-Contra Costa Transit in Oakland, California, used an estimate of 45 to 60 s in planning their systems in Richmond and Fremont. In the start-up of the SCCTD system, the reservationists were inexperienced in handling customer calls and took significantly longer to consult maps, procedural guides, and supervisors than they would in a mature system. Even worse was the fact that the callers had almost no knowledge of the system, of how the system could be used, or of the information required and the procedure for making a reservation. Thus the information interchange was terribly inefficient.

In addition, many of the calls during the first few weeks were calls from people who wanted to learn about the system and how to use it but did not wish to make reservations. At first these calls were handled by regular reservationists who were not well trained to provide general information about the system. These calls required an average of 6 to 9 min of communication. The result was that a caller spent an unusually long time talking to a reservationist and frequently ended up not even making a reservation. The number of telephone lines and the number of reservationists proved to be totally inadequate to serve the realized calling volume.

Eventually this situation eased, but the damage had been done. More telephone lines were obtained, more reservationists were hired (the number of reservationists was increased from 55 to 155), customers began to call only for reservations as they learned about the system, and both customers and reservationists became more knowledgeable, resulting in faster and more efficient information transfer. Thus the time required to make a reservation decreased to about 45 s, but some potential customers had been lost forever. The disastrous early days had made many citizens permanent enemies of DAR. Most of these were transit-dependent people who were doubly hurt since they were not only unable to ride on DAR but had also been deprived by the cutback of fixed-route arterial service that accompanied the initiation of demand-responsive service. Many people gave up on DAR very early, but they continued to be vocal opponents of the system throughout its life, as well as opponents of the SCCTD in general. As large as the dollar cost of DAR was in Santa Clara County, it is much less significant than the residual sentiment

against public transit that remains and probably will continue for quite some time.

Clearly then a mistake was made in not providing adequate service capacity in terms of telephone lines and reservationists. This was especially true during start-up and resulted in part from an unrealistically low estimate of communication time. However, there is another reason that the calling volume overwhelmed the system. The SCCTD undertook a large advertising campaign before beginning the DAR service. County residents were bombarded via several media with messages extolling the virtues of the soon-to-be-initiated system. The advertising was very effective in creating interest in the new system, but it conveyed almost no information about how to use DAR. This added greatly to the initial calling volume, especially the large number of information-only calls.

A few recommendations seem to follow directly from the problems caused by the inadequacy of the customer communication system. First, care should be taken not to overadvertise the system before beginning its operation. It is desirable to have a small initial calling volume, with subsequent advertising, if necessary, to increase the volume as the reservationists become more skilled in handling calls. This will maintain a balance between the demands on the communication system and its call-handling capacity. Second, advertising should contain information on how to use the system. Third, during start-up, special information operators should handle questions regarding the system, leaving reservationists to perform their special task. In this way, the bulk of the queuing will occur initially in the information area and will not tie up the reservation system. This will prevent the anomaly of having too few vehicles to serve the customers, but simultaneously having those vehicles underused because customers cannot get reservation calls through.

Fourth, for a period of 1 to 2 weeks before the initiation of service, an information number should be available for questions about the system. Instructions can be given on how to use the system and how and when to make reservations. This personalized information service should be widely advertised, and the telephone number can continue to be the information-only number after service begins. Fifth, realistic (even conservative) estimates must be made of the communication time required to make reservations. Further, recognition that this time will decrease as the system matures through the use of elementary learning curves is recommended. The importance of these estimates cannot be overemphasized since, together with estimates of the volume of calls, they determine the required number of telephone lines and reservationists for a given level of service. Finally, the system should start small and grow as the reservationists learn more about their jobs, the system, the geography of the area, and the arterial routes. That is, of course, the second of the great mistakes made in the Santa Clara County system.

Starting the Entire System at Once

The DAR system served essentially the entire county from the first day service was offered. As a consequence, all mistakes had large impacts and all problems were systemwide from the very beginning. With large expensive problems always at the forefront of public attention, the staff of the SCCTD had no choice but to constantly be putting out fires. They had essentially no time for even short-range planning during the 5½-month life of DAR. The system soon became a hodgepodge of the initial design plus the design changes made to correct immediate problems. Most of these immediate problems were not unusual or unusually difficult; they were the kind that always arise when a new system is implemented. Given sufficient time to work on them, the SCCTD staff would probably have solved them efficiently, but the magnitude of the system multiplied the visibility of the problems and, hence, the importance placed on their immediate solution. This time pressure on the staff meant that the systems aspect of the problem in particular was largely ignored. That is, not enough time was spent determining how that part of the system under examination interacted with other parts and thus how the various alternative solutions to the problem affected other parts of the system. Predictably, these patchwork solutions nearly always created new problems, and the staff ended up chasing its tail.

An example of this is the manner in which the problem of inadequate call-handling capacity was handled. The public outcry caused the Transit Board to direct the staff to immediately increase the number of telephone lines and reservationists. This increase of more than 60 percent was more than could be efficiently and adequately trained and supervised, so the call-handling capacity was not increased sufficiently. In response, even more telephone lines and reservationists were added. Their insufficient training and supervision led to increased call-handling times. To counteract this, an automated "address look-up" file was added to the computer system, but the file-maintenance system necessary to keep the file updated was never implemented. Thus, although reservations could be made more quickly, the accuracy of the file deteriorated with time; this of course degraded the entire system.

Another example comes from the relationship of DAR to the fixed-route system. Shortly after demand-responsive service began, the fixed routes were modified, with the new routes determined at least partially by DAR zone boundaries. They were less extensive than the old routes because fewer buses were available. The idea was that areas not well served by the new routes could be served by DAR. Intense public pressure forced the SCCTD to resume service on some old routes. This not only took buses away from an already vehicle-deficient DAR system, but it also added routes somewhat randomly to an existing network without considering how they interacted with existing routes.

There are several reasons that public systems tend to be put into operation all at once, some of which have to do with optimal systems design and economics. However, the reasons are often purely political, as in the case of the SCCTD. It is difficult to tell the county residents, most of whom are voters, that a new transportation system providing high-quality service is going to be available in only a limited section of the county, even though all county residents are paying for the costs of the system. This is especially true when the new system is not experimental but is intended to eventually be part of the total county public transportation system.

As politically difficult as initiating a DAR system in only a portion of the county (or any overall service area) may be, the recommendation is obvious. Start the system small and let it grow as capabilities increase and normal problems are solved. We have already seen that this can have the beneficial effect on the communication system of keeping the demands on that system in balance with the capacity. Here we have seen that, with an initially small system, the normal and expected problems will not be magnified to an extent that will result in a public outcry. An added bonus of starting small is that some overcapacity will likely exist, which can be used to make certain that the level-of-service goals decided on are met. These goals must of course be realistic, so as not to create a crisis in expectations when the sys-

tem is enlarged to its eventual size. Meeting the level-of-service goals will result in satisfied customers, who will be friends of DAR and probably proponents of public transportation in general.

Inadequate Number of Vehicles

Throughout the life of DAR in Santa Clara County, the number of vehicles was inadequate for the established level-of-service goal, which was specified as a waiting time of 5 to 10 min for DAR (1). To achieve this level of service, 334 buses would have been required during the peak commuting periods and 210 buses for the average midday demand in the SCCTD (1). What actually occurred was that about 75 buses were assigned to DAR during midday and between 40 and 50 for the peak commuting hours. Due to vehicle breakdowns and routine maintenance, between 5 and 10 of these buses were not dispatched during any given day. Thus 65 to 70 buses were available when at least 210 were required to meet the goals set by the SCCTD. It may be that the 5- to 10-min waiting time level-of-service goal was unrealistic and more than people were willing to pay for. Nevertheless, it was a stated goal and contributed to the aforementioned crisis in expectations.

The inadequate number of buses led to unacceptably long waiting times in some cases and very unreliable service. The long waiting times were especially bad for transit-dependent people with no alternative modes of transportation, and they complained bitterly. For others, the long waiting times simply meant that another mode of transportation would be selected; many learned not to even consider DAR as an alternative unless they were able to plan their trips far in advance. Thus DAR was not useful for the spur-of-the-moment trip, the very kind of trip that it should serve, since the alternative is usually the automobile carrying only one person.

The unreliability of service, however, had a far more devastating effect on customers. People were afraid to use DAR because of the uncertainty of being picked up for the return trip. There were numerous letters published in local papers recounting stories of people being stranded in some remote and unfamiliar location. Given that they had taken DAR to that location, their alternatives for the return trip were significantly reduced.

The problem of stranded customers may not be primarily due to the shortage of vehicles. A person planning a trip may not know exactly when he or she will be ready to return and may therefore make only one reservation. If, when the customer is ready to return and calls to make the reservation, he or she is given an unrealistically long waiting time, like 1 or 2 hours, this customer has been effectively stranded due to a shortage of vehicles. However, consider the case in which reservations for the return trip are made at the same time as the reservation for the outbound trip. In this case the customer is stranded if the bus for the return trip is unduly late. If there is a telephone within walking distance, a call can be made to check the reservation, but this involves the risk of missing a bus that arrives while the call is being made. If a telephone is not available, the customer cannot even call a cab. Thus stranding can occur even when the number of vehicles is adequate; it can result from breakdowns in routing, scheduling, or reservation accumulation. It is probably the worst thing (other than physical harm) that a transportation system can do to a customer. Stranded customers completely lose confidence in the system, and they will not continue to use it if they have alternative means of transportation.

Taxicab Buyout

The fourth mistake was the straw that broke the camel's back, since its effects became known after the effects of the other mistakes were apparent. Early in January 1975, the Santa Clara County Superior Court ruled that the SCCTD must either discontinue DAR or immediately begin negotiations to buy out eight competing taxicab companies that were then operating in Santa Clara County. The presiding judge ruled that the SCCTD was operating in violation of the legislative act under which the SCCTD was formed. This act rather clearly specified that if the SCCTD initiated a service that competed with any existing public transit operation, the district must either compensate the competing system or buy them out. It was clear from the beginning that the taxicab companies were a public transit operation. However, the staff of the SCCTD took the position that DAR was not in competition with them primarily due to the shared-ride nature of DAR and its circuitous routes with multiple scheduled pickups and drop-offs. The Superior Court did not agree and held that the door-to-door service of DAR, the fact that routes and schedules were not fixed, and the use of the telephone to make reservations taken together made DAR a service essentially similar to and hence in competition with the taxicab companies.

Immediately following this ruling, the Transit Board voted to continue DAR and begin negotiations with the taxicab companies. Before negotiations reached the point at which offers were made, DAR was dropped in all but the southern portion of the county, where it continues with six vehicles. Based on the cost of the taxicab buyout in the southern portion and other estimates, it is estimated that the total cost of the countywide buyout would have been in the neighborhood of $1.5 million.

The major mistake in connection with this ruling was one of omission. The taxicab competition issue should have been resolved before the system progressed past the initial design stage. The resolution of that issue would have had a bearing on what kinds of service DAR should have provided and on what the vehicle mix should have been. Furthermore, a cost of the magnitude of $1.5 million and the necessity of providing taxilike service could have had an effect on whether or not the SCCTD still wanted to go ahead with DAR. It is therefore recommended that all legal issues be carefully examined and resolved as far as possible well in advance of the final system design stage of a DAR project. This is especially true with respect to issues involving the possibility of driving extant privately owned firms out of business. Regardless of the provisions of transit acts and public utility codes, the courts are probably not going to look kindly on the use of public funds to subsidize public transit organizations in competition with already existing private companies.

COSTS

Even though the costs of the SCCTD DAR were not unusual as DAR systems go, costs are worth discussing briefly because they are relatively high in any DAR system. If a system is initiated and none of the foregoing mistakes is made, nor any other serious mistakes, the system could still be an economic failure due to the failure to realize that the system is so costly. The problem is the gross mismatch between revenues and costs in a DAR system such as Santa Clara County's. A large number of cost and revenue figures are available (1) and could be presented, but the three shown below are sufficient to indicate the magnitude of the problem. For comparison purposes, data from the Haddonfield DAR system are also shown. The Haddonfield data

are for the period from October 20, 1973, to January 31, 1974, and are taken from a recent report (2).

System	Productivity (riders/ vehicle-hr)	Revenue ($/ vehicle-hr)	Cost ($/ vehicle-hr)
Santa Clara DAR	5	0.75	20-21
Haddonfield DAR	8	2.26	19.25

Note that, although the Haddonfield cost figure is about 6 to 7 percent lower than that for the SCCTD, the data from Haddonfield were collected one year earlier. The particular period selected for Haddonfield's data was just following a fare reduction from 60 to 30 cents. Thus both the fare schedule and the costs were very similar to those experienced by the SCCTD. This is not unexpected since the systems are both relatively new and very much alike in most respects. The major difference is in the size of the service area; Haddonfield is about 28 km^2 (11 $miles^2$) and the SCCTD serves about 518 km^2 (200 $miles^2$). The tremendous start-up difficulties of the SCCTD's system, described earlier, account for the low productivity. Haddonfield, having begun operations in February 1972, is a more mature system. Finally, the revenue for Haddonfield is higher due to both a higher productivity and a higher average fare.

The numbers shown should not be considered exact. They are subject to considerable error in measurement, and it is almost a certainty that they are calculated in at least slightly different ways in the two systems. However, even with this in mind, there are two significant points to be made. First, the costs incurred by the SCCTD system do not seem to be out of line for the type of system they chose to implement. Second, there is a huge gap between revenues and costs in the SCCTD system, and this gap would remain even if the productivity doubled. In fact, if the productivity tripled to 15, which is the level in SCCTD for scheduled commuter-special buses and also for arterial bus routes (1), the revenue would increase to about $2.25/vehicle-h, assuming no change in fare structure. A large gap would still remain between revenues and costs. A productivity of 15 is certainly an upper limit for many-to-many DAR services, and 10 is probably a much more reasonable upper limit. These are staggering and sobering figures, but they must be considered when decisions are being made regarding the establishment of a DAR system.

CONCLUSIONS AND RECOMMENDATIONS

For the four major mistakes discussed earlier, detailed recommendations have already been made. However, there are several other recommendations that should be made for completeness. They do not necessarily pertain to mistakes made in the SCCTD system, or any other system for that matter, but they do represent the accumulated experience I acquired during my work on DAR systems.

DAR should be considered for implementation only in areas of low demand density. For the SCCTD the overall productivity for arterial routes is 15 with some routes achieving 70 passengers/vehicle-h during peak periods (1). From this it is evident that arterial routes can exploit high densities and achieve corresponding increases in productivity. However DAR, by its very nature, cannot take advantage of high density when operating in the many-to-many mode. Because of the multiplicity of trip origins and destinations, an increase in productivity can be achieved only with a corresponding deterioration in the level of service. However when the demand density is low, arterial routes will suffer low rates of productivity since buses are nearly empty much of the time. If headways are increased in order to increase productivity, for example, the level of service will deteriorate. In summary, if demand density is high, use arterial service because productivity can be increased without a corresponding deterioration in the level of service. If demand density is low, use DAR because the level of service can be held to the desired level without a corresponding decrease in productivity.

In addition to specifying arterial or DAR service on the basis of the geographical characteristics of demand density, the time characteristics can also be used. In almost all geographical regions, demand density is greatest during the peak commuting hours. For exactly the same reasons discussed above, it is desirable to curtail DAR service during these periods and replace it with an arterial-like service that is scheduled and that has a sharply reduced number of origins or destinations, perhaps with gather or scatter modes of operation, which have many origins and one destination or one origin and many destinations, respectively. The objective is to increase the productivity of the buses that are diverted from regular many-to-many DAR service by taking advantage of the temporarily high demand density. Once the peak period has passed, the buses return to regular DAR activity. Even during peak periods, some buses should continue to provide many-to-many service for emergencies, for the handicapped, and for others who for some reason are not able to use arterial or arterial-like service. However, it must be clearly understood by everyone that the level of service in the many-to-many mode will deteriorate severely during these peak periods.

A related issue that should be resolved before service is initiated concerns the transportation of school children. This is especially relevant for private schools for which publicly supported school buses are not available. In many areas, the number of students to be transported could swamp the system during certain hours. Essentially, the transit agency must determine whether or not it wants to be in the school busing business and, if so, how that function should be organized. This is a very emotional issue for taxpayers whose children attend private school. The right solution depends entirely on the goals and resources of the agency and citizens involved. The recommendation here is that the issue be thoroughly discussed and decided upon before DAR service is begun.

It is recommended that every new DAR system be thought of as an experiment, regardless of the degree of enthusiasm for and commitment to the new system. This kind of attitude will greatly facilitate the routine collection of data that will be important in making decisions regarding the system. A recent report (3) detailed the data that should be collected for the Haddonfield DAR system, but it applies equally well to any DAR system. This experimental attitude during the early stages of systems planning will lead to the most efficient design for data collection. During the early stages of any new DAR system, a great many questions will be asked about the system. The existence of reliable data logically and efficiently summarized can immensely improve the chances for a systems success.

The normal procedure is to initially purchase all vehicles of exactly the same size. Under some circumstances, that may be the appropriate action. However, since both large and small vehicles have advantages, it is possible that a mix of vehicle sizes will be more efficient. Large vehicles have the important advantage of flexibility. These buses can easily be used for arterial routes, bus pools, charter service, and so forth when

they are not being used in DAR service. On the other hand, smaller vehicles are less expensive, have lower operating costs, and are more easily maneuverable on residential streets. Due to the nature of DAR, it is rare to have many passengers on board simultaneously, and a vehicle that carries 10 to 15 passengers may be more than sufficient. This has the added psychological advantage of not having mostly empty large buses on display for the taxpayers to observe. It is therefore recommended that two or more vehicle sizes be considered, particularly if many-to-many service is going to be maintained during peak hours.

Finally the question of what fare to charge must be carefully considered. The SCCTD selected 25 cents, which was felt by many to be too low. When DAR is operating at or near its level-of-service goals, it is a high-quality service; customers will realize this and expect a reasonable fare. It is important to remember that the fare serves two primary functions. It contributes to paying system costs and it helps to allocate a scarce resource—transportation opportunity. The fare will probably never even approach paying the operating costs of the DAR system, but the gap between revenues and costs can be minimized by a judicious choice of fare levels.

It is also clear that in most places public transportation is being used as an instrument of social policy. The young, the aged, and the handicapped are almost always offered reduced fares. This has an effect on the overall fare level since planners feel a social obligation to keep the cost of transit within reach of the transit-dependent citizens, who also tend to be poor. The use of the fare as a rationing device gives the DAR operators a degree of control over demand for the service. The estimation or prediction of transit demand is one of the most difficult transportation problems in existence. It may be wise to initiate DAR service at a fare larger than the expected steady-state level to ensure that the system will not be overwhelmed by initial demand. It will be a relatively easy matter to reduce fares later when the system is past the start-up difficulties. Also, this kind of a change may provide valuable information regarding the response of ridership to fare reductions.

The purpose of this paper has not been to criticize but rather to analyze. A number of recommendations have been made that may prove useful to systems planners in various stages of designing DAR systems. The SCCTD's system was analyzed with respect to four major mistakes to provide a case study in which issues that seem now to be easily resolvable led to the death of the system. The lesson is that no matter how good the system or how talented the people involved a systems failure can, and probably will, result from a lack of or a poor job of systems planning.

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A Statewide Dial-a-Ride Program

Gerald A. Geile, Urban and Public Transportation, Michigan Department of State Highways and Transportation

In 1972 the Michigan legislature voted to make state funds available for public transportation programs. This paper describes the kinds of programs undertaken with this support and explores the factors that have made these programs highly successful.

We are quite proud of Michigan's statewide dial-a-ride program, which has succeeded in providing a cost-effective transportation service for the general public in 28 communities. State-sponsored dial-a-ride service has in turn given us the experience to implement additional paratransit programs for special groups. Among these programs are 20 curb-to-curb transportation services for the elderly and handicapped persons in rural areas and metropolitan cities, 18 programs under section 1662 in support of private nonprofit agency transportation, and the nation's first regional transportation system under section 147.

One of the lessons we have learned is that a state can accomplish much on its own to expand mobility for its residents. Our investment in a statewide dial-a-ride program that covers 28 communities and carries 1.5 million riders a year has required less than 5 percent of all state moneys allocated for public transportation. I am certain it is within your financial and technical capabilities to launch a dial-a-ride program similar to Michigan's—similar, but not exactly like Michigan's program, because there is no single correct way to design a dial-a-ride system. There is no magic formula that, if followed faithfully, guarantees success or, if altered, dooms your efforts. Each of our small-town dial-a-ride systems is unique. Each one is managed under a slightly different structure. Each one's operations are tailored to local needs. It is not because we have found the correct procedure or scored a technological breakthrough that our program is so well accepted by such a broad range of communities. It is because our program is tailored to local needs.

I believe Michigan's dial-a-ride programs are also successful for two more reasons—the state, on its own, willingly shouldered the risk of innovation and we adopted a minimum-planning, maximum-implementation approach to dial-a-ride.

POLICY AND DECISION-MAKING BACKGROUND

In mid-1972 Michigan, like many other states, saw its transit services staggering into the last stages of financial collapse. Only nine of our largest cities had even the remnants of a bus system—60-min headways and rolling stock 12 or 15 years old. Cities as large as Flint (population 350 000) periodically lost bus service as local support was withdrawn. Middle-sized and smaller cities had no alternative to the private automobile. In this respect, Michigan was much worse off than many other states in which bus service survived in many mid-sized communities.

It was clear to Governor Milliken and, fortunately, to a majority of state legislators by 1972 that public transportation is a necessary public service and one that must be publicly supported like police and fire service. After much debate, Michigan took an important step in late 1972. The legislature approved diverting 0.5 cent of the state's 2.4 cents/liter (9 cents/gal) tax on motor fuel into an exclusive fund for transit purposes. This sum—about $22 million annually—was shared at the outset by the nine surviving metropolitan bus systems. Funds were used for operating aid up to $\frac{1}{3}$ of costs and as a 20 percent local match for federal capital grants. Responsibility for public transportation programs was incorporated in a new bureau of the Department of State Highways and Transportation. The State Highway Commission, advised by a Public Transportation Council, sets policy for public transportation programs.

Thus, we began in 1973 to rebuild a decent public transportation system for our state. Our efforts began in the nine cities with bus service still in place. Yet we recognized that the need for a transportation alternative transcends urban boundaries. Gasoline in mid-1973 cost the same 16 cents/liter (60 cents/gal) in northern Michigan and was in just as short supply there as in Detroit. More important, small towns and rural areas contained the same (or greater) proportion of elderly, poor, and handicapped persons—the mobility-deprived—as our larger cities.

As we looked for a solution to the transportation prob-

lems of small and rural communities in 1973, we had to look no further than Ann Arbor. An experimental dial-a-ride program funded through the state had been in operation there for two years. It had just won the overwhelming support of voters in a campaign to levy an additional property tax. Ann Arbor's dial-a-ride service was successfully providing door-to-door on-demand transportation to one Ann Arbor neighborhood that contained roughly the population of a small outstate city. If Ann Arbor could provide door-to-door bus service to part of a large community, why couldn't a smaller city provide the same service to all of its residents?

Why not indeed? The State Highway Commission and Public Transportation Council decided to try. These bodies approved a demonstration of dial-a-ride service in nine outstate communities. We already had funding to carry out such demonstrations at 100 percent state expense under a section of an act that established the General Transportation Fund. That act earmarked 10 percent of the fund's annual receipts to be used for demonstration purposes—in the words of the act, "to encourage... application of new ideas and concepts in public transportation facilities and services."

According to the Urban Mass Transportation Administration (UMTA), a demonstration is a controlled, highly planned application of a theory in a limited field test. An UMTA demonstration tends to be structured like a laboratory experiment in which the success of the program being tested is secondary to the opportunity to collect data. If an UMTA demonstration succeeds, it does so for precisely identifiable reasons. In contrast, Michigan's definition of a transit demonstration is considerably looser. We are willing to try an idea we think will work and to demonstrate over and over again that it will work in as many communities as are willing to make a minimum commitment to our program.

THE FIRST DEMONSTRATION PROGRAMS

On July 11, 1973, the State Highway Commission formally approved a first-year dial-a-ride demonstration program budgeted at $1.2 million. This money would start service in nine communities selected from a list of 22 cities with populations between 9000 and 35 000, excluding those communities within the jurisdiction of a metropolitan transit authority. Our plan was simple. We would offer the first nine communities to show interest in the program a one-year trial of dial-a-ride service at state expense. We would buy vehicles and make up operating deficits. We would establish an operations headquarters, train drivers and dispatchers, apply for radio licenses, and see to other details before service was implemented. Average start-up and first-year operating costs for a typical dial-a-ride transportation (DART) system using four small vehicles turned out to be $105 000. The local commitment required was minimal: a token $1000 contribution and a good-faith pledge to retain service with partial local funding in the second year. The state agreed to sign over title to vehicles and radios in the second year for $1.00, so that all capital equipment purchased by the state became local property. Furthermore, the state continued in the second year to underwrite up to ⅓ of operating costs through our regular transit assistance formula.

The State Highway Commission's action approving this kind of high-risk demonstration is perhaps unparalleled. UMTA certainly would not undertake such a risky program, one unsupported by exhaustive preplanning. For the state of Michigan to go into the field with a million dollars and a relatively unproven paratransit technique and then to spread that program around nine communities on a first-come, first-served basis in less than one year set heads shaking in amazement at UMTA. In fact, the feedback we get suggests that Washington still does not believe we have succeeded.

But we have succeeded. We have succeeded beyond our hopes. Our first three DART systems began operating in February and March 1974, just 6 months after the commission resolved to fund dial-a-ride programs. By the end of 1974, 13 systems were in operation, scattered around the state. In November of that year, our infant program faced its first critical test. Special votes on levying additional property taxes were scheduled to determine whether voters in the first three communities to adopt dial-a-ride would tax themselves to retain service. Confident as we were that dial-a-ride was needed and appreciated in small communities, we waited nervously for those election results. We need not have worried. By approvals as high as 73 percent, all three communities said yes to dial-a-ride.

And that has been the story ever since. Of 18 communities to face the question of second-year funding, 11 approved special property taxes for dial-a-ride, and 7 agreed to fund it with existing local revenues. Not a single state-sponsored DART system has been discontinued. Clearly, Michigan dial-a-ride has scored its greatest success at the grassroots level. Having seen dial-a-ride in operation and having had a chance to use it, local residents are overwhelmingly willing to pay for it.

And from our state DART experience, we have expanded into paratransit programs for the elderly and handicapped in 34 rural counties and 11 metropolitan areas, which include commuter or supplemental bus service in conjunction with metropolitan line-haul service; a section 16b2 program in 28 rural areas; and a 3-county section 147 program in our eastern Upper Peninsula. A second 4-county section 147 project may be approved this month.

One side effect of statewide dial-a-ride has been to turn many skeptical legislators into strong supporters of transit programs. Outstate legislators who bitterly opposed our first diversion of gasoline tax funds are now convinced by the success of dial-a-ride in their districts that public transit is indeed a worthwhile cause. That change of heart has translated into expanded state funding for our public transportation program.

Operationally, our systems are among the most efficient in the nation. The average subsidy per ride across 15 systems with one year of operating experience is $1.32, the average waiting time is less than 20 minutes, productivity per vehicle-hour averages 6.0, and the monthly per-capita ridership is 0.33.

Our ridership and trip-purpose profile suggests the kind of social impact dial-a-ride is having on small and rural communities. Ridership is split about equally among older persons, youngsters, and the general adult public. A great percentage of the trips are made to a downtown shopping area or to medical-professional services.

About half of our passengers in one survey said they would not have made the trip, or would have postponed it until someone else could drive them, if dial-a-ride were not available. The other half can be characterized as riders by choice. In addition to providing first-class citywide transit service for all residents, dial-a-ride is giving the elderly and handicapped residents of Michigan's small towns the kind of mobility most of us take for granted.

I would also like to briefly touch on Michigan's carpooling experience. At the height of the 1973 gasoline shortage, the state of Michigan launched a program to encourage car pools among state employees. We used a computer-aided matching system to bring riders to-

gether and reserved the choicest spots in state parking facilities for car poolers. At the most, we estimate this effort removed about 250 cars from state lots. Some of our metropolitan areas also undertook car-pooling efforts in 1973. The most aggressive (Grand Rapids) attempted to enlist the cooperation of private employers. This effort, too, was only moderately successful. Interest in car pools has nearly disappeared today.

Our highway park-and-ride lots have been more successful. The Michigan Department of State Highways and Transportation has established 51 such lots statewide by erecting signs and making modest improvements to the shoulders of state rights-of-way near freeway entrance ramps leading to metropolitan areas. This program actually legalized what motorists have done informally for years and has generated about twice as much interest in ride sharing.

CONCLUSIONS

There are three factors that I believe contributed most to Michigan's successful paratransit experience. First, I believe our program succeeded from a policy basis because we started with the basic assumption that every small community needs some kind of public transportation service. We did not spend months on prescreening candidate communities. As a corollary, we assumed that dial-a-ride or demand-responsive transit was the correct strategy for meeting this need. We did not spend time on an analysis of alternatives. Our procedure was simply to introduce dial-a-ride in communities that made a minimum commitment at maximum state risk. Our assumption that local communities will gladly pay to retain service after the first year has been proved correct.

Second, I believe we have succeeded because our state implementers allowed each dial-a-ride or paratransit system to develop with a minimum of interference. They resisted the temptation to inflict their prejudices about how a dial-a-ride service should be organized. As a result, we have systems operated by cab companies, systems operated by community action agencies, and systems operated directly by local governments. Some of our DART dispatchers use a zone system. Some use a card file. But all of the systems are working. I cannot stress enough the need for a state or regional agency to allow—in fact, to require—local initiative in establishing a paratransit system. The community must perceive it as its own, not another remote government boondoggle.

Finally, I believe dial-a-ride has succeeded in our small communities and in Ann Arbor because our programs started small and grew from there. We rejected sophisticated technology. We avoided the problems some large unsuccessful systems stumbled over by choosing conventional hardware off the shelf. We started with manual rather than computer-aided dispatching. Ann Arbor's system began on a manageable scale in one neighborhood. Over the years, it has slowly expanded. Today, Ann Arbor is working into computer dispatching and other sophisticated software, but it is doing so with a solid background of operating experience.

We believe that statewide dial-a-ride has had a profound impact on Michigan. Obviously, the 1.5 million rides it provides in outstate communities represent a significant number of shopping trips downtown or trips by elderly or poor persons to receive basic services. Furthermore, dial-a-ride has caused a major shift in public attitudes toward public transportation. When Michigan began its efforts to restore transit, the outstate rural legislators were bitterly opposed to spending state money on something for the big cities. Today, outstate legislators give public transportation their strong support, thanks to the enthusiasm with which their constituents have greeted dial-a-ride. The $22 million annual funding level for public transportation programs approved in 1972 has been boosted to $52 million this year and more than $70 million in fiscal year 1976-77. Transit dollars spent in southeast Michigan and Detroit rather than on outstate dial-a-ride systems would have had a negligible impact on service levels there. If a total of $3 950 000 were spent in southeast Michigan on line-haul service, it might have purchased and operated 30 buses—less than a 2 percent increase in the region's bus fleet. Instead, $3 950 000 spent on dial-a-ride is annually providing 6 440 000 km (4 000 000 miles) of highly visible service in 28 cities.

There is a new mood of public support for state transit programs in Michigan, thanks to dial-a-ride. That new attitude was expressed well, I believe, in an editorial on July 5, 1975, by outstate rural legislator Sen. Richard J. Allen.

> Times change. So do people . . . even some politicians. The Senate easily passed the mass-transit bill allowing for bonds to be paid off by gas tax revenues.
>
> Only a few years ago such a proposal would have met with strong resistance from a number of sources. Most of us outstate legislators would have opposed it automatically on the basis that statewide tax dollars would be going primarily to big cities and especially to southeast Michigan.
>
> Motorists all over the state would have put up a howl that they should not pay for systems they did not use. Auto manufacturers would have strongly protested that their product was being forced to finance its competition.
>
> The ball game has changed. . . . Even motorists who hope never to ride a bus or a subway now support their development. They recognize gasoline supplies will be continually restricted and they hope more of it will be left for them! Auto companies have begun to have an inkling that an efficient mass transit system may be necessary to preserve the auto as a viable part of our transportation system. Mass transit is no longer viewed as the poor man's choice; we all are beginning to realize we may want to use it . . . if not right now, certainly by the time gasoline hits two dollars a gallon!
>
> Times change; even some of us politicians do. I voted for mass transit.

Demand-Responsive Public Transport in Great Britain

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This paper reviews the development of demand-responsive public transport (dial-a-ride) in Great Britain, as well as describing some of the other innovative small bus systems currently in operation.

A paper on the Mansfield, Ohio, dial-a-ride (DAR) demonstration, published in July 1970 (1), was the first description in Britain of demand-responsive bus operation. This led to a number of inquiries from potential systems operators (2), and in June 1972 the first British DAR system started in Abingdon, operated by City of Oxford Motor Services Ltd., a subsidiary of the National Bus Company. This service was followed in September 1972 by the Maidstone service, run by private taxi and minibus operators, then the Harrogate Chauffeur Coach (October 1972), Eastbourne Corporation's service (November 1973), and finally the Carterton Dial-a-Bus service, which was also operated by City of Oxford (3). These early services were all small, used no more than two vehicles, and were limited in operation, since none of them ran throughout all normal bus operation hours.

The second generation of British dial-a-ride services started with the Harlow Pick-Me-Up service in September 1974, quickly followed by London Transport's Hampstead Garden Suburb Dial-a-Bus, the Sale Dial-a-Ride system, Milton Keynes' Woughton Dial-a-Bus, and most recently (December 1975) the West Midlands Passenger Transport Executives' Knowle and Dorridge Dial-a-Bus. These services are distinguished from the earlier ones by being rather larger operations, carrying considerably more passengers, and operating throughout the day and evening at least 6 days a week.

Of the first-generation services, Abingdon ceased operation in July 1973 and was replaced by a fixed-route hail-stop minibus service. Both the Harrogate and Eastbourne services are still in operation, though with changed service areas and times of operation. The Carterton service is also still in operation but will probably be replaced shortly by a revised routing of the conventional stage-carriage service, which also operates within the dial-a-ride service area. The Maidstone service continues to operate and, although a number of proposals have been made for its extension (4, 5), it is still running in its original form.

SECOND-GENERATION SYSTEMS

Harlow Pick-Me-Up

The Department of the Environment, through the Transport and Road Research Laboratory (TRRL), has taken an active interest in the development of demand-responsive bus services. A number of the services mentioned above have received some assistance, including funding from the department, but the principal demonstration project has been the Harlow service. The Centre for Transport Studies at Cranfield is under contract to TRRL to analyze and evaluate DAR in Britain, and, although all the systems in operation fall within the ambit of the research work, much the greater part of it has been devoted to the Harlow service.

Operational Characteristics

Detailed descriptions of the operation of the service have been given elsewhere (6, 7); briefly the system operates between a service area (Old Harlow) and a small number of important trip generators elsewhere in the new town. Old Harlow is primarily a residential area, though it has an attractive and fairly comprehensive local shopping center. The area contains approximately 5000 people in an area of 1.8 km^2 and is about 3 km to the northeast of the new town's principal shopping center (The High).

The Pick-Me-Up (PMU) service is operated by London Country Bus Services and runs from 7:00 a.m. to 11:40 p.m., Monday through Saturday, providing a many-to-many service within Old Harlow and a many-to-few service between Old Harlow and The High, the main railway station, a local shopping center, the principal hospital in the new town, a recreation area, and two schools. Three 16-seat Ford Transit buses are used during daytime hours and one in the evening. Two other similar vehicles are held in reserve as traffic and engineering spares. The control office for the service is located in the main bus station at The High, from which the PMU vehicles depart at regular intervals (in the daytime, approximately every 20 min; in the evening, every 45 min).

Passengers traveling out of the service area can book either in advance or on demand by telephone to the control

center, or they can place a standing order for regular pickup. Hail-stop travel is also permitted within the service area but, since there is no fixed route, this usually only occurs at one of the three points that each bus is required to pass on every tour through Old Harlow. Household telephone ownership within the service area is fairly high by British standards (66 percent versus below 50 percent nationwide), but, since there is a significant proportion of the population without immediate access to a telephone, 10 free direct-line street telephones were placed in the service area. Another 3 free lines are located at the railway station and at the local shopping center en route between Old Harlow and The High. To travel to Old Harlow a passenger can board the bus at the bus station in The High or telephone to arrange for a pickup from any one of the other principal locations served by PMU.

Prior to the introduction of PMU, Old Harlow was served by regular stage-carriage bus with three services per hour between the western side of Old Harlow and The High and a rather less frequent service from the eastern side. No changes were made to any of these regular services when PMU was brought into operation. At the start of the experimental services, the one-way fares charged were 10 pence (adult), 8 pence (child), and 5 pence (pensioner)—a difference of 1 or 2 pence over the fares charged on the regular services. Since then the fares of all services have increased, and, at the time of writing, the PMU fares, while remaining the same for journeys wholly within the service area, were 15 pence for adults traveling outside the service area. The one-way adult fare on the regular services has also risen and is now 12 pence. The PMU service covers about 30 percent of its total costs from fare-box receipts.

During the first full week of operation, the service carried approximately 3000 passengers. The ridership then rose to 3500, stabilized temporarily at that level (weeks 3 to 10), and then continued to rise, finally plateauing at a little more than 4000 passengers from week 23 onward. This represents an average of approximately 17 passenger-journeys/bus-h, a level significantly higher than anything achieved in the earlier British DAR systems and equivalent to between 50 and 60 percent of the system's passenger capacity.

The service exhibits peaking characteristics but to a much lesser extent than is usually the case with conventional urban services. In fact the evening peak emerged first, followed by a midday peak, and then, from about 3 months on, the morning peak (8). The relative lateness in the establishment of the morning peak suggests that users prefer to try the service at times and for journeys on which arrival time is not critical, until they feel secure enough to trust that the service really will perform satisfactorily in this respect. However, although peak periods are discernible in ridership levels, daytime off-peak hours are also well used, with more than 40 passengers/h, compared with 55 to 65 in the peak period. The evening period from 8:00 p.m. onward has remained at a much lower level (about 10 passengers/h), though it should be remembered that there is only one vehicle in operation during this time, which lowers the service standards. The daytime service was designed to give an average response time of approximately 15 min and a maximum time, under heavy load conditions, of less than 25 min. Analysis of estimated and actual pickup times for passengers boarding in the service area shows that these service standards have been met and that the accuracy of the estimated pickup times given by the PMU dispatchers is good: Between 85 and 90 percent of actual pickup times are within 15 min of the estimated time.

A series of surveys has been carried out on the service and its users; among these were a before-and-after household and travel survey in the service area and in a control area elsewhere in Harlow, on-vehicle surveys on the PMU vehicles and passenger counts on the stage-carriage services, special travel surveys of elderly and handicapped persons in Old Harlow, operational measurement surveys, and a PMU driver-attitude survey.

User Characteristics

An On-Vehicle Quarterly Survey (9) was conducted on May 15 and May 20, 1975. The total ridership on May 15 was 633, of whom 502 were interviewed, and on May 20, 726, of whom 545 were interviewed (children under age 5 were not interviewed). Their ages are shown below.

	May 15, 1975			May 20, 1975		
Age Group	Male	Female	Total	Male	Female	Total
5 to 11	4	5	9	9	7	16
12 to 16	6	23	29	16	25	41
17 to 24	37	107	144	37	96	133
25 to 44	27	98	125	22	106	128
45 to 64	19	104	123	17	127	144
Over 65	29	43	72	28	51	79
Not known	0	0	0	1	3	4
Total	122	380	502	130	415	545

The patronage had a male-to-female ratio of approximately 1 to 3. The level of use by age cohort suggests fairly even use among the three cohorts in the 17-to-65 age band, but if these results are shown against the age structure of the population in the service area (using data from the 1971 census), differences become apparent.

		Percentage of PMU Users	
Age Group	Percentage of Population	May 15	May 20
5 to 16	23.0	7.6	10.5
17 to 24	11.4	28.7	24.4
25 to 44	27.2	24.9	23.5
45 to 64	26.8	24.5	26.4
Over 65	11.6	14.3	14.4
Not known	0.0	0.0	0.7

The difference in dates between the census information and the PMU survey makes it impossible to make an absolute comparison, but in general the service appears to draw a disproportionately high number of riders from the group aged 17 to 24 and, to a lesser extent, from the elderly, while children seem to be making relatively little use of it. The predominance of female riders occurs consistently throughout all the age groups except the youngest (5 to 11), in which the sexes are evenly split, and the oldest, in which females still predominate but to a lesser extent than in the intermediate age groups.

The purposes for which journeys were made on PMU showed the importance of work and shopping trips made inbound (Old Harlow toward The High).

	Inbound		Outbound	
Purpose	May 15	May 20	May 15	May 20
Work	66	50	33	31
Shopping	68	110	0	4
Education	14	16	2	1
Personal business	26	22	8	10
Social-recreational	35	34	11	23
Return journey	37	34	185	196
Other or unknown	13	10	4	4
Total	259	276	243	269

Of the 259 inbound passengers on May 15, 78 percent were coming from home and 9 percent were coming from

work; on May 20 the figures were 78 percent and 8 percent, respectively. Thus, although Old Harlow is predominantly residential, it does contain a number of employment sources and these are reflected in the pattern of service use. As would be expected, the predominant trip purpose on outbound trips was to return home. In the aggregate, the ridership was evenly distributed between inbound and outbound journeys, but, as the data for May 15 only shows below, there were distinctive changes throughout the day.

	Inbound		Outbound		Total	
Time of Travel	No.	%	No.	%	No.	%
7:00-8:00 a.m.	25	9.6	1	0.4	26	5.2
8:00-9:00	40	15.4	18	7.4	58	11.6
9:00-10:00	25	9.6	7	2.9	32	6.4
10:00-11:00	18	7.0	15	6.2	33	6.6
11:00-12:00	15	5.8	27	11.0	42	8.4
12:00-1:00 p.m.	18	7.0	16	6.6	34	6.8
1:00-2:00	26	10.0	13	5.4	39	7.8
2:00-3:00	18	7.0	21	8.6	39	7.8
3:00-4:00	16	6.2	20	8.2	36	7.2
4:00-5:00	20	7.7	18	7.4	38	7.6
5:00-6:00	1	0.4	37	15.3	38	7.6
6:00-7:00	19	7.3	30	12.4	49	9.8
7:00-8:00	8	3.1	1	0.4	9	1.7
8:00-9:00	3	1.1	9	3.7	12	2.4
9:00-10:00	5	1.9	2	0.8	7	1.4
10:00-11:00	0	0.0	3	1.2	3	0.6
11:00-12:00	2	0.8	5	2.1	7	1.4
Total	259		243		502	

Peak use was between 8:00 and 9:00 a.m., reflecting mainly work trips in both directions. Shopping journeys spread throughout the day and were followed by the evening peak outbound, returning from work. The two minor peaks at this time on inbound journeys probably reflect returning from work in Old Harlow (4:00 to 5:00 p.m.) and social-recreational trips to The High (6 to 7 p.m.). The time-of-travel data for May 20 (not reproduced here) presented similar characteristics, although the morning peak was less dominant and the hour of heaviest use was 1:00 to 2:00 p.m.

One area of concern at the introduction of DAR into Britain was the relatively low level (by North American standards) of telephone ownership. As stated previously, 66 percent of the households in the service area had a telephone. One item in the survey dealt with telephone ownership by PMU users.

Day	Percentage With Phone	Percentage Without Phone	Unknown
May 15	67.9	31.7	0.4
May 20	68.8	30.8	0.4

Thus it may reasonably be said that lack of a home telephone does not appear to inhibit the use of PMU, although there were free direct lines available on the street in the service area. The method passengers used to contact the PMU service is shown below in percentages.

	May 15		May 20	
Method	Inbound	Outbound	Inbound	Outbound
Standing order	38.6	26.9	27.5	23.4
Home phone	19.3	3.7	31.1	6.7
Other private phone	5.8	3.3	7.6	1.9
Free phone	6.6	4.5	5.8	1.1
Public call box	2.3	0.8	1.5	3.0
Hail-stop	24.3	52.7	23.6	59.1
Personal call	0.0	7.8	0.4	4.1
Other or unknown	3.1	0.3	2.5	0.7

On inbound journeys the standing order or booking by home or other private phone, which might be considered the usual methods of contact for DAR, accounted for more than 60 percent of the users; the only other significant method was hail-stop, largely for passengers who boarded at one of the three points passed by the PMU bus on each tour. Similarly, on outbound journeys from The High, the hail-stop category mainly covered people who walked on at the town-center bus station. Even in this direction, however, the prebooked category accounted for about a quarter of the passengers. The free (direct-line) phones were relatively little used (about 60 calls per day). This would seem to imply that, provided there are a limited number of fixed pickup points that are reasonably accessible to residents of the service area, free on-street telephones are not of great value to the system.

Although there was little difference between home telephone ownership by PMU users and the average within the service area, there were clear differences in another household characteristic, automobile ownership. On May 15 almost 50 percent of those interviewed did not have an automobile (or private van) available for use in their household; on May 20 the figure was somewhat lower (43 percent). The following comparison with a household survey in Old Harlow shows the percentages of automobile ownership by household.

Category	No Car	One Car	More Than One Car	Unknown
PMU users				
May 15	49.4	39.0	11.6	0.0
May 20	43.1	44.4	11.9	0.6
1975 household survey	23.0	57.0	19.0	1.0

As would be expected, DAR drew more heavily from the non-automobile-owning households, but it also drew patronage more heavily from the stage-carriage bus services than from any other mode (shown below in percentages).

Mode Replaced	May 15	May 20
Car driver	1.4	2.0
Car passenger	4.0	4.8
Bus	68.3	61.5
Taxi	3.4	2.8
Motorcycle, bicycle	0.8	0.9
Walking	12.5	10.8
Would not have traveled	6.6	14.7
Other or no answer	3.0	2.5

The PMU draw from the private car was quite light. The percentages represent about 40 trips per average day, and in this respect DAR seems to have been less successful than was originally hoped. It does appear to generate a considerable number of trips (more than 80 on May 20), but there is little consistency in the percentage of those who would not otherwise have traveled shown by the various on-vehicle surveys. The actual range is from about 6 percent to more than 16 percent on the four surveys carried out to date. A response of "would not have traveled" can reasonably mean "would not have traveled at this time on this day," as well as "would not have traveled at all." Whatever the real meaning, it must be remembered that the figures are based on replies to a hypothetical question and must therefore be treated with caution.

The wider questions of trip generation and the effects that PMU might have on trip purpose and destination were addressed in the recently completed analysis of the before-and-after household and travel diary surveys (10). Extensive surveys were undertaken in Old Harlow in

April 1974, prior to the start of PMU, and in April 1975, by which time PMU had been in operation for more than 7 months. A similar survey was conducted in a control area (Latton Bush) in the new town to facilitate removing the effects of important externalities from the Old Harlow analysis. Among the more significant of these were sharp rises in the national retail price index and national average earnings, increases in the local level of unemployment, and a 16 percent rise in gasoline prices. Bus fares in the new town, which are on a flat-fare basis, also rose—off-peak fares by 25 percent (8 pence to 10 pence) and peak-hour fares by 11 percent (9 pence to 10 pence).

The analysis was based on the identification of similar-mobility groups:

Employed youth, ages 12 to 24
Full-time employees, ages 25 to 44
Full-time employees, age 45 and over
Housewives under age 65
Students, ages 5 to 11
Students, ages 12 to 16
Students, ages 17 to 24
Nonworking adults and housewives, age 65 and over
Part-time employees, age 25 and over

It concluded that there was little evidence to suggest that the introduction of PMU had either improved the accessibility of facilities in the new town enough to make apparent changes in their use or had resulted in identifiable redistribution or generation of trips. The survey suggested that PMU carries approximately 5 percent of the total trips generated on an average weekday by the residents of Old Harlow. It is therefore overall very much a minority mode, and in these aggregate terms the possible generation of new trips referred to above cannot be regarded as very significant. However, the importance of PMU to the different similar-mobility groups does vary. Out of the nine similar-mobility groups identified, eight showed a modal split to PMU of 2 to 8 percent, with the lower levels recorded for full-time employed persons in both age groups and the higher levels for schoolchildren ages 12 to 16 and persons employed part-time. Nonworking adults and housewives over 65 had a 26 (±5) percent modal split to PMU. Clearly the older people in the community place much more reliance on the service than any other group, which probably stems from their appreciation of its doorstep pickup and drop-off and possibly from the fact that any extra travel time involved may be assumed to be of less importance to them than to a full-time worker.

Sale Dial-a-Ride

The Sale service started in October 1974 and is the only second-generation DAR that is privately owned. It is operated by Dial-a-Ride Ltd., a company jointly formed by the Godfrey Abbott Group (coach operators) and Greater Manchester Transport. The original service area covered some 6.5 km^2 with a population of 20 000 to 25 000, but this was extended in May 1975 to cover the whole of Sale (population 60 000 and area 14.6 km^2).

The service runs 6 days a week (Monday through Saturday) from 7:00 a.m. to 7:00 p.m., using the Sale Town Hall in the town center as its principal origin-destination. The service area is divided into four zones, and during peak hours the buses operate on a basic many-to-one (morning) or one-to-many (evening) form, although many-to-many trips within any one zone can also be accommodated. During off-peak times the service operates as a full many-to-many system. Hail-stop service is not permitted, although there is a walk-on facility at the Town Hall, so users have to rely on either telephoning the control center or arranging standing orders for pickups out in the service area. Household telephone ownership in Sale is approximately 70 percent, well above the national average.

Started with six 17-passenger Bedford CF Deansgate buses, the service now uses up to 8 during peak hours and 10 during the many-to-many operation. The fares were raised in mid-1975 to 10 pence (adult one-way) for intrazonal journeys and 15 pence (off-peak hours) or 20 pence (peak hours) for interzonal journeys. Concessionary fares (5 pence) are available for children.

The system was designed by DAVE Systems, Inc., and draws heavily on their experience gained in operating North American DAR services. The intention is that the service should be self-supporting, although it is understood that it has not yet reached the break-even point. As in Harlow, no modifications have been made to the existing stage-carriage services in Sale since the introduction of DAR, but (unlike the operators in Harlow) the operators can employ both part-time and women staff members and so have rather lower labor costs than other systems that employ only men as drivers on a full-time one-man-operation basis.

No detailed figures are currently available on ridership, but it is understood that the average level of vehicle productivity is approximately 12 passengers/bus-h on weekdays (Monday through Friday) and rather more than this on Saturdays. Before the expansion of the service area, average daily ridership was between 300 and 400. At the time of writing, in the larger area, it was about 600 per day. Unfortunately, like the other privately operated DAR service (Maidstone), Sale DAR is subject to some restrictions that probably reduce the number of passengers below the level that could be obtained with complete freedom of operation. In particular there are restrictions on the number of vehicles that can stand at the main origin-destination point in the town center. Originally only two buses were permitted at any one time; this has been increased to four, but the stand area is not designated for the exclusive use of the DAR buses, so that on occasions it is still not possible to get four vehicles there at the same time.

The operators of the service consider that, if the stand point were available at all times for their buses and if they were permitted to display details of the service on a notice board at the same place, which at present they cannot, then ridership could be further increased. In particular they consider that there is an untapped potential for more inbound journeys in general and for more commuter journeys in particular. In the future it is possible that the DAR services will be integrated with the scheduled stage-carriage services in Sale. If this were to happen, system ridership could be expected to rise and possibly bring the service closer to complete cost recovery.

Hampstead Garden Suburb (London) Dial-a-Bus

London Transport's DAR service started in Hampstead Garden Suburb on October 19, 1974 (11). The nature of the service area shows considerable differences from the one in Harlow. It comprises a portion of Hampstead that was planned and developed as part of the Garden Cities movement in the first decade of this century. Housing in the service area was developed between 1908 and the mid-1930s and is all privately owned (by comparison, 55 percent of Old Harlow's housing is publicly owned). Both automobile and telephone ownership are high: 42 percent of households own two or more auto-

mobiles, 36 percent own one, and 93 percent have a telephone available. Another distinguishing feature is that there are no conventional stage-carriage services within the 1.6-km^2 service area, although there are frequent services along the northern and western edges.

The DAR service operated as many-to-many within the service area and as many-to-one from there to the main local shopping center at Golders Green. At this point there is interchange with a large number of other bus services and with the Underground. As in Harlow, the DAR ran Monday through Saturday, but for slightly longer hours each day (7:15 a.m. to 12:45 a.m.), reflecting the operating hours of the Underground. Three vehicles [Ford Transit public service vehicles (PSVs) with 16 seats] were used throughout the day until approximately 7:00 p.m.; two vehicles were used thereafter. The control office was located at the Golders Green bus station and the facilities for prebooking, on-demand, and hail-stop service were similar to those described for Harlow.

Ridership started at 2790 in the first week and stabilized very quickly in the range of 3600 to 4000. As in Harlow, the hourly loadings were spread rather more evenly through the day than on most other public transport services, though Hampstead had a relatively higher peak in the late afternoon than Harlow. The evening loadings were also a little higher than those shown by the PMU service.

During the first 9 months of the service a flat one-way fare of 15 pence was charged for all passengers except old-age pensioners, who were allowed a concessionary fare of 5 pence during off-peak hours. A flat fare of 5 pence was also charged for the last 0.8 km of the (fixed) route into Golders Green, but this appears to have been little used. Part of the promotional campaign at the start of the service included distribution of 10-pence-off vouchers to all households in the service area. These were valid for 13 operational days; 3000 were distributed but only 154 were used in more than 7000 passenger journeys.

On July 14, 1975, the flat fare was raised to 25 pence (concessionary fares doubled to 10 pence), which compared with a fare of 7 pence for a journey of approximately equivalent length by London Transport stage-carriage bus services. Ridership dropped sharply to between 2000 and 2300 in the weeks following the fare rise, and, although some decrease in ridership was to be expected during the summer holidays, there can be little doubt that the fall was largely attributable to the fare rise. During autumn the ridership recovered, reaching 3000 per week by early December, and then fell back again slightly after Christmas to 2800, equivalent to a vehicle productivity of 10 to 11 passengers/bus-h. Even at this level, actual fare receipts were some 25 percent above the levels prevailing before the fare increase and covered approximately 30 percent of total service costs.

In February 1975 a home-interview survey was carried out for London Transport by Opinion Research Centre, following an on-vehicle sample survey of passengers. The on-vehicle survey gave the following breakdown of trip purposes.

Purpose	Percentage	Purpose	Percentage
Work	24	Entertainment-sport	7
Social visits	23	Employers' or personal business	8
Shopping	18	Other	7
Education	13		

Precise comparison with the Harlow data on trip purpose is not possible, but they are broadly similar, with perhaps slightly greater emphasis at Hampstead on work and education and rather less on shopping.

As in Harlow, the Hampstead DAR was much more heavily used by females than by males—a ratio of 74 females to 26 males, compared with a ratio of 57 to 43 in the service-area population. However, the age pattern of the users was much closer to that of the population, with the elderly (age 65 and over) and the younger (under age 35) forming only marginally more of the riders than they do of the population as a whole. Again, as in Harlow, Hampstead DAR drew patronage more heavily from households that did not own automobiles (shown below in percentages).

Category	No Car	One Car	More Than One Car
DAR users	37	31	32
Service-area population	21	36	42

As in the Harlow on-vehicle surveys, a question on the mode of travel replaced was asked; the results are shown below.

Mode Replaced	Percentage	Mode Replaced	Percentage
Car driver	3	Walking	35
Car passenger	4	Would not have traveled	5
Bus	38	Other	2
Taxi	13		

Comparing these results with those from Harlow shows significant differences that are attributable to the absence of any conventional intraservice-area bus service in Hampstead, the shorter distances involved (i.e., more walking trips), and (partly as a reflection of the former and partly because of the general affluence of the area) a high draw from taxi service. The apparent 5 percent trip generation is rather lower than that at Harlow.

The home-interview survey was used to probe more deeply into the attitudes of the service-area residents toward the service. The main findings were

1. The then-current fare of 15 pence represented good value for the money,
2. There was little interest in reduced fares for children (normally available on other London Transport services),
3. There was considerable interest in reduced-rate season tickets (also available on other London Transport services),
4. More than 90 percent of service-area residents (including nonusers) thought DAR was a very good idea, and
5. There was no hostility on environmental grounds to the DAR vehicles running through the area (previous suggestions for scheduled services using larger vehicles had been strongly resisted by residents of the suburb).

Although the fare increase referred to above did produce an increase in total revenue, the service still continued to show a substantial loss (approximately $75 000 a year on a fully accounted basis at mid-1975 prices). Given the effect of the fare increase on ridership, it was considered that any further rise would be unlikely to improve the financial situation; therefore the Greater London Council (which had been underwriting the service) and London Transport decided to replace it with a fixed-route hail-stop minibus service beginning March 1, 1976.

This service uses two (of the three) former DAR buses and, with associated savings in control staff and radio equipment, is expected to reduce the annual loss to about $34 000. The hours of operation are similar to those of the DAR service, and the route used runs through those parts of the service area that produced the heaviest

ridership. The fare has been reduced back to 15 pence (adult one-way) to bring it in line with other minibus and midibus services in London, and pensioners are able to ride free at off-peak times, as on other London Transport bus services. Early indications are that ridership is being maintained at about the same level as on the DAR service.

Woughton (Milton Keynes) Dial-a-Bus

This service, operated by United Counties Omnibus Company for Milton Keynes Development Corporation, started on March 10, 1975. Woughton is an area in the southern part of the new city that contains largely new residential development and had, at the start of the service, a population of about 3500. Since that time further residential and related development has taken place; in March 1976 the population was 6500 within an area of 10.2 km^2. More than 80 percent of the service-area population lives in rented public housing.

The DAR provides a many-to-many service within Woughton and many-to-few between it and the major shopping and employment center at Bletchley (approximately 3.5 km to the west), the Open University, and Milton Keynes Development Corporation offices in the old-established village of Wavendon. The latter two are to the east of the service area. Six Mercedes L406D 15-passenger buses were made available to the service at its inception, with up to five in use during peak periods. The service operates 7 days a week (Monday through Thursday 6:30 a.m. to 11:30 p.m., Friday and Saturday 6:00 a.m. to midnight, Sunday 9:30 a.m. to 11:30 p.m.) with fares of 8 pence (adult one-way) for journeys wholly within the service area and 15 pence for journeys to or from any of the external destinations. All the usual demand-responsive facilities of standing order, prebooking, on-demand, and hail-stop service are available. The southern and eastern parts of the area are also served by conventional stage-carriage services; a new fixed-route service that penetrates into the southwestern part of the area was started recently.

Ridership started at approximately 2350 in the first week of operation and is currently running about 4000 per week. The weekday average is 625, while on Sundays the average is 200 passengers. This is the only DAR service currently operating that runs on Sundays, although the first service (at Abingdon) also did.

The Milton Keynes Development Corporation carried out an on-vehicle passenger survey of the service in November 1975 (12). The user characteristics were much like those for Harlow and Hampstead. Sixty-nine percent of the passengers in the survey were female, from children to the elderly. Within the service area 53 percent of the population are females, and they account for 49 percent of all trips (all modes) made by service-area residents. A comparison of the ages and sex of the DAB users and service-area residents by percentages is shown below.

	DAB Users		Service-Area Residents	
Age Group	Male	Female	Male	Female
5 to 16	2.3	3.9	11.2	13.8
17 to 24	9.4	26.3	6.8	9.7
25 to 44	11.8	25.0	21.6	20.9
45 to 64	3.8	8.4	5.4	5.6
Over 65	4.0	5.1	2.0	3.0

Females from age 17 on clearly make disproportionately heavy use of the service, particularly so in the 17 to 24 group. This mirrors the Harlow experience, as does the relatively low level of use by the youngest group.

The general difference in the age structure of the two areas, with an older population in Harlow, reflects the very recent development of Woughton, with its emphasis on the younger females.

The purpose for 1880 of the surveyed trips (42 percent) was to return home. Excluding these, the predominant purposes were work and shopping, as shown below.

	Trips Recorded	
Purpose	Number	Percent
Work	800	31.4
Shopping	760	29.9
Education	59	2.3
Personal business	293	11.5
Social	571	22.5
Other	62	2.4
Total	2545	

As in Harlow, trips for educational purposes were relatively trivial in number, but the social trips (visiting friends, entertainment) were of considerable significance. A comparison was made with the trip purposes of users of the stage-carriage services prior to the start of the DAR, which showed that the conventional bus was more heavily used for shopping (46 percent) and less well used for work (25 percent) and social purposes (11.5 percent); all these figures exclude trips to return home.

The apparent ability of DAR to generate off-peak travel and so to produce a relatively even hourly ridership profile is again shown in the Woughton service.

Time of Travel	No.	%	Time of Travel	No.	%
6:00-7:00 a.m.	77	4.3	3:00-4:00	117	6.5
7:00-8:00	135	7.5	4:00-5:00	143	8.0
8:00-9:00	125	7.0	5:00-6:00	129	7.2
9:00-10:00	117	6.5	6:00-7:00	97	5.4
10:00-11:00	124	6.9	7:00-8:00	67	3.7
11:00-12:00	136	7.6	8:00-9:00	65	3.6
12:00-1:00 p.m.	121	6.8	9:00-10:00	28	1.6
1:00-2:00	146	8.1	10:00-on	36	2.0
2:00-3:00	131	7.3			

In fact the time profile at Woughton is even flatter than that for Harlow, with barely discernible peaks in the morning, at lunchtime, and in the late afternoon. It should, however, be borne in mind that the evenness of hourly use may to some extent reflect a reduced supply at peak periods.

As in Harlow, there are a number of free direct-line telephones within the service area; 40 are planned in total, so located as to ensure that no residential development is more than approximately 225 m away from one. The use of these phones is considerable; after hail-stop, which includes walk-on facilities at the main destinations outside the service area, the free phones are the most heavily used method of contacting the service. A comparison with the average figures for Harlow (in percentages) is shown below.

Method	Woughton	Harlow (avg)
Standing order	18	29.0
Private phone	11	20.2
Free phone	23	4.5
Public call box	13	1.9
Hail-stop	29	39.6
Other	6	4.8

The contrast with Harlow is very clear and may be taken to reflect the much lower level of private telephone ownership (approximately 32 percent of the households in Woughton, compared with 66 percent in Old Harlow), the fewer possibilities for hailing or walking on within the

service area, and the greater number of free phones per capita.

The heavier use of this free facility no doubt helps to account for the fact that, as elsewhere, lack of a private telephone apparently does not inhibit the use of the service; 73 percent of the trips made in the survey period were by passengers from households without a telephone. However there is a relationship between telephone ownership and automobile ownership (for example, in Woughton only 15 percent of households without an automobile had a telephone), both being to some extent related to income, and it may be that the use of the service by those who do not own telephones is a reflection of the need to use whatever public transport is available. There is a clear relationship between automobile ownership and use of the DAR service (shown below in percentages).

Category	No Car	One Car	More Than One Car
Woughton DAB users	66.0	31.0	3.0
Service-area residents	32.5	58.5	10.0

The area is, of course, still a long way from completion (the new city's present population of 70 000 is planned to grow to 250 000), and the public transport services, both present and planned, are therefore under constant review. One of the goals formulated at the inception of the new city was to provide good-quality public transport, from the beginning, for both captive patrons and patrons by choice. Given the land use and demographic structure planned (relatively low density with dispersed main trip generators and a basic grid of principal roads at approximately 1-km intervals), it seems reasonable to suppose that demand-responsive public transport has a part to play in the future transport system of the city. This may evolve as a series of DAR services that operate as a complete mode of travel during off-peak times and during peak hours as feeders to the fixed-route stage-carriage buses that are routed largely on the principal roads. It is also possible that peak-hour subscription services will be introduced; this is being considered for the present DAR area in which peak demand exceeds present DAR capacity.

Knowle and Dorridge (Solihull) Dial-a-Bus

The good sense of integrating DAR with conventional services rather than treating it simply as an overlay in addition to existing services was recognized by the West Midlands Passenger Transport Executive (WMPTE) when planning its Knowle and Dorridge service, which started on December 15, 1975. It currently provides a many-to-many off-peak service within the suburban area of Knowle and Dorridge. During peak hours (6:45 to 9:00 a.m. and 4:45 to 7:00 p.m.) the buses run on a fixed route through the same areas. Up to four midibuses (23-passenger Alexander S-Type on Ford A-series chassis) are used in the service, although WMPTE purchased eight, since it is planned to extend the DAR operation at a later date.

The service area is 4.2 km^2, with a resident population of approximately 12 500. In character the area is similar to Hampstead Garden Suburb and consists of predominantly middle-class private housing. Dorridge railway station, toward the western end of the service area, is used as the principal waiting point for the buses, with a temporary control office situated in the station approach. The only other fixed point through which all buses pass on every tour is in Knowle's town center. The service area is divided into two approximately equal parts, with a zoned flat-fare system of 5 pence (adult one-way) for any trip wholly within one zone and 10 pence (adult one-way) for journeys from one zone to another. Children's fares are 3 and 5 pence respectively, and the concessionary passes for the elderly can be used on the service, as can the WMPTE's four weekly travel cards. Provision for standing orders, prebooking, on-demand calls, and hail-stops is the same as in Hampstead. The service operates 6 days a week from 6:45 a.m. to 11:45 p.m. and connects with the frequent suburban train services from Dorridge into Birmingham.

Although both Knowle and Dorridge have small shopping and business areas, the principal commercial center in their vicinity is Solihull, approximately 5 km to the north. Three stage-carriage bus services connected the service area with Solihull and also provided for local movements. When DAR was introduced, one of these services was taken off, and the remaining two are likely to be modified when the DAR service is extended as planned to encompass journeys between the service area and Solihull.

It is still too early to judge what the steady-state ridership will be, but the service has already carried higher weekly and daily loads than any other British DAR. During the first 7 weeks of 1976 (January 5 to February 21) the weekly average was approximately 5500, with a peak of 5900, and daily figures varied within the range of 700 to 1150. Bus productivity measured in passenger journeys per bus-hour is also higher than elsewhere (present average is 25 per bus-hour). Round-trip travel times vary from as little as 25 min under light load conditions to approximately 60 min.

No detailed surveys have yet been carried out on the service, though an on-vehicle survey is currently being planned, so it is not possible at this stage to say to what extent the service has drawn from the remaining stage-carriage services or has generated additional journeys. The only figures currently available show that a substantial proportion of the passengers are pass-holders (including the elderly and schoolchildren) and that their use of the system has grown much more rapidly than has that of direct fare-paying passengers. In the first 3 weeks of operation, pass-holders accounted for a little less than 25 percent of all users; in weeks 8 to 10, they accounted for almost 40 percent. This obviously has a depressive effect on the revenue from fares taken in by the service; fares have risen since service began, but by a much smaller proportion than total ridership.

DAR STUDY PROGRAM

As mentioned, the Centre for Transport Studies has been engaged by TRRL to do an extensive study and evaluation of DAR in Britain. Some of the reports produced as part of this work have already been noted above. Other reports cover topics from preparatory planning reports (13) to industrial-sociological studies of the attitudes of DAR and conventional bus staff (14, 15) and the reliability of the vehicles themselves. The survey analysis studies are supplemented by continuing work on demand (16) and supply modeling at TRRL and at Cranfield, with the intention of producing a comprehensive view of the attributes, performance, and value of DAR to the community. It would however, be wrong to give the impression either that interest in DAR is limited to the essentially urban-suburban systems described above or that DAR represents the only form of experimental small-bus system current in Great Britain.

Probably the most widely used innovation in small-bus services is the Postbus. This type of service, of which there are now approximately 100 in operation, has developed as a means of providing at least minimal pub-

lic transport in sparsely populated rural areas. The delivery and collection of mail require that the Post Office must be able to get to virtually every part of the country at least once each weekday. A variety of vehicles are used for this purpose but, since the driver-postman represents the primary cost, it makes relatively little difference to the total service costs to permit fare-paying passengers to be carried. Thus it is possible to provide a public transport service to parts of the country that are otherwise remote from bus services. For obvious reasons, the levels of service provided by this means in terms of frequency and journey time are not high, but in some areas even this is a great deal better than nothing.

The majority of the Postbus services are in Scotland, and typically each service provides two journeys each day Monday through Friday and one on Saturday. In summer months, when patronage tends to be higher, some services are duplicated. A variety of vehicles is used, from 4-seat Landrovers to 25-passenger midibuses, but for the most part 11-passenger Commer vehicles are employed. Postbuses in Scotland now serve more than 1600 km of roads with an annual total of more than 1 million bus-km; in 1974 they carried 35 000 to 40 000 passengers. There is every indication that the network of these services will continue to expand in rural areas.

There is also considerable interest in rural areas in such systems as community bus services and automobile sharing. In Norfolk a community bus system was started in November 1975 to provide a service in six villages at the eastern end of the county that were too small to support a conventional service. One 12-seat Ford Transit minibus is used, with a team of volunteer drivers drawn from residents of the six villages. The schedule of the bus provides for school journeys, shopping journeys 3 days a week, and a once-a-month connection to Eastern Counties' existing service to Norwich. The fares charged range from 5 pence to 25 pence, with concessionary fares for children, and it is calculated that, given volunteer drivers, the service will need to take in about $36 per week in fares to cover its costs. The volunteer drivers have all been trained to PSV standards by Eastern Counties, and 12 have now obtained PSV licenses.

The Oxfordshire County Council has encouraged the establishment of automobile-sharing schemes and three are now operating, although it is reported that there has not been a great rush of participants. The County Council is also considering further experiments, including one that involves staggered work hours for council employees, with a special reduced bus fare for those who adopt the less regular hours, and another that permits groups of parishes to run school buses during those times of the day that they are not required for the schoolchildren.

In a much more urban setting, Westminster City Council (London) is considering setting up a jitney service in the West End of London using a 12-seat Maxi-Taxi. The service is planned to have fixed starting and destination points but flexibility within the service area, according to demand, between those two points. A fixed fare would be charged and revenue from parking meters would be used to launch the scheme, the cost of which is reported to be $500 000. To date the service remains no more than a proposal.

There are other examples of the experimental use of small buses in both urban and rural areas, ranging from city-center precinct services to holiday or recreation-area services. Most are designed with the objectives of providing relatively low-cost services for people who are not currently well served, to give a measure of basic mobility to all, and to encourage those with automobiles available to make either less use or more effective use of them.

EUROPEAN DAR APPLICATION

It would also be misleading to imagine that Britain is the only country in Europe in which DAR has been implemented. The Dutch were very early on the scene with the Emmen service (17), and more recently services have started in France and Sweden.

The French system started September 29, 1975, in St. Cloud, a town near Paris of 28 000 persons and covering a built-up area of some 3.6 km^2. The service, run by the Paris Regional Transport Authority, operates 7:00 a.m. to 8:30 p.m., Monday through Friday, with up to four buses in operation (one is held as a spare). The vehicles used are Saviem SB2 buses with a capacity for 12 seated passengers and 8 standees. Fares are 2.00 F (adult one-way) or 1.40 F for regular standing-order journeys. Ridership has risen since the service started; it is currently about 2100 passengers per week (equivalent to approximately 10 passengers per hour) with revenues of a little less than 30 percent of total system costs. The French Ministry of Transport's Institute of Transport Research is monitoring the progress of the service and expected to publish a report on the first on-vehicle survey in April 1976.

A number of municipal authorities in France have expressed interest in DAR but, to my knowledge, the only other system in operation is a privately owned service in Andresy (25 km northwest of Paris). Few details are available, but the service area encompasses some 25 000 people, two small vehicles are used, and daily ridership is approximately 180 passengers. The fare structure is analogous to that for taxi fare and is based on journey length measured in stages of 800 to 900 m (0.50 F minimum fare up to 4.50 F maximum). The present daily revenue is about 350 F with direct daily operating costs (fuel and drivers' and telephone operators' wages) amounting to 250 F. Fully accounted costs are not known, but it would appear that this service is operating at about the break-even point. The owner of the service, a former taxi operator, plans to introduce three 12-seat minibuses and to operate with a flat fare of 3.00 F.

In Sweden very detailed proposals have been produced for the Projekt Taxibuss DAR system in Gothenburg (18), but the plans are in abeyance while awaiting a government decision on funding for the service. In the meantime an experimental DAR system was implemented in Boras in October 1975, planned initially to run for 6 months. The system is operated jointly by Volvo and Boras Public Transport and provides for journeys to and from an industrial estate in the town 5 days a week (no weekend service). One bus is used, operating on approximately 30-min headways, and its ridership 2 months from inception was about 500 passengers per week.

The interesting feature of this service is that it has an automatic control system. When a prospective passenger dials the service number, an automatic answering device acknowledges the call and directs the caller to another number that connects him to the bus stop at which he wishes to be picked up. Each bus stop in the system has a unique identification number, and, when a request for pickup is made, that number is processed by a computer to appear on the bus driver's running schedule, which is printed out at each terminus. This printout tells the driver at which bus stops passengers are waiting, so that he can then determine his route. If there are no requests for service, the bus tour is not made.

There is interest in DAR in other European countries, including Germany and Switzerland (where the city of Zurich is currently planning a service), but no operational systems have been reported. To an even greater extent than in Great Britain, most public transport operators in Western Europe are facing substantial deficits (19), and therefore the climate for innovation, even on a relatively small scale, is not a good one.

RURAL APPLICATION OF DAR

The potential value of DAR to rural communities has not been ignored; currently Cranfield and TRRL are jointly seeking appropriate areas in which small-scale rural DAR could be operated. Rural public transport, in common with many other public services, has suffered from recent cost inflation. The majority of truly rural bus services operated by the National Bus Company do not cover their fully accounted costs from fare-box revenue. Reduced frequencies and service withdrawals are to be expected in a period when national economic considerations determine that public expenditure cannot be permitted to rise. The rural application of DAR is therefore being considered from the point of view of realizing some savings over conventional bus operation in a given area, as well as providing an improvement in accessibility.

Two possible operational forms of DAR have been identified as offering at least the possibility of achieving these two objectives: a route-diversion service and an area-coverage service. The former is designed to replace an existing bus service between (for example) two small towns. It would follow a basic fixed route with diversion from this to pick up or set down passengers on demand only, thus reducing unproductive diversions to a minimum (20). The area-coverage service is applicable in districts where a wide scattering of the population makes it difficult to select a single fixed route that serves even the majority of settlements.

In both cases it is probable that the DAR service offered will not be immediately responsive to demand in the way that the current urban services are. Since cost saving is an important element in the exercise it is likely that only standing orders and prebooked requests for pickup will be handled. Thus it should be possible to manage the system without a formal control office and staff and without vehicle-based radio equipment. Passengers boarding the vehicle would be able to tell the driver their destinations, and he would be responsible for selecting his own route around the various pickup and setting-down points. It is TRRL's intention to mount a rural DAR experiment in late 1976, probably as part of a wider investigation into bus-service options in rural areas.

Some guidance on the value of DAR to rural communities will be obtained from a service operated by Eastern Counties in an area southwest of Peterborough. One 22-seat midibus will be used to provide a mixture of school, fixed-route, and on-demand services to a scattering of small villages and will link them with the neighboring towns of Peterborough and Huntingdon.

FUTURE OF DIAL-A-RIDE IN GREAT BRITAIN

Two patterns appear to be developing for the future of the existing British DAR services. Those systems that have been added onto existing services with no changes made in the routing and scheduling of the stage-carriage services seem likely either to become more conventional fixed-route minibus services or possibly to disappear in a reorganization of the scheduled services, triggered at least in part by the demand patterns shown by DAR. Hampstead has already become a fixed-route hail-stop service, as did the first DAR in Abingdon, and Harlow seems (to me) to be likely to develop in much the same way, though perhaps with an option for dropoff when the experiment is concluded (August 1976). The Carterton DAR will probably be replaced shortly by a revised stage-carriage service using larger conventional buses.

The two systems that have been specifically integrated with stage-carriage service (Woughton and Solihull) both appear to have a better chance of remaining demand responsive and of extending their areas of operation. However, it has to be said that DAR, because it is so labor intensive, is an expensive form of public transport to operate. Typically the second generation DAR services cover about 30 percent of their total costs from fare-box revenue, the only notable exception being the Sale service. Although there is clear evidence that this type of service is popular, particularly with those groups of people (the elderly and housewives) who are less likely to have a car available, there is very real doubt whether people are prepared to pay the true costs for such a service. It can be said that this applies to conventional bus services as well, since an increasing number are running at a deficit. In 1974 the National Bus Company had an operating deficit of $11.7 million, compared with a surplus ranging from $2.6 to $6.5 million in the three previous years. Most urban bus services operated either by passenger transport executives or by local authorities also operate at a deficit. However, the fact remains that, although DAR can generate some new traffic, it does so at a unit cost that is too high for many operators (or local authorities) to sustain during a period of financial stringency.

It cannot be said, therefore, that in the near future Britain is likely to see anything comparable to the recent growth in DAR systems in North America. What seems most likely is the further, but slow, development of integrated DAR, as in Woughton and Solihull, and the establishment of a number of relatively small-scale rural services as part of a wider program designed to evaluate alternative ways of meeting rural transport needs. If it is to be successful and to develop in the longer term, urban DAR will have to demonstrate that, integrated as a significant part of an urban transport system, it can offer economies of scale as well as increased attractiveness to the passenger that will bring its costs per passenger down much closer to those of conventional bus services. If rural DAR is to develop, it will probably have to demonstrate that it is a least cost method of providing for rural travel demands.

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Part 3
Services

Mobility for the Elderly and Handicapped in a Totally Accessible Full-Sized Bus

Bishop White, Municipality of Metropolitan Seattle

This paper describes the planned expansion of limited service for the handicapped to a five-bus system serving the elderly and the handicapped.

Information is perhaps most useful when it assists in decision making. It will therefore be most helpful to each of us to have a program description that does one or more of the following:

1. Tells where there are current successful programs and describes how and why they are successful;
2. Describes, from experience, problems and mistakes to be avoided (including the issues raised); and
3. Informs others about the bases on which decisions of interest were made.

The decision that Metro has made that is apparently of interest is to expand our program of service to those of limited mobility by purchasing five full-sized buses. This decision was based on

1. Our experience in operating a vehicle that served residents of an apartment complex of physically handicapped persons (Center Park),
2. Our perception of special service experiments elsewhere,
3. Current operations practices within Metro, and
4. Available technology.

BACKGROUND

Metro's service area is King County, Washington. The county covers about 9100 km^2 (3500 $miles^2$) and has a population of about 1.2 million people; about 500 000 of these reside in the city of Seattle, 400 000 reside in small to medium-sized urban and suburban areas, and about 300 000 are scattered throughout the rural areas.

Within this service area, Metro is the sole operating authority for the public transportation system. Metro has taken the position that, for the foreseeable future, conventional bus operations are and will be the backbone of this system. We are of course aware that this commitment leaves certain problem areas, the solutions for which may involve other forms of public transportation. For example, in many instances the conventional bus system cannot be immediately or readily (if at all) adapted to provide an adequate public transportation option to people with limited mobility.

Like many other transit operators, Metro is faced with numerous theoretical alternatives for rendering better service to these people. These alternatives range from making the whole bus system accessible by putting lifts on all buses to establishing a complete and separate special service system, such as a small-bus dial-a-ride system. That neither alternative has been adopted elsewhere to date and that in-between experiments have been small in scale indicate the complex planning and operational issues involved, from the standpoints of both the user and the operator. With numerous untested options available, Metro is taking a conservative position in order to avoid making costly and embarrassing mistakes that would be a disservice to operator and user alike.

At the same time, Metro is keenly aware of the great importance to the elderly and the handicapped of some service as soon as possible. In this connection, Metro was fortunate to have the benefit of a small ongoing successful experience in serving the handicapped in our Center Park operation. Therefore, while we proceed with a full planning effort to develop our service program for all those of limited mobility, we are also developing a program to put five specially equipped full-sized buses into service for the group. These buses are being purchased, pending approval by the Urban Mass Transportation Administration (UMTA), from Eagle International in Texas, though the buses themselves are manufactured in Belgium by Bus and Car, Inc. Vehicle modifications will be made in the United States to specially equip the bus for services to the handicapped.

DECISIONS

Why did we opt for the big bus?

1. We do not believe that the small buses are capable at this time to stand up to the demands of public transportation operations.
2. Metro has established large-bus experience. Our operations, maintenance facilities, and procedures are

set up to handle large buses.

3. Most of the successful aspects of operating our Center Park service would not be improved by the operation of large buses. On the other hand, many of our problems with the Center Park operation can be attributed to the small bus.

4. It was our feeling that the capacity of the large bus could be more cost effective than other options.

Why did we select Eagle buses?

1. The Eagle buses were immediately available from the manufacturer.

2. There were no alternative buses in the United States, nor would there be for at least two years.

3. The Eagle bus had many features important to operations in our service area, such as a small turning radius. Furthermore, the Eagle bus was the most readily adaptable to service for the handicapped, e.g., options for lift installation in the large front door and more interior space for maneuvering wheelchairs.

CURRENT STATUS

Much of Metro's confidence in moving forward with buying the Eagle bus came from our successful Center Park experience, from which we could expand and make modifications. Since the inception of this program, however, other new systems have been developed and tested. Because UMTA approval of the bus purchase is still pending, Metro is using this delay to take a closer look at other options or modifications to the Center Park operation. We wish to ensure that, while we cover ourselves from a technological or operational point of view, we use the service plan that maximizes the service potential of the selected technology.

Special Transit Needs Program in the Denver Metropolitan Area

Barbara Williamson and Sue Osterhoudt, Regional Transportation District, Denver

The special transportation needs of people within Denver's Regional Transportation District who have limited mobility are being served by a program that includes special equipment for the handicapped, special midday shopper service for the elderly, and a plan to make regular service more accessible to these groups. The special equipment for vehicles that provide subscription service to handicapped patrons includes wheelchair lifts, lower-step entry, side destination signing, and several other special features. The needs of the elderly are met in part by special midday shopper service on a weekly schedule. A program to make the entire fleet of buses more accessible by retrofitting certain items, such as extendable steps, grabrails, and side destination signing, is under evaluation. The entire special-needs program is continually being reviewed, modified, and upgraded.

The object of transportation planning is to design transit systems that will maximize the achievement of community goals as they relate to the total transportation system with the least social cost and maximum social benefit. A special goal cited regularly by Denver area groups is that plans should be made for a balanced community that provides residents with a wide variety of opportunity. The ultimate goal of the Regional Transportation District (RTD) is to develop, maintain, and operate a public transportation system for the benefit of the residents of the district in accordance with governing legislation. The RTD's Board of Directors has approved objectives and adopted guidelines to achieve this goal. One of these guidelines specifies that transit improvements must recognize the needs and demands of the elderly and handicapped and must be responsive to those needs.

The elderly and handicapped may be defined as having limited mobility when their access to usable public transportation is severely restricted or nonexistent. In September 1973, when the RTD became an operating transportation authority, there was no special public transportation service to accommodate such people. Handicapped and elderly persons had to contend with the same characteristics of the system that confronted the entire transit-riding populace, including fixed routes, high steps on buses, inadequate signing, and insufficient grabrails. Some of these characteristics, which present little or no obstacle to most patrons, actually prevent others from using the system.

Before service could be designed for the elderly and handicapped, it was necessary to determine the characteristics of the groups to be served. Estimating the number of handicapped persons within the district has been difficult since no real data are available. A rough estimate of between 9 and 25 percent has been made from projections based on a 5 percent sample from 1970 census data (1). The estimate of 25 percent would include all disabilities, whether or not they limit mobility. For transportation planning, it would seem more reasonable to use the 9 percent figure, which covers a wide range of handicaps and includes people who, with some assistance, could use an unmodified transportation system, as well as those to whom the system would be inaccessible without some major engineering and design modification. It includes both the temporarily and the permanently disabled, the person with a broken leg as well as the person who can expect to spend the rest of his life in a wheelchair. For transportation planning, it includes all who, for any of a variety of reasons, have impaired mobility, including those whose ability to walk is reduced or absent without personal or mechanical assistance and those whose visual loss is sufficient to prevent movement without assistance. Impairment or loss of motor skill can make it difficult or impossible to use public transportation. Serious mental disabilities may also reduce a person's capacity to perform the actions that are required to use public transportation.

RTD has accepted the responsibility of providing public transportation to all segments of society, including those with limited mobility. Fortunately, members of the elderly and handicapped communities within the district have been eager to assist in defining their transportation needs and in planning to meet those needs. To facilitate a cooperative working relationship with RTD, two committees have been formed, Mobility Among the Disabled and the Elderly Advisory Committee. The Elderly Advisory Committee was organized by the Council on the Aging of the Denver Regional Council of Governments. With the encouragement of RTD's staff, the handicapped themselves organized Mobility Among the Disabled. A number of groups and organizations are represented on these committees, for example, Muscular Dystrophy, Easter Seals, Cerebral Palsy, Denver Regional Council of Governments Council on the Aging, and

Denver Community College. The two committees function in an advisory capacity similar to that of the 10 other citizens' committees that serve RTD. They reveiw problems, discuss solutions, and make suggestions for changes. RTD supplies the technical assistance the committees need to fulfill their advisory functions. Without the help of Mobility Among the Disabled and the Elderly Advisory Committee, it is unlikely the program for transportation services to these groups would have developed in the same form. It is also unlikely it would have progressed as quickly without their help.

LEVEL OF ACCESSIBILITY

One of the first issues to be resolved in planning transportation services for the elderly and handicapped is the desired level of accessibility or the degree to which it is physically possible to get on and off the vehicles. Should the system be designed and engineered to allow anyone, no matter how severely disabled, to use it or is a modified approach in order?

At first, the committees argued that the entire system should be totally accessible. Separate services, they contended, could not be equal and separation leads to undesirable social effects. To support the argument for a totally accessible system, they cited Section 16 of the Urban Mass Transportation Act of 1964 as amended in 1970, which states that the elderly and handicapped have the same right as others to use mass transportation facilities and services and that special efforts must be made in the planning and design of transportation facilities to ensure the availability of usable mass transportation to the elderly and handicapped. Federal highway legislation (Federal-Aid Highway Act of 1973, Section I65B) has also indicated that highway funds will not be granted to transportation agencies or authorities that are not currently planning toward implementing transportation services for the elderly and handicapped.

For the purposes of the Urban Mass Transportation Act, the term "handicapped person" means any person who, by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability, is unable, without special facilities, special planning, or design, to use mass transportation facilities and services.

The guidelines of the Urban Mass Transportation Administration (UMTA) for implementing Section 16 are as follows:

> In the planning and design of mass transportation facilities and equipment, reasonable efforts should be made to ensure that the elderly and handicapped will be able to effectively use the facilities.

This is especially important when new facilities are to be built, but modifications to present facilities and equipment must also be considered. The question then is whether Section 16 or UMTA's guidelines require total accessibility. UMTA has not addressed the question formally but its informal position has been articulated in a number of intra-agency memos and demonstrated by its administration of Section 16.

UMTA and the transit industry are concerned with the operational problems inherent in making a fleet of buses totally accessible. UMTA aided in drafting and supports a provision of the Unified Transportation Assistance Program that provides for alternative transportation for the elderly and handicapped in lieu of total accessibility.

The real transportation issue in UMTA's opinion has apparently been service rather than hardware. Guaranteeing access to transit vehicles and facilities does not necessarily guarantee real access to the system and may be remote from reality. The point here is that route modifications, the addition of special service, and modification of buses short of the ability to board wheelchairs can be undertaken to provide mobility without providing total accessibility to the system. But total accessibility to the system cannot be undertaken and be effective without the concomitant addition of special service, route realignment, bus modification, and so on. Because there is a finite amount of resources and financing available, a transportation authority might very well be forced to choose between total accessibility (i.e., ability to board wheelchairs on all vehicles), which would not resolve the question of mobility because it does not necessarily provide service to the elderly and handicapped, and alternate service, which would provide mobility but would not resolve the issue of total accessibility to the system.

At the suggestion of the advisory committees, RTD investigated the feasibility of providing a transportation system that would be fully accessible to the handicapped and elderly. Close examination revealed that the cost of such a system would be staggering. Cost estimates obtained for fitting buses with wheelchair lifts alone, perhaps the single most expensive modification, were more than $10 000 a bus. Assuming that funds could be allocated to remove all barriers to transportation facilities and equipment, there would still remain topographical, architectural, and social barriers over which a transit operator has no control. The handicapped person would have to arrange for his trip to the boarding point and would be responsible for the completion of his trip upon deboarding. He would have to contend to varying degrees with hilly or rocky terrain, steps, curbs, and rough-textured streets over which it might be difficult to maneuver a wheelchair. Inclement weather could become a serious hindrance to mobility.

Consideration of the implications of a fully accessible transportation system also revealed operational disadvantages. Constraints on the size and capacity of buses would probably permit space for only one wheelchair on each bus. Once this space was taken, no other wheelchair patron could board that bus. A wheelchair-bound person could conceivably have to wait twice as long as or even longer than a nonhandicapped person for a bus that could accommodate his needs. Upon boarding, the wheelchair patron would have to maneuver to the tie-down space and secure the wheelchair. A fully accessible system would also result in irregularities in service that would affect all patrons. It takes from 3 to 5 min for a wheelchair patron to board a bus with a lift device, which could be a significant factor in unpredictable and uncontrollable schedule delays. Such delays would diminish the attractiveness of the system for other patrons.

To meet the special mobility needs of elderly or handicapped persons, consideration must be given to all mobility barriers, not only those directly related to the transportation industry. To find timely feasible solutions to the problems relating to transportation services for the elderly and handicapped, RTD is using mobility, not total accessibility, as its goal.

Mobility Among the Disabled is divided in accepting this posture. Some believe that mobility rather than total accessibility is an acceptable start and that the program will be expanded to reach greater numbers of handicapped people. Others still believe a fully accessible system is the only acceptable way to approach the problem. The ultimate solution to this conflict should be brought nearer by what is learned from this program. In the meantime, it will demonstrate significant steps toward the attainment of that solution.

SERVICE NEEDS

Before appropriate service could be initiated, it was

necessary to determine the needs of the groups to be served. By and large, people over age 65 are not employed and do not attend school. The majority use transportation mainly during the off-peak hours for medical, social, shopping, and recreation trips. Most of the elderly could use existing public transportation more extensively if it were modified to make it a little easier to board and deboard. Lower steps and extended nonskid grabrails are among the useful modifications.

Many of the handicapped, on the other hand, could take advantage of employment and educational opportunities if they had the means of reaching the appropriate facilities. It quickly becomes apparent that there are three groups of people defined as elderly and handicapped—(a) those who can use the existing bus service, (b) those who can use buses if certain modifications are made, and (c) those who need transportation provided by vehicles especially designed to accommodate their more severe mobility problems. Transportation services for the elderly and handicapped should be designed to address all these needs.

The Special Transit Needs Program at RTD therefore has three parts. One, the HandyRide program, provides transportation services and facilities for the handicapped. Another, which grew out of the HandyRide program, provides midday shopping services for the elderly. The remaining part is the retrofitting program, which involves modifications to existing rolling stock to meet the needs of the elderly and the ambulatory handicapped.

HandyRide

HandyRide got its official start in April 1974, when the RTD's board authorized the lease of 12 buses specially equipped for the handicapped. That same month, requests for proposals stating general guidelines for vehicle specifications were sent to bus manufacturers. Those guidelines related to vehicle size and accessibility. At the subsequent bidders' briefing, requirements were discussed in more detail. The committees' recommendations were given as a guide to the degree of specialization required. Bidders were informed that vehicle choice would depend on overall quality, innovative design, attention paid to specific needs of the elderly and handicapped, and the ratio of value to cost. The lowest bid would not necessarily be the one accepted. Four bids were received, and the RTD staff and the two citizens' committees evaluated them independently. There was a concensus to accept the bid submitted by the FMC Corporation of San Jose, California. Two citizens' committee members, one who is a quadraplegic and a practicing engineer and one who is not handicapped, went with RTD personnel to the FMC offices at San Jose to assist in designing the vehicles.

The FMC bus is built on a custom chassis with four-wheel independent suspension for a smooth ride and greater traverse stability during turns and lane changes. The passenger door is 71 cm (28 in) wide, 5 cm (2 in) wider than standard. There are two steps from the ground to the 47-cm (18.5-in) floor height. One of the steps is electrically operated by the driver for use where curbs are absent or a lower step is required.

The door for wheelchair use is 104 cm (41 in) wide and features a 91 by 114 cm (36 by 45 in) hydraulic elevator. The outboard section of the lift is hinged to restrain the wheelchair by an upward tilt of the ramp. The hinge is also used to provide adjustment on irregular terrain and to serve as a ramp when backing the wheelchair onto the lift. Designed for a 320-kg (700-lb) load, the lift is capable of traveling from the floor height to a point 7.6 cm (3 in) below ground level to satisfy adverse loading conditions. The lift platform is hinged inside the door line and is brought to a vertical stowed position before the doors are closed. When stowed, the elevator protrudes 30.5 cm (12 in) into the coach's interior. The elevator doors are interlocked with the vehicle's accelerator and brakes to prevent inadvertent motion of the vehicle while the elevator is in use. Similar vehicle locks are provided for the passenger door. Space is provided for four wheelchairs and 12 seated passengers. There is also space for a seeing-eye dog.

RTD also required bench seating, flip arm rests, specially coated nonslip handrails and stanchions, audible signals for doors to assist the blind, additional lighting in stepwell and door areas, and an internal public address system. At the discretion of FMC, accessible signal tape switches also were provided. The buses were to be painted to be consistent with the district's established graphics. "The Ride," the name chosen for the entire system, is painted in large brown letters on the white buses and "RTD" is painted in red. In addition to these standard graphics, the international wheelchair logo is painted on the sides and fronts of the HandyRide buses.

Once the order was placed it was time to prepare for putting the buses into service. Schedules had to be planned efficiently to accommodate as many as possible of the prospective patrons. Routes had to be planned to provide curb-to-curb service, since it would be difficult or impossible for many patrons to get to a bus stop or travel any distance to complete a trip. The decision was made to establish subscription service, dynamically scheduled to accommodate the special needs of those with limited mobility. Subscription to this service was accomplished by filling out a form with specific trip information including origin, destination, days of the week, and times that service would be desired. Additional information was requested on trip purposes and type of handicap. About 25 000 of these forms were delivered to social service and rehabilitation agencies, nursing homes, high-rise apartments for the elderly, appropriate clubs and organizations, and anyone else who requested them. The citizens' committees were helpful in distributing forms and in suggesting places to distribute them. A cut-off date was established for the return of the forms, although people who returned forms late were not necessarily denied service. The initial cut-off date was established merely to facilitate the scheduling of the initial service.

To qualify for service, applicants had to need to make regular trips and were required to complete and correctly fill out the application for subscription service. From the metropolitan Denver area, 637 qualified applications were received by the deadline. An additional 527 were received after that time. Of the 1164 from the greater Denver area, 50 percent were 65 or more years of age. The remaining 50 percent were handicapped. Of the handicapped 22 percent (11 percent of the total qualified applicants) were confined to wheelchairs. From Boulder County, 259 qualified applications were received by the deadline. Of these, 176 (68 percent) were handicapped and 83 (32 percent) were elderly. Twenty percent of the handicapped (14 percent of the total qualified applicants) were confined to wheelchairs.

Many of the forms received were incorrectly or incompletely filled out, largely because the initial form was quite long and somewhat confusing. The form was redesigned and condensed to alleviate such problems.

With only 12 buses, it was not possible to serve all the qualified applicants. Priorities were established to give preference to the handicapped over the elderly, to the handicapped in wheelchairs over other handicapped persons, and to work or school trips over other trips. Last priority was given to those whose disabilities did not significantly interfere with their use of public trans-

portation. Included in this category were, for example, the mentally retarded and those with epilepsy.

Before the service began, a sensitivity training program for drivers was conducted. Drivers were selected from a group who had requested to participate in providing the service and a 2-day training session was conducted for them. Members of the RTD staff and Mobility Among the Disabled met with them and provided ample opportunity for the drivers to ask questions of those who planned and would be using the service and their representatives. In addition, members of the committees explained what they would expect of the drivers.

A prototype bus was received by RTD in November 1974 and was examined by both staff and citizens. The bus was then sent on a tour around the country for display. Suggested modifications were incorporated in the RTD buses.

Since the reliability of the HandyRide coaches had not been proven, it was decided to begin service in the Denver area, where mechanical difficulties could be most conveniently handled. Service was begun with seven buses, leaving five spares. On March 10, one of those five buses was deployed within the Boulder urbanized area, reducing the number of spare vehicles to four. The reliability of the vehicles proved great enough that further service increases and consequent reductions in the number of spares could be made. The number of spares was, therefore, reduced to three in May and two in June. The greater Denver area is now being served with nine of these buses, Boulder is being served with one, and two serve as spares. There have been recent occasions when mechanical difficulties have prevented using the anticipated number of vehicles, making it necessary for other vehicles to serve more than their regular routes. Records have been kept on vehicle maintenance and are shown below.

Month	Road Calls	Driver Complaints	Inspections
February	1	72	–
March	5	85	–
April	6	40	–
May	3	37	8
June	4	6	10
July	6	11	9
August	5	15	7
Total	30	266	34

Of the 296 times the vehicles required work other than inspections, about 50 were associated with the hydraulic lift, extendable step, or wheelchair tie-down devices. The significance of this information will be considered in the overall evaluation of the program.

Fares were set at 25 cents one way. As in the regular service, passengers are required to have the exact fare. They are also responsible for getting on and off the buses themselves, although the drivers have, in fact, been assisting. Passengers may arrange for someone to ride with them to assist if required, and there are agencies within the district that refer passengers to volunteer assistants. So far, no assistants have been used on a regular basis.

Recently a Saturday shopper service for nursing-home residents was begun using the special equipment. Due to the rather severe disabilities of those nursing-home residents for whom the service was designed, it has not been successful. That service will be changed from regularly scheduled to specially scheduled, so that it will be available when needed.

Groups or organizations with special needs may charter this equipment as it is available to provide service to persons previously excluded from group activities because of special transportation needs. Charter rates for these vehicles are the same as for other RTD equipment. Chartering of these vehicles has not been frequent. The difficulty seems to be that most of the requests are for weekday charters, when the vehicles are in regular service.

Services for the Elderly

One of the early observations about the HandyRide program was that many of the elderly could be served with regular equipment. They did not need the wheelchair lift or other special features of the HandyRide buses. Acting on this observation, six special midday shopping trips for the elderly were initiated in March 1975. These tours originate at various high-rise apartment complexes, take elderly patrons to nearby shopping centers, and return approximately 2 hours later. Each trip runs once a week. Support for this service was enthusiastic at first, with ridership climbing from 211 weekly passenger trips when the service was begun in March to a weekly average of more than 850 passenger trips in April. The total number of passenger trips in April was 3476. Ridership has since declined however. The first week in June, the service carried only 684 weekly passengers.

Several reasons have been suggested for the decline in ridership. It could be in part because the elderly do not need to make weekly shopping trips. It has also been speculated that the reason for the decline was the weather. With pleasanter weather making it easier to get to a local bus stop, patrons switched to regular service. Another explanation may be that many of the elderly were in fact using the service for recreation and it no longer has the appeal of novelty. Members of the Elderly Advisory Committee have requested service for recreation trips, and this possibility is being considered.

Retrofitting Program

Improving the accessibility and usability of the entire bus fleet is the object of the retrofitting program. A list of suggested features for buses was compiled from recommendations on the specifications for the HandyRide vehicles that were made by representatives of the elderly and handicapped committees. Of the 18 separate recommendations, 4, including bright color for all buses, full-width grabrails on seat backs, yellow step-tread edging, and nonskid tread and flooring material, were already standard items on buses. Consideration of 7 other recommendations was deferred for diverse reasons. Push-bar rear exit doors are to be specified on new buses in spite of a recommendation to provide some other type of rear-exit door because the push-bar doors have a documentably better safety record. Low-level stop signal or tape switches were considered appropriate for the 12 specially equipped buses but not for regular buses since no manufacturers were, at that time, installing them. This item is now available and is specified on orders for additions to the regular bus fleet.

Seven items were considered appropriate for retrofitting and in-service evaluation, including extendable steps, additional grabrails and stanchions, side destination signing, additional lighting in the stepwell and door area, internal public address system, and audio warning signals for door operations. Age was the determining factor in whether a bus would be suitable for retrofitting. The expenditure was not merited for some of the older equipment. From 37 to 184 buses were chosen to be retrofitted with any given item. It was not necessary to retrofit all items to all 184 buses since some were already equipped with several of the recommended items. Manufacturers were contacted and costs for the program, for materials and labor, were estimated at $204 061.10.

The extendable step units chosen are manufactured by FMC of San Jose and Environmental Equipment Corporation of San Leandro. No others were available. There were some initial difficulties with fitting the extendable step units, specifically with the interlocking devices on the doors and the sensitive edge on the extendable step. The EEC unit has now been installed and is in use.

After all units have been installed, their effectiveness will be evaluated to determine whether the items should be specified on subsequent bus orders.

EVALUATION

Although a few observations can be made about the value and efficiency of the HandyRide program, thorough evaluation will have to await the completion of a study in progress. The study involved in-person interview surveys of members of the organizing committees, user applicants, and nonuser applicants. The study, conducted with the help of a market research firm, will yield both quantitative and qualitative information on patronage, cost, and the sociological and psychological benefits of the program. The results will be used to help determine whether this demonstration program will be continued in its present form, continued in a modified form, or abandoned. Whatever the outcome of the evaluation, the program will have provided valuable information in determining not only the transportation requirements, limitations, and desires of the handicapped and the elderly, but also what public transportation can do in attempting to meet these requirements, limitations, and desires.

Patronage

Ridership figures have been collected from drivers of the vehicles and computed using an average fare. Figures for the Boulder urbanized area have not yet been incorporated with those for the remainder of the system. Passenger counts for the Denver urbanized area are available and are shown in Tables 1 and 2 for the HandyRide vehicles and for the shopping services for the elderly. As part of the evaluation, data will be quantified on a common basis. Until that study is complete, only general statements can be made about patronage. Although ridership more than doubled from the initiation of service in February to May, much of that increase was due to the addition of the shopping service for the elderly. These figures will be separated for use in the evaluation. Another reason for this dramatic increase is that service was begun on a small scale to facilitate dependability.

Initial patronage figures seem to indicate a rather high percentage of patron-cancelled trips. As part of the evaluation, an attempt will be made to determine why this figure is so high and whether it can be reduced.

Cost

The precise method of cost evaluation has not been finalized, but figures have been developed to show the actual cost of the HandyRide and the services for the elderly separately. Those figures will then be combined to show a true estimate for both services.

Cost figures have been developed to include all related expenses. They are tentative, however, in that they incorporate only preliminary patronage data. The cost per HandyRide passenger at the beginning of the service in February was $29.44. By May, this had been reduced to $11.70. Cost per passenger for the elderly shopper service has remained at 83 cents.

Sociological and Psychological Benefits

Sociological and psychological benefits are the most difficult to evaluate since they do not easily yield to quantification. Nevertheless, for those persons who previously

Table 1. Productivity of HandyRide and special services for the elderly.

Month	HandyRide Service			Special Service for the Elderly			Services Combined		
	Passenger Trips	Passenger Trips/km	Passenger Trips/h	Passenger Trips	Passenger Trips/km	Passenger Trips/h	Passenger Trips	Passenger Trips/km	Passenger Trips/h
February	1714	0.06	0.72	—	—	—	1714	0.06	0.72
March	1776	0.08	1.01	586	0.28	6.36	2362	0.09	1.18
April	2044	0.00	0.00	3476	0.00	12.05	5520	0.15	2.05
May	2384	0.07	1.25	2948	0.64	13.65	5332	0.13	2.09
June	2604	0.07	1.15	2920	0.73	17.16	5524	0.13	1.91
July	3472	0.08	1.54	4216	0.89	14.19	7688	0.16	2.87
August	3120	0.08	1.44	3104	0.64	9.94	6224	0.13	2.41
September	3880	0.09	2.24	3748	0.80	8.29	7628	0.16	3.49
October	3652	0.06	1.44	3544	0.78	10.33	7196	0.13	2.33
November	2872	0.08	1.51	3280	0.64	10.09	2408	0.14	2.55
December	2860	0.07	1.32	3724	0.47	16.19	6584	0.14	2.66

Table 2. Characteristics of patronage of HandyRide and special services for the elderly.

Category	February	March	April	May	June	July	August	September	October	November	December
HandyRide											
Subscribers served	30	41	51	94	107	117	125	132	137	137	130
Persons in wheelchairs	16	21	22	35	46	50	56	59	59	59	53
Other handicapped	14	20	29	58	60	66	68	72	77	77	76
Elderly	0	0	0	1	1	1	1	1	1	1	1
Persons assisting	0	0	0	0	1	1	1	1	1	1	1
Trip purpose											
Work	25	33	39	65	69	73	79	80	84	84	83
School	5	8	10	16	21	26	38	34	34	34	30
Medical	0	0	2	12	16	17	17	17	18	18	16
Other	0	0	0	1	1	1	1	1	1	1	1
Special service for the elderly											
Residences served	—	16	24	28	28	31	32	32	34	34	34

had been supported by welfare but are now able to hold down jobs because special transportation is available, there are a number of sociological benefits.

HandyRidy will also provide many elderly and handicapped persons with the opportunity to share their experiences and wisdom in the classroom, which was not often possible in the past. For the first time in the lives of many of the handicapped people, they do not have to depend on family members or friends for transportation. They now have the freedom to move from one place to another via public transportation. They are also able to use public transportation without fear of having to fight for a seat or of being hurt by having to compete with the able-bodied.

Furthermore, by providing the handicapped with the opportunity to become gainfully employed, many of their psychological needs have been fulfilled. Studies have shown that a person's ability to work is a major social device for his identification as an adult. Much of who and what people are to themselves and others is interwoven with how they earn their livelihoods.

Another dimension of the psychological benefits associated with the service is that the elderly and handicapped patrons are now able to visit shopping, health, and recreational facilities that had previously been beyond their reach. By providing the elderly and the handicapped with specialized transportation, the range of functions in which they can now participate has been dramatically broadened.

However, the very nature of the service and various submarkets within the main market classification of the elderly and handicapped indicates that before the evaluation criteria are complete a study must be conducted to give the RTD some valuable data in relation to

1. The real benefits of the service to the user;
2. The degree to which the users' lives have changed in comparison with those of nonusers since the service began;
3. The values, life-styles, and attitudes of users versus nonusers;
4. The impact on family, social workers, employers, and so on;
5. The characteristics of the system that would aid us most in increasing patronage;
6. Methods of locating handicapped persons who have not previously identified themselves;
7. The latent demand characteristics of users and nonusers;
8. The true needs of the handicapped and how they differ from those of the elderly; and
9. The communication channels that would assist us most in getting factual information about the HandyRide service to all handicapped persons (i.e., media selection, citizens' committees, friends, and so on).

CONCLUSION

After the entire evaluation is complete, modifications may be made in the services provided for the elderly and the handicapped. We hope the service can be significantly expanded to reach more handicapped and elderly people who are unable to use regular transit service. From the applications received, RTD is acquiring valuable data related to the elderly and the handicapped that will be used to help design services that meet the needs of these groups. RTD wants this program always to have the flexibility necessary to improve service and meet changing needs.

REFERENCE

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Diversified Transportation Services With Emphasis on the Elderly and Handicapped

Marvin L. Glassman, Columbus Green Cabs, Columbus, Ohio

This paper advocates the use of taxicab companies to provide paratransit services for the elderly and handicapped. The author provides examples from his company's operation to show the kinds of services a cab company can handle for a locat transit authority.

Do you remember wishing as a youngster that things would disappear or go away—like that next exam in Latin or the bully waiting for you around the corner? There are a lot of people who would like to see the problems of transporting the elderly and handicapped disappear. But, like the bully and the Latin test, they just won't leave.

Our industry and especially my company have for many years been concerned with transportation of the handicapped and the elderly. Contrary to what some of the writers and experts in the field say, taxis are currently the best mode of transportation available to them. They constitute a large portion of our total business; people 60 and over represent 21.7 percent of our volume and adding housewives, students, and unemployed and incapacitated persons brings it to 60 percent of our volume.

Many planners and transit people question the ability of our industry to handle the elderly and handicapped. James Bautz of the Urban Mass Transportation Administration (UMTA) said at a special meeting of the International Taxicab Association in 1975,

> While we (UMTA) are having some success in gaining your active involvement in demonstration projects, much remains to be done before urban areas become convinced of the potential your industry offers. We have yet to demonstrate effective mechanism to purchase your services through public agencies. One possible outcome, unless more progress is made, is to see all these services eventually provided directly by public agencies rather than through private operators like yourselves.

Long before Mr. Bautz made his statement, we had already made contact with our local transit authority to help them provide these services.

I would like to show you how and why a diversified taxicab operation is the only logical way to properly handle a community's responsibility to its aged and handicapped. There is no need for a superagency or for the local transit authority to enter a field in which it has no expertise. An examination of our total operation can show why a local governmental agency should purchase service from its local taxicab operator. Other companies may be larger and some smaller, but with a cab company there probably would not be a need for any additional operations facility.

Our industry has been in demand-responsive transportation since we replaced the horse and buggy as a means of transportation. When I consider what is being done today when local health agencies acquire funds for vehicles and set up their own transportation system, it makes me shudder. These health agencies or welfare organizations use full-time and part-time volunteers who are, for the most part, untrained drivers to drive their buses, vans, and automobiles. Every one of our drivers must go through an intensive 2-day safety course.

Earlier I mentioned that 60 percent of the industry's passengers are housewives, students, and the unemployed, retired, and incapacitated. Some indication of how this builds up to such a high percentage can be seen in our figures of more than 1400 exceptional school children and day-care-center children taken to and from their programs. Each new driver is instructed in the care of these exceptional children, the physically handicapped, the neurologically handicapped, the blind, the deaf, the hyperactive, and the educable mentally retarded.

Some of you may be asked why they are not transported by the regular school bus. These schools are spread out all over the city and there is not a school or class for each of these students near their homes. A long bus ride can cause a child who is already disadvantaged to become a problem in the classroom and also to cause problems at home after he has finished a tiring day in school. Each driver is given this special training even though he might be driving an airport limousine or leased van or his hours might be those when there is no school. Our supervisors are able to shift drivers from one area to another without affecting any of our schedules or customers.

The typical organization serving the mobile handicapped or those with limited mobility will generally have its vehicles repaired at the corner gas station or at the dealer's shop if something major happens. You will find that most cab companies have their own maintenance

shops and follow a rigid preventive maintenance program that enables us to get a much longer life out of a vehicle. The shop is a totally self-contained repair shop that includes motor and transmission rebuilding, frame straightening, bodywork, and an electrical department. Most of the vehicles have more than 400 000 km (250 000 miles) and some as many as 480 000 km (300 000 miles). Equipment properly maintained results in better service to the customer and, of course, lower overhead.

Just like every other type of business, we have our piles of paper work that eventually find their way into our computer. In addition to the normal business functions, we receive two very valuable pieces of information. The first is our fuel consumption report, which tells our shop foreman the distance each vehicle travels and the amount of fuel it consumes. When you use 4 000 000 to 6 000 000 liters (1 000 000 to 1 500 000 gal) of gasoline a year, a 10 percent savings means quite a few dollars. The second report is a productivity report on each individual driver.

I have discussed some of the reasons why and how a diversified paratransit organization can and should be involved in more than just the ordinary needs of the mobile handicapped. But the key to the entire program is our communications center. This is the area that makes the whole operation move. We have about 60 incoming telephone lines and we use four separate channels to dispatch a minimum of 3000 orders and up to 6000 orders every 24 hours. Unlike cab companies in cities like New York, Chicago, and Washington, we depend on our communications center for 80 to 90 percent of our total business. We are so concerned about the service we give the general public that we recently purchased two electronic answering devices to enable our customers to be answered and have their orders taken without any great delay.

The communications center is where our grouping and mixing are done for school and day-care-center children, as well as our industrial take-home program (some industries must transport their employees by cab if there is no public transportation available). Of course we are only people who must serve the public 24 hours a day. We cannot shut any of our operation off just because business slacks off.

I believe that many transportation systems reflect the feelings of management when it comes to the elderly and the handicapped. Those of us who do care seem to be the ones in the forefront. We were one of the first cab companies to have a wheelchair taxicab so that those who were confined to a wheelchair and their homes would be able to have some freedom. One of our customers, for example, had been confined to her home for many years and only traveled at the convenience of her family; she was able to go to the polls alone to vote for the first time in more than 20 years when our service was started in 1969. We have been able to transmit this feeling of concern to our employees because they know that a number of their fellow employees have physical handicaps.

We have developed two plans for the elderly and handicapped. The Mid-Ohio Regional Planning Commission has received funds for the planning of the first program. Our program is unique in that we have a lot of agencies involved. We initiated our program in late 1975 with a discussion involving our local transit authority, the regional UMTA representative, a representative from the mayor's office, and our management team. The purpose was to develop a demand-responsive system of transportation for the elderly and handicapped, but not a dial-a-ride system. As our discussion developed, we all came to the conclusion that we should not undertake too much. We all felt that, to develop a sound program, the demonstration should be developed over a 3-year period. One of the first problems we faced was that of identifying the mobile handicapped, those with limited mobility, and the elderly. The mobile handicapped and those with limited mobility could be identified through health agencies and the elderly through the transit authority's Good-as-Gold Discount Card.

The second step was to find some cooperating health and service agencies. Our United Cerebral Palsy Agency in the last couple of years had developed a fleet of 14 vans and a bus and was getting tired of the transportation problems discussed above. Their operating funds are derived from title 20 funds from the Department of Health, Education, and Welfare (HEW). Their program is such that their vehicles are used between 7:30 and 9:00 a.m. and 3:30 and 5:00 p.m., with one vehicle used each afternoon for a recreational program. The second organization we contacted was the City of Columbus Recreation Department's Council on Aging, which has a nutritional program that is also funded by HEW. They had 5 vans that are used between 9:30 a.m. and 3:30 p.m. Here was another agency that wanted to get out of the transportation business and back to their concern with the problems of the aging. The two agencies made a perfect match and we were able to eliminate 5 vehicles.

We anticipate serving as a subcontractor of the transit authority. The routing and scheduling will be done in our communications center in cooperation with the participating groups. As the entire program develops, such agencies as the Red Cross volunteer program for the elderly and the Crippled Children's Society may become part of our match. Once we have completed the involvement of all the agencies, this program will go beyond the necessities of life (training, shopping, doctors) and give these people the opportunity to enjoy a type of social life (theater, lectures, dining out) that is not available today. In the long range we can also see the fulfillment of some of the other needs using a type of dial-a-ride feeder system that will allow these people to use conventional buses.

This program for the elderly and handicapped is one that will not be developed just for Columbus but, with modification, for any town of any size. There is no need for that superagency Mr. Bautz called for. There is at least one cab company in each of 3561 communities throughout the United States to carry out this program.

Our second plan, one that is still on the drawing boards of our company but that will be of great assistance to many small communities, is what we call Operation Outreach. Although we do not know the actual needs, we would have a fleet of multipurpose vans, such as a maxi-van that has theater-type seats around the perimeter that will fold up when you must use a wheelchair. Through the use of an incoming WATS line, the people in such towns as Newark and Granville would be able to order the type of service they needed. It would require 24 hours advance notice for service, but the elderly and handicapped would be given the freedom of mobility that other people have. The number of communities that could be served depends, of course, on the availability of funds and the cooperation of the communities.

I believe that private paratransit organizations can participate with both the local and national agencies of government to give the elderly and handicapped a more than adequate system of transportation.

Research in Special Paratransit Service for the Handicapped

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This paper discusses the development of the Disabled Adult Transportation System in Edmonton, focusing on the user from two points of view: research and marketing. Three research techniques were used to determine and identify the user—incidence levels, civic census, and a registration system. Each technique is defined and described with a review of its advantages and disadvantages. The underlying philosophy of the marketing program was to involve disabled persons. This was achieved by information meetings, public meetings, and an Advisory Council that included disabled persons. The Advisory Council has met on a regular basis throughout the developmental and operational stages of the system and is considered to be central to the system.

This paper describes the development of the Disabled Adult Transportation System (DATS) in the city of Edmonton, inaugurated in April 1975. In the development of any demand-responsive transportation (DRT) system, three key elements must be considered:

1. Management—organization, board of directors, management scheduler, dispatcher, clerical workers, and drivers;
2. System—equipment, scheduling, driver training, costing, fare structure, and types of services; and
3. User—profile information, disability, and trip characteristics.

In this paper the emphasis will be placed on the user, since (a) the user defines the market, (b) the user provides a control for the system by eligibility or trip restrictions or both, (c) the location of the user defines the service area, (d) the user defines the demand for the system, and (e) the characteristics of the user dictate requirements for special equipment.

It is clear that the user is a dominant factor in planning the other two key elements. The user will be examined from two perspectives, research and marketing.

RESEARCH

Three separate research techniques were used to identify the user element—incidence levels, civic census, and registration. Each of these techniques will be discussed in terms of a definition of the disabled, a description of the technique, advantages and disadvantages of the technique, and evaluation of the technique for identifying potential users.

Incidence Levels

A broad definition of the physically handicapped that includes almost all types of physical disabilities was used. The mentally retarded and the elderly, if they are physically or mentally disabled, were also included within this definition. It should be noted that the disabled population includes more people than just those in wheelchairs. It includes, for example, people with multiple sclerosis, cerebral palsy, and strokes who may not be in wheelchairs; people with disabilities that are sometimes not obvious, such as hemophiliacs and people suffering from heart problems and respiratory diseases; people with specific sensory handicaps, particularly those with impairments of hearing or vision; elderly people who are afflicted by such diseases as Parkinson's disease, arthritis, or rheumatism, which are often accompanied by impairment of hearing or vision; and people without limbs as a result of accidents or war wounds.

The technique we used is common among demographic studies. It is based on the rate of occurrence of a particular phenomenon in a larger population. Surveys conducted in Canada (10 000 households), the United Kingdom (83 000 households), and the United States (84 000 households) to determine the incidence of major disabilities indicated that 7 to 8 percent of the general population is physically handicapped.

Application of this technique to Edmonton's population indicated that 31 065 individuals were disabled, of whom 16 250 were estimated to be restricted in their use of the public transit system.

Among the advantages of this technique are that, once the incidence levels are determined, the technique may be readily applied to any population and that it provides a reasonable profile of the disabled. Among the disadvantages are that it cannot be subjected to independent verification, the incidence levels are derived from surveys that can no longer be considered reliable for today's situation (the most current data for Canada are in the Canadian Sickness Survey, conducted in 1950-51), the technique's averaging factor does not discriminate be-

tween the higher incidence of some disabilities (e.g., multiple sclerosis) at certain ages, and it does not take account of that portion of the population that is disabled, either temporarily or permanently, because of accidents.

It was difficult to corroborate all of the incidence figures with actual numbers of disabled people. In fact, the only actual check available was with membership in the Canadian National Institute for the Blind (CNIB). Our figure for people with visual impairment was 671, and the CNIB has a membership of just more than 600. However, it is interesting to note that the technique estimated 655 wheelchair-bound people, including children, but the current DATS registration file has 1438 wheelchair-bound people registered, excluding children. It is clear from this discrepancy that the incidence-level technique cannot be the only one used to plan a DRT system for the disabled.

Civic Census

The census defines a handicap or disability as a long-term (one year or longer) condition. The handicap or disability may be physical, mental, or both.

The census is a technique that is used at regular intervals to enumerate a population. A civic census is conducted annually by the city of Edmonton, since provincial funding is based on population.

Among the advantages of this technique are that, within a given boundary, the census collects information on the age, sex, marital status, family and household characteristics, education, income, and occupation of the total population and that the census material may be used to indicate trends over time as well as to serve as a base from which population projections may be made. Among its disadvantages are that the cost of the census could be prohibitive, especially if it is designed to enumerate only the disabled population; although it is a universal technique, it does not ensure complete enumeration of a population since there may be enumerator errors and there are individuals who, for whatever the reason, do not wish to be enumerated (illegal immigrants, certain of the disabled, and other people who do not wish to be identified as members of a minority); and there is often a time lag between enumeration and release of the results of the census.

The city, in its review of transportation for the disabled, used the incidence-level technique. Due to the limitations of the technique, it was decided to do a census of the disabled in conjunction with the annual Edmonton civic census. A mail-back form was left at households in which a disabled individual resided. The survey was designed to determine the number of the disabled, their disabilities, and their needs. Although confidentiality was guaranteed, there was no obligation on the part of the disabled to identify themselves.

The census identified 4770 disabled individuals, 1185 in institutions and nursing homes and 3585 in private residences. The institutions returned all of the mail-back forms, but the rate of return for private residences was 36 percent (1287).

Preliminary data analyses have been completed, but we feel the results are not indicative of the total population of the disabled because of the disadvantages of the census technique outlined earlier.

The incidence level and census techniques only give information on the profile of the disabled and inadequate information on their transportation requirements. Consequently, they can only serve as gross demand figures for a DRT system for the disabled.

Registration

An operational definition was required to identify eligible persons who wanted to use DATS. A disabled person was defined as one who is unable, for one reason or another, to use the existing Edmonton Transit System.

DATS registration ensures that only eligible people use the service. Registration forms are mailed out on request. The returned registration forms are numbered and entered on a master computer file. After a person is deemed eligible, a registration card and brochure outlining the available transportation services are mailed to him or her. The registration form provides the initial base information concerning each user, e.g., location, type of disability, whether an attendant is required for travel, and type of service and purpose of trip requested, by origin and destination and by the day of the week.

Among the advantages of this technique are that the registration system is designed to provide all of the user information required to plan the system and management elements (origin-destination information, loading times, disability, need for attendants, special equipment, and whether trip requests are regular or casual); it ensures that only eligible people use the service; it allows the monitors of the service to record the trip characteristics of the user; and the system, if computerized, will allow for continuous updating and other statistical analyses. Among its disadvantages are that the registration file provides a listing only of those who request special transportation services, so that it is not representative of the total disabled sector of the population, and there may be problems inherent in the organization of the registration file itself, e.g., information that is not detailed enough for planning the system and management elements.

The registration system was set up by the city of Edmonton in order to plan the system and management elements. The format is detailed enough to plot the actual trip request by day, arrival or departure time, origin and destination, disability, requirement for an attendant, estimated loading time, and registration number. In short, the trip information provided by the user allowed the planners of the system to plot the demand by trip purpose (work, medical, so forth), type of service (subscription, reservation, so forth), and time of day. To date, 2660 disabled persons have registered with DATS, excluding children.

In summary, if a DRT system is being planned for the handicapped, it is highly recommended that a computerized registration system be instituted. In addition, it is recommended that this registration system be instituted before the system and management elements are planned, since it forms the basis for them.

MARKETING

The underlying philosophy of the development of DATS was to involve disabled persons wherever possible. Marketing of the DATS service included several components at every stage in its development.

Public Participation

Three techniques were used to involve the disabled in the original work—information meetings, public meetings, and the Advisory Council.

The original research on transportation for the disabled was conducted during August 1974. Numerous meetings were organized between the planners and agencies for the disabled (Ability Fund Drive, United Way Committee on Transportation for the Disabled, Action Group of the Disabled, Edmonton Interagency Council for the Handicapped, Handicapped Housing Society) and

providers of existing transportation service. The results of these information meetings provided much of the basis for the report.

Two public meetings were held in September 1974, one for information purposes and one for discussing the results of the report and its recommendations in detail. More than 250 disabled persons were in attendance at each meeting. Based on the feedback received from these meetings, the report recommendations were revised and subsequently approved by the City Council on November 12, 1974.

One of the recommendations of the report was to institute a council to assist in the detailed planning and implementation of the DATS project. The Advisory Council is made up of seven disabled persons who represent various agencies, two representatives from the United Way Committee on Transportation for the Disabled, and two representatives from the city of Edmonton's Engineering and Transportation Department.

Since its inception in December 1974, the Advisory Council met on 17 occasions in 1975. The council was divided into committees delegated to review components of the system and management elements, e.g., registration, eligibility, vehicle safety, and bid review. The various committees have met approximately 40 times.

Through the council and its committees, the following aspects of DATS were reviewed: tender specifications, fare structure, registration system, accessibility to rapid transit and the pedway system, review of bids, eligibility criteria, types of and level of service, vehicles and safety equipment, terms of reference and objectives of DATS, development of logo, census of the disabled, complaint system, brochure and registration card content, service comments, DATS evaluation, and DATS study design. The Advisory Council is the hub of activity from which the marketing and development of the system grew.

Newspaper Advertising

The Registration Subcommittee produced a newspaper advertisement that invited people unable to use the Edmonton Transit System (ETS) to register for the transportation system for the disabled. The ad was run 10 times between December 1974 and the end of January 1975. A copy of the ad was also placed in the Alberta Handicapped Forum and ethnic newspapers. As mentioned earlier, 2660 disabled individuals have registered with DATS.

DATS Graphic Package

A graphic package including a logo, color schemes, brochure, registration card, and letterhead was developed for DATS. A graphic artist, himself disabled, was hired to prepare the package. It has been used to identify DATS as a parallel paratransit system of the ETS.

Mass Media

At various stages in the development and during the operation of DATS, various news releases were issued to the media. The inauguration of the DATS service took place on April 28, 1975. A plaque was presented to the mayor of Edmonton to commemorate the occasion. Members of the media were present and the service received excellent coverage on television and radio and in the newspapers.

Newsletter

Due to the large number of registrants and to modifications in the service provided, it was necessary to find an outlet for information. It was decided to use two local monthly papers to provide this information, the Alberta Handicapped Forum and the Transit News. These papers are used to provide information concerning the DATS operation to the users and the public at large.

Open House

Two open houses are planned in April 1976, one for the elected officials and representatives of the media and one for the agencies that provide various services to the disabled. The purpose of the open houses is to give these groups an opportunity to see how the DATS service operates.

SUMMARY

This paper has identified three key elements of DRT systems: management, system, and the user. The paper has dealt with the research and marketing of the user element. If anything is to be learned from the development of Edmonton's Disabled Adult Transportation System, it is the importance of the user, in particular, the development of a computerized registration system and the involvement of the handicapped in the detailed planning, implementation, and review of the system.

Servicing the Industrial and Government Complex

Neal C. Nichols, Transportation, Inc., Arlington, Virginia

This paper describes a six-company taxicab and delivery service corporation that provides for varied paratransit needs in the Washington, D.C., area, particularly serving the needs of business and government.

A significant application of diversified taxicab paratransit services lies in the business and government complex. The ever-increasing need for transportation of both personnel and materials has created a demand for specialized services that can only be met efficiently by various forms of paratransit, with their inherent flexibility.

For clarification, the definition of the industrial-government complex should be expanded. It includes both offices and plants in the business sector, government offices and military installations, and airports and other transportation terminals. The transportation services required may range from individual commuting to the handling of vital documents for business and government.

My organization consists of six companies that operate taxicabs and delivery vehicles in the Washington metropolitan area. Red Top Cab Company in Arlington, Virginia, has a 190-car fleet that handles an average of 4000 trips a day, with a high of 5000 trips on Friday and a low on Sunday of 1500. The Yellow Cab Companies in Arlington and Fairfax Counties operate approximately 200 cars, with daily ridership roughly equal to Red Top's. The Airport Cab Companies, one at Dulles and another at Baltimore-Washington International Airport, consist of 60- and 30-cab fleets, respectively, with average daily trip counts of 400 and 250. We also now have an application pending for operating authority to institute a limousine service using vans to serve both National and Dulles Airports on a scheduled basis. All-State Messenger and Delivery Service operates 85 vehicles, including trucks, vans, sedans, station wagons, and motorcycles; it handles 750 priority deliveries a day in addition to hundreds of low-priority bulk shipments. Thus ours is a multimodal operation using approximately 565 vehicles of various sorts and serving two large metropolitan areas.

All of these companies combined operate eight different two-way radio transmitters. These transmitters are located throughout the metropolitan area wherever the service demands of the particular company are best met. For example, Red Top Cab Company uses two UHF radio frequencies and has broken Arlington into two geographical areas with one transmitter responsible for each area. All-State Messenger and Delivery Service has two transmitters also, but these both operate on the same frequency. This is necessary because this company serves the entire Washington metropolitan area, a much larger territory than is covered by any one of the taxicab companies. Good two-way radio communication is essential to any demand-responsive transportation system.

TAXICAB SERVICES

Our most prevalent form of paratransit to date is standard exclusive-use taxicab service. The bulk of taxicab ridership across the country, at least 60 percent, is made up of the elderly, handicapped, housewives, and students. However, many users, especially in urban areas, are business people traveling to and from work, between offices, and to and from air and train terminals. This is certainly true in the Washington area, which houses the offices of the federal government and many major business concerns and thus has a large white-collar population. For many years taxicabs have provided for the specialized transportation needs of business and government, although the impact of these services has until recently received little recognition by transportation officials.

Those who use our taxicab service between 7:00 and 10:00 a.m. and between 3:00 and 6:00 p.m. make up 40 percent of our ridership. Those are the peak commuter hours, and the vast majority of those passengers are going either directly or indirectly to or from their offices. They are primarily business people, government workers and officials, and military personnel. Many use taxicabs to connect with Metrobus routes, thus eliminating some of the need for fringe parking and helping to ease downtown traffic congestion. When the subway system is completed, it is anticipated that taxicabs will serve as feeders to and from the subway stations, serving further as a vital segment of the overall transportation system.

Arlington County was awarded a grant by the Urban

Mass Transportation Administration to study the feasibility of shared-ride taxicab service for Arlington. Red Top Cab Company participated in an earlier unsubsidized shared-ride demonstration project and is cooperating with the Arlington Department of Transportation on the current study. Incorporated into the new program, in addition to neighborhood service, is the concept of shared-ride service in coordination with Metrobus and Metrorail lines, thus amplifying the role that taxicabs play in transporting business and government personnel. In addition, the new program will encourage the use of subscription service. With the many government and business offices located in Arlington and a high concentration of professional people in the community, this should enable us to offer an efficient service, similar to van pooling, using taxicabs to transport employees to and from their offices on a contractual basis.

Taxicabs are often used during the day by people traveling between offices. Interoffice travel is especially frequent between businesses and government installations in the Rosslyn and Crystal City sections of Arlington County and downtown business and government districts. Business and government people going to and from the airports and other transportation terminals also rely heavily on taxicabs for that purpose. In fact, most airlines and railway companies use our taxicabs and vans to transport crews between terminals or between the terminals and area hotels during layovers. These and other businesses use our services so frequently that most have established charge accounts with us in order to better control their transportation expenditures.

The reasons for the increase in this particular facet of our business are easily understood. The scarcity and cost of parking and the traffic congestion in downtown areas and at the airports have made it more and more infeasible for people to drive from office to office. Bus service, while relatively inexpensive, is time consuming except when traveling between in-line points via express service. The expense of maintaining in-house drivers and vehicles for transporting personnel and running errands is great in relation to the degree of use. The logical choice of transportation mode that offers both convenience and comparative economy has been the taxicab.

Our airport cab companies at Dulles and Baltimore-Washington International Airports are more specialized operations. Both are operating under government contracts and specifically serve passengers going to and from these airports. The ridership primarily consists of incoming air travelers going to locations within the metropolitan area, although we are actively promoting return business to the airports. Government and business activity in the Washington area generates a high volume of air travel, with the majority of the passengers being professional and government personnel traveling on business. While taxicabs are generally more expensive than limousine or bus service, to the professional traveler the convenience of efficient door-to-door transportation and the attendant time saving are among the most significant factors determining selection of travel mode. As a sidelight it might be noted that the open cab system in effect for nearly two years at Washington National Airport, where no controls were enforced, resulted in a high incidence of fare overcharges and passenger inconvenience due to undertrained and largely incompetent drivers. This is indicative of the advantages of a well-run franchise taxicab operation.

In addition to passenger service, all of our taxicab companies offer rapid courier service. The airport operations primarily carry mishandled luggage for the airlines, although they also deliver newspapers and special mail. The regular taxicab operations provide a more diversified service, carrying interoffice memoranda, documents, blood for area hospitals, and work orders and equipment for telephone, electronics, and computer companies.

COURIER AND FREIGHT SERVICES

In the past 5 years the demand for courier service has increased at such a rate that it has become a full-time business. Two years ago the volume reached a level that mandated the formation of a separate company, All-State Messenger and Delivery Service, to take advantage of this growing market. Using a radio-dispatched fleet and a full-time sales staff, the company has experienced a continual growth that indicates that, for the foreseeable future, much of the expansion of taxicab paratransit services in urban areas will include the delivery field.

The increase in demand for this service can, as in the case of taxicab use, be attributed to time- and cost-effectiveness. Under today's pressures, businesses find it necessary to maximize their use of their employees' time and to scrutinize carefully all overhead items in an effort to maintain peak operating efficiency. The ability of a specialized courier service, such as All-State, to provide a high level of performance (minimal delivery time for priority items) with a competitive price structure has become an essential commodity. The use of couriers frees office employees from time-consuming, less productive tasks, which enables them to perform their intended functions and thereby reduces tangible and intangible costs.

All-State's service is predicated on a 15-min service response time and completion of the delivery within 60 min. That goal is accomplished, except during unusually heavy peak periods, while still achieving a high degree of vehicle productivity by routing the drivers so that each handles at least two deliveries simultaneously whenever possible. The dispatchers are able to exercise the necessary operational control by coordinating our staff of well-trained drivers who, while they are employees, work on an incentive basis.

By using several types and sizes of vehicles, All-State is able to fulfill a variety of customer delivery needs. Started initially as a courier or small-parcel delivery service delivering papers for law firms, accountants, and other service-oriented businesses, All-State has grown substantially and now even offers delivery capabilities up to and including small freight shipments. Several customers are computer firms that use us to transport both software and hardware items. Much of our work is done for airlines at National and Dulles Airports. Mishandled baggage, special deliveries, and crew transportation are some of our airport service specialities. In addition, All-State acts as the Washington, D.C., area agent for Emery Air Freight, handling both large and small express-freight deliveries. Thus, while it was initially an offshoot of the taxicab operation, All-State, or any similarly run operation, is able to offer a greater diversity of delivery capabilities while maintaining the flexibility and convenience of demand-responsive paratransit.

CONCLUSION

As is evident from our operations, taxicab and paratransit can be synonymous terms. In urban areas like Washington, we have become essential supportive services for the business and government communities. Taxicab companies have grown to fill the service requirements in very specialized areas of demand, i.e., airport service, exclusive use, shared-ride modes, courier ser-

vice, and the whole spectrum of what we now call paratransit. This is indicative of the fact that demand-responsive transportation is virtually assured of success when it is operated in an efficient, conservative manner, particularly when the private entrepreneurial instinct is allowed to function.

There is nothing really new about what we are doing—taxicab companies have been providing these services for years. When these service demands can be met in a market area that is reasonably free of restrictive government controls, and when there is no unfair competition with government-subsidized operations, paratransit can and should remain in the private tax-paying sector, while it fulfills a necessary role in the urban transportation picture.

Part 4
Dispatching and Vehicles

Computer-Controlled Versus Computer-Aided Dispatching

G. H. McAdoo, Regina Transit System, Saskatchewan

The city of Regina, Saskatchewan, instituted demand-responsive transit on a very limited budget. The author describes the training program designed for the system's initial personnel, who worked without computer assistance, and notes the benefits of the computer programs that are now in use.

In considering dispatching and its function in paratransit operations, we would do well to start with a definition of the dispatching function. In consulting my dictionary, I find that the most appropriate meaning for "dispatch" is "a method of effecting a speedy delivery of goods." As I see it, if we should choose a meaning less than this we have surely missed the prime function required to successfully operate a demand-responsive transit service.

Dispatching must then be considered as the operation in its entirety. The system must become activated immediately on receipt of demand and remain operational until the demand has been satisfied. With this concept of the dispatching function, the discipline of accumulating and distributing information becomes merely one area of the operating sphere. If dispatching should be considered the orderly control of vehicular equipment in order to attain a predetermined objective, the entire operation of a demand-responsive service must be considered the dispatching function.

With this definition, we must consider what activities are involved in the overall function—telephone answering, information storing, communications distribution, and vehicle operations. This group as a whole, and only as a whole, can complete the dispatching function. In order to emphasize this basic principle I shall describe the Regina experience in demand-responsive operations. We do not consider our system unique, nor would it be fair for me to say that this is the way it should be done. We do feel, however, that our operations have been moderately successful, with the primary and basic cause being that the staff participates in a working team, on a work program that can satisfy the individual's need for personal contribution and job satisfaction.

BACKGROUND

In September 1971, Regina instituted an experimental program in demand-responsive transit services. For those who are not familiar with previously published reports, I shall present a short overview. Regina is the capital city of the province of Saskatchewan and has a population of 150 000 persons. The prime employers of the area are the city of Regina and the province of Saskatchewan. Industrially, the city is primarily a distribution center with a few manufacturing industries that are generally agriculturally oriented. The city's public transit service dates back to 1911, at which time vehicles were electrically powered on fixed routes. Basically, this type of vehicle was maintained until 1962. At this time conversion was made to the more flexible diesel-powered vehicles of current transit operations. Unfortunately, the old school of fixed-route transit operations remained in charge, which resulted in a loss of passengers to the more flexible personal automobile.

In 1969 our transportation engineers, realizing the plight of public transit, embarked on a program to investigate the possibility of using the flexibility inherent in new transit vehicles. It was hoped that such investigations would provide a system that could cause public transit to become a workable alternative to the personal automobile. Subsequently, the Regina experiment was designed as a system of demand-responsive services within an area or zone to feed an established fixed trunk route. The area chosen was the high-income district in which transit ridership was the lowest in the city.

Until now nothing has been said that would indicate that the Regina operation might be unique. What I am, in fact, attempting to stress is that the city of Regina's transit operations were completely like those of most Canadian cities of comparable size. What was unique in this experiment was the fact that there was no funding for operations. Money was provided by the federal and provincial governments for such software purposes as feasibility and engineering studies, while the municipal government was to provide operational funding. But with growing transit deficits and an apparently bleak future for transit operations, the urban government was not sympathetic to further expenditures. In addition, the idea of buses running around from door to door to gather and distribute their passengers was ridiculous to some. Surely if transit buses operating on fixed routes were a losing proposition, then the time involved in doorstep

pickup would cause costs to skyrocket. The lack of funding indeed created operational hardships since costs had to be maintained within the predetermined budget. The consequences of this restriction placed the department squarely behind the eight ball. It became very obvious to the management team that, in order to maintain credibility, the idea of demand-responsive transit must not fail.

PLANNING THE SERVICE

First, an accounting of available resources had to be made. At our disposal was a fleet of regular transit buses that would be freed by the elimination of many fixed routes within the area. Second, we had the good fortune to have had some of these vehicles radio equipped. Third, we had manpower, and this had to be the prime resource that could make or break the entire project.

The course of action now was to systematically build a public-relations-oriented door-to-door pickup and delivery transit service. It was realized at the outset that our success or failure would hinge on the operating personnel. The prime task confronting management lay in the training and indoctrination of personnel. Training programs were immediately instituted. Personnel were given a classroom session that began with general public relations and department responsibilities and concluded with an orientation to demand-responsive services in principle, practices, and expected results. Then came the simulated operations. Operating personnel were taken on location and presented trip tour sheets complete with pickup and drop-off addresses. The principle of the game was to have the operator accurately plan and execute, from a map provided, a route that would lend itself to the maximum convenience of the passengers and still return to the point of departure within a predetermined time.

With a well-planned training program, we can give our personnel an appreciation of the objectives of the operation and, more important, an appreciation of their contribution to the success or failure of the operation. No longer are personnel merely pawns in the organization's structure. They now have a position of responsibility, of involvement in decision making, contributing to the success or failure of the overall objective.

Having created this team, we entered the field of operation. Here was the proving ground for our planning. Our operations were small at first—a dispatcher and one radio-equipped bus with operator. Our planning told us that operations should run smoothly, as they certainly did through the first day. Not a hitch was encountered, nor should it be with a well-trained team. On the first day we carried eight passengers in an 8-hour shift. As the days passed, the number of passengers grew and more buses were added. Another zone was added and there were more passengers and more buses. As winter arrived again the number of passengers grew, buses were added, and another zone was added. By this time winter was fully upon us. Our system was operating effectively and nearly flawlessly.

Then came the crunch, as it can only come in a western Canadian climate. As the day broke at 6:00 a.m., the temperature was -41°C (-42°F). Only those who have experienced such conditions can fully appreciate how devastating they can be to the personal automobile. Our dispatcher went to work with the telephone in one hand and the radio transmitter in the other. His fleet of buses and operators were as well prepared as possible for the situation. Calls began to roll in moderately at first but with an increasing tempo, and they peaked at 8:00 a.m. Our dispatcher and operating team were working beyond capacity. Calls continued to flow in, with backlogs developing. Something had to be done, but what? There was no extra equipment available and, even if it were, by the time it was in service the backlogs would be in a hopeless state.

Here the resourcefulness of the human brain, coupled with a conscientious working team, made an obvious adjustment to meet the situation. Since vehicles can only make so many house calls within a given time, the objective was to permit the system to collect more persons per stop and to eliminate as much driving distance as possible. People calling in were directed to walk to a neighboring address where somebody was already awaiting a bus. Others were directed to go to a certain street where the bus would be passing within a few minutes. In this manner the morning rush was accommodated and pressures dropped by 9:00 a.m. A count of the recorded pickups revealed that, between 6:30 and 9:00 a.m., the dispatcher had processed 360 transactions. Each involved receipt of a call, dispatching a communication, and operator responses; many also involved intervehicular cooperation at fringe zones.

Surely that morning was the moment of truth and the proof that the system would work. It was also the proof of what had really happened in the training program. We had not had the budget for a computer-assisted program, but our training program had produced many human minicomputers—minicomputers who could think and adjust, who had feelings and compassion, and who had an operating cost of $5.50 per hour. Herein lay the ultimate secret of success or failure of any such venture.

COMPUTER USE

By now I may have given the impression that the computer and its assistance are not required in our or any similar operation. This is not so. We in Regina now use a computer to assist in dispatching. Our passengers are divided into those with permanent bookings and those who book on demand. Regular riders are programmed into the computer files according to the days service is required and the time of day the trip has to be made. Daily printouts are produced on the operators' trip sheets and are distributed to the operating personnel. This provides a convenience to the passenger since one call to the control center can establish a regular daily pickup. Should this service not be required during a given time (vacations), a simple call to our dispatcher can suspend or reinstate service as required.

Among those who prebook are many students who use the system five days a week with the exception of regular and special school holidays. Needless to say, a lot of work would be required to suspend and reinstate each booking in this category. A simple and relatively inexpensive computer program adjustment has now made it possible to provide this transaction en masse. The program also provides an assist in overall operations that eliminates the need for daily call-ins by this group, which frees the telephone lines for additional demand calls. We have also consulted our computer center with regard to the effective programming of demand calls. This service can be provided with keypunch input by one of our telephonists. The stored information can then be released on command to either the vehicle or the terminal teleprinter. Though the costs are somewhat greater, such a service could be beneficial in both time and labor costs.

At the time of writing, the Regina system was operating with 13 vehicles during peak-hour operations and 15 vehicles during off-peak hours. These units are serviced by a total of 2½ dispatchers and 2½ telephonists, aided by the computer printout. One could consider

such overhead in communications personnel as being costly, but since our operations cover an 18-hour period with a minimum requirement of 2 persons during daytime hours, no fewer communications personnel can be provided. The provision also leaves room for fleet expansion, particularly during off-peak periods. What must also be considered is that we are not yet sure what our actual capacity is. We do know that an average winter day produces some 3000 passengers and this may now double with our larger fleet. Also important in this regard is our theory of decentralization. Though the Regina system is fully integrated in the total operation's financial structure, our demand-responsive service is operationally decentralized.

In summation, I do agree that the computer is an effective tool in a people-oriented operation, but it is only a tool. No other system is as economically effective as a human being with a mechanical aid.

Ann Arbor's Dispatching System

Barbara Potter, MetrOscan, Inc., Buffalo, New York

This paper attempts to describe in detail the operational procedures used in the computer-aided dispatching system installed at the Ann Arbor Transportation Authority facility in Ann Arbor, Michigan. It is designed to facilitate the needs of the demand-responsive mass transportation concept that has been introduced and is in operation in Ann Arbor. The system has two basic parts: the central control center and the mobile units that handle the digital transmission.

The Ann Arbor Transportation Authority (AATA) Teltran Communications and Dispatching System is a coordinated 81-bus (45 dial-a-ride buses and 36 express buses) computer-assisted dispatching system. It has been operating successfully since August 5, 1975. The system was designed on the basis of the previously used manual dispatching procedures.

The basic functions of the system are automatic assistance in order taking and the associated dispatcher functions, such as bus scheduling, status reports, emergency calling, and vehicle identification. In addition, there is provision for supervisory facilities with respect to start-up, organization, and off-line procedures.

Express routes in the city of Ann Arbor are designed so that express buses cover all major trip attractors and generators. The express vehicles run at 10-min headways during the peak periods Monday through Friday and at 20-min to 30-min headways during midday periods and Saturday hours.

Depending on the day and time of operation, the city is divided into a specified number of zones, with demand-responsive (dial-a-ride) vehicles assigned to each zone. During weekday peak hours there are approximately 20 zones, with from one to three demand-responsive vehicles assigned to each. These vehicles take care of intrazonal travel and also act as collectors and distributors for the express buses. Each demand-responsive vehicle proceeds on a 20-min to 30-min tour starting and ending at the express-bus-coordinated transfer point that corresponds to its zone. In off-peak hours, transfer points may also accommodate dial-a-ride to dial-a-ride transfers. Vehicles within each zone run out of phase, each of their schedules being coordinated with that of an express vehicle. Zones are redefined in the less busy times of the day into larger areas in order to correspond to their respective express-bus schedules.

In addition to the express-bus system and the demand-responsive or dial-a-ride service, the AATA provides a demand-responsive service for the handicapped that supplies door-to-door transportation service within the city limits during all operational hours. Subscription-service vehicles for school or work runs are also provided for groups of 20 or more persons going from the same general area to the same destinations at the same time. Charter vehicles are also offered for those groups that request such service.

Because of the nature of the service, a high percentage of trips start with a telephone request for pickup. This necessitates a highly sophisticated communications system to process telephone-demand trips into tours and to transmit tour rosters or other necessary information to and from the demand-responsive vehicles.

The central equipment consists of a processor, storage, peripheral equipment, and the interface units that connect to the radio channels. The processor is a 16-bit word-length machine with 48K word-core storage and a million-word disc-cartridge backup storage. Cathode-ray tube (CRT) display units, provided with special keyboards, provide for local input of information to the system, and local printers provide various hard-copy logs of the daily transactions handled by the system.

The central control system consists of nine work stations located in a single control room. Eight of these work stations are designated as call-taker or dispatcher stations and one is designated as a supervisory console.

There are basically three distinct functions of the dispatching procedure. The primary series of functions is that of call taker. The second series is the dispatcher and includes all the call-taker functions as well. The last series is the supervisor and can handle all the call-taker and dispatcher functions, as well as those specifically assigned to the supervisor.

The Teltran Dispatching System is a man-to-machine computer-assisted dispatching system. That is to say, there are virtually no decisions made by the computer. All decision making remains in the hands of the dispatcher. This part of the system will become more evident as we describe each of the functions in detail.

CALL TAKER

Incoming telephone calls from the public requesting service are processed at the dispatching center by call takers, each of whom has a CRT for entering relevant data into the system.

The trip-entry sequence is the basic function of the call taker and is presented as a series of cues from the computer. The call taker types in all the pertinent information from the customer, such as pickup point, destination, requested time, number of passengers, and additional information such as telephone number, handicap, back door, and so on, that may be relevant. The destination can be a specified transfer point (a two-character alpha designation) or another address within the pickup zone.

When all the pertinent data have been accumulated, the computer prompts for zone (the zone of the pickup address). Since there is no gazetteer file in the computer, it is the call taker's responsibility to determine the zone (a three-character alpha notation). A gazetteer file is essentially a map of the city. Although many systems include a gazetteer file, it was eliminated in Ann Arbor in order to allow for more flexibility and capability to cross zones. If the zone entry does not correspond to a valid zone, however, an error message will be displayed.

After the call taker has specified the zone, the computer responds with up to three available tours, along with the number of passengers already booked on each, that will satisfy all the requirements that have been accumulated by the call taker. If a transfer point has been specified, only tours with that transfer-point destination will be displayed. If the destination is another address, however, tours in both directions will be displayed and the call taker can determine the best direction for the trip.

Each tour is specified by a six-character name; the first four (numeric) characters signify the starting time of the tour and the last two (alphabetic) characters signify the destination transfer point. This kind of identification makes it very simple to make an intelligent decision as to which tour is most applicable.

In order to further facilitate the choice of the tour, the call taker may make the decision from the display of tours or may choose to look at the tour roster itself. The tour roster displays all the pertinent information about the tour including the zone, tour name, bus number, and number of passengers. The roster also contains a list of the addresses and pickup times for all the trips that are already booked on that tour. The call taker may cycle all three available tours and then choose the one that is most convenient for the trip in question. In this operation, the call taker may also change the estimated time of arrival of the trip or choose three other tours if none of the three previously displayed are satisfactory.

It is through this trip-entry sequence, and only through this sequence, that a trip may be deleted from a tour roster. The deletion of a trip has deliberately been made rather cumbersome in order to avoid the possibility of deleting a trip accidentally.

Another major function of the call taker is entering a standing order into the system. Once a standing order has been entered into the system, it is automatically put onto the specified tour roster at start-up of the designated day.

In order to enter a standing order into the system, the call taker starts the procedure in the same way as for trip entry. The pickup point and destination are determined. When the time is requested, however, the call taker depresses the STO key and the display for the last name of the customer. Once the last name and initials are entered, there appears a matrix representing the 7 days of the week. The call taker then fills in the zone and time for each applicable day while the computer responds with up to three available tours for each day specified, as well as the number of standing-order customers already booked on each of those tours.

When the matrix is complete, the call taker continues with the pertinent data, number of passengers, and telephone number until ready to specify the tours for each trip. If there is a common tour that is satisfactory for two or more trips, the call taker may enter these trips cumulatively, in one step, or individually if he or she so desires.

In order to complete the standing order there are three more cues—expiration date of the order (optional), the "go live" date (required), and up to three "ignore" dates (optional). The standing order is now entered into the system and is automatically taken care of by the computer at the beginning of the day. If, however, a particular standing order needs to be amended or deleted, the call taker need only recall that standing order and make the specified changes or remove the order from the files.

An advance-order entry is very similar to a standing order entry. Since an advance order is simply a one-trip entry for any time other than today, it does not require as much information as the standing order. The call taker starts the procedure in the same way by entering the last name and the initials of the customer. The computer responds with the same 7-day matrix. The call taker need only enter the zone, the time, and the date of the requested trip on the one line set aside for Monday's entry. The computer designates the three tours available on that day and at that time and also indicates to the call taker the day of the week the trip applies. Passenger and information cues follow; the call taker chooses the tour and the advance order is then entered into the system and will appear on the specified tour roster on the particular day requested. Advance orders may also be amended or deleted from the system in the same way as standing orders.

There are, then, basically five functions in the call-taker mode: trip entry, standing-order entry, advance-order entry, standing-order examine, and advance-order examine. These five functions tend to cover all the possibilities that might arise from an incoming telephone call from the public.

DISPATCHER

Let us now turn to the dispatcher functions. How do all these trips and tour rosters reach the bus to be expedited? The dispatcher's directory lists three function modes: trip entry, tour roster, and bus status. The trip-entry mode includes all of the functions described above for the call taker. The tour-roster mode includes editing tour rosters and organizing them so that they are ready for automatic transmission to the bus. In the bus-status mode, the dispatcher may check the next tour coming up for a specified bus.

When the dispatcher specifies the tour-roster mode, the computer requests the zone and tour name. Once this information has been provided, the tour roster that has been requested is displayed. Again, the tour roster has all the information about the tour as well as a list of trips already booked on that tour. If the dispatcher decides that the roster he is looking at is not satisfactory, he chooses to enter the edit mode. In this edit mode, the dispatcher may cycle from one roster to another and has the ability to remove a trip from one roster and add it to another. Up to three trips from one or more rosters

may be removed at any one time. However, each trip must be assigned or added to another tour before the dispatcher can leave the edit mode. This fact prevents the loss of any trip from the files.

Once a tour roster has been edited to the dispatcher's satisfaction, which is to say that all trips on the roster are meaningful geographically, the roster is ready to be ordered or organized. Ordering requires setting up pickup and drop-off points in such a sequence that the tour can be completed from the bus's starting point to the point of destination in a logical and effective manner. The ordering process can be completed in one or several steps according to the dispatcher's needs.

Tour rosters are designated as either organized or unorganized. After editing and ordering a roster, the dispatcher organizes or "blesses" a tour roster. If it is designated as organized and stored accordingly, the tour is automatically transmitted to the bus through the central system when the bus to which it has been assigned signals that it is ready for the next tour. However, the time at which such a transmission is sent to a bus is regulated to coincide with the scheduled starting time of the tour. This control of tour transmission time is provided so that no bus shall start its tour too early and to allow for the implementation of last-minute trips. Conversely, if a particular bus is running late or has had some mechanical difficulties, the dispatcher can override the predetermined system and transmit the tour to another bus.

The third function in the dispatcher's directory is the bus-status mode. Through this mode, the dispatcher can check the next tour coming up for a specific bus or for a number of buses. This operation enables the dispatcher to make sure that the tour roster is ready for transmission to the bus or buses he is responsible for. When the bus-status mode is indicated, the computer asks for the bus number. When the bus number has been specified, the computer responds with the zone, tour name, and number of passengers booked on the tour and, if a minus sign is present, it informs the dispatcher that the tour has already been organized. If a bus that has no tours is specified, a message to that effect is displayed. The dispatcher can specify up to nine buses on one page; the tenth bus clears that screen and starts a new page.

Dispatchers are responsible for up to 20 demand-responsive vehicles. That is to say, it is their responsibility to check on the status of each of these 20 buses and to act upon the status accordingly. For this purpose, the last three lines on the dispatcher's display screen are reserved for bus-status messages and voice communication information. No matter what the operation, the last three lines will constantly supply this information. An update of the information will occur every 10 s if the directory is being displayed or every time the screen is blanked during general operating procedures.

The bottom two lines of the screen are reserved for status messages that relate to the buses within the jurisdiction of the particular dispatcher. These messages are activated by the drivers by means of the mobile equipment in the bus, which automatically transmits these messages to the central system for the dispatcher's attention. The dispatcher's responsibility lies in the interpretation of these status messages and subsequent action if any is required.

Similarly, the third line from the bottom of the screen is reserved for voice-communication information. It shows which buses are currently on voice communication and which buses are awaiting voice communication. The display shows the radio channel on which a particular bus is engaged, as well as a listing of all buses that have requested voice communication, in order by longest waiting time. This line is also reserved for emergency calls. If a driver signals an emergency, voice communication queues are obliterated and an emergency signal is displayed. This display will remain until action is taken by the supervisor.

To summarize, the dispatcher has three function modes available: trip entry, tour roster, and bus status. In addition to these function modes, he is responsible for status and voice communication for up to 20 demand-responsive vehicles.

SUPERVISOR

The supervisor can perform all the functions of the call taker and dispatcher. Under software control the supervisor can also check and control the system status; handle bus assignments; create, amend, or delete tours for today; and handle the daily bulletin. In all, the supervisor's directory lists eight function modes: dispatcher's directory, shut down, bus reassignment, bus-to-radio assignment, change tours, system status, daily bulletin, and dispatcher-to-bus assignment.

The shut-down mode should only be selected when it is necessary to shut the computer down at the end of the day or if an automatic restart is required. If the supervisor enters shut down and there are still some dispatching positions in operation, the computer responds with a warning (still dispatching) and waits for instructions for a normal shutdown or an automatic restart. If a normal shutdown is requested, the system goes into set up and sets up the discs for tomorrow. Otherwise, the supervisor may request a copy of the master disc or restart without a copy.

The bus-reassignment display enables the supervisor to switch buses. A very important feature is that the supervisor has the ability to examine the effects of bus switching before committing himself. During system start-up for the day, a hard-copy report of the day's tours is provided, sequenced by assigned vehicle number. When the bus-assignment display is requested, the system provides a list of spare vehicles (those not assigned to any of the day's tours) and a display of vehicles that are currently down. The supervisor can amend this list by entering as spare any bus listed as down that is now available or entering any bus that is newly down. The system responds to any such additions or the transfer of buses from tours with a list of unassigned tours in a chronological sequence, along with the vehicle that was assigned to that tour. The supervisor may assess the effect of changes in bus assignments by obtaining a list of the unassigned tours that would result without actually implementing these changes. He may then reassign tours to available buses and produce a hard-copy report of current bus assignments.

In order for the computer to communicate digitally with the vehicles, it must keep track of the radio-channel assignments of every bus equipped with digital equipment. By calling for the bus-to-radio assignment display, the supervisor assigns vehicles to radio channels and stores this information in the computer. The computer cannot cause a radio channel to be changed in the vehicle. Therefore, the supervisor must vocally instruct a driver to switch channels before informing the computer of the change. However, this table of bus-to-radio assignment is automatically updated if an incoming message from a bus is detected and the channel is different from that held in the table.

In the change-tours mode, the supervisor can create a new tour, delete an existing tour, or amend an existing tour. In order to create a new tour, the supervisor supplies the computer with the zone, starting time, ending

transfer point, and ending time. A three-digit bus number indicates which bus is assigned to the new tour. To delete a tour, on the other hand, the supervisor need only supply the zone and tour number. The trips affected by a tour deletion are printed out as unassigned trips and must be reentered by means of the normal trip-entry sequence. To amend a tour, the supervisor enters the zone and tour name and follows the combination of procedures used in the creation or deletion of a tour.

The system-status program deals with the status of the computer system itself. Peripheral failures, if detected by the software, are logged on both printers and are noted on the supervisor's CRT if a system-status report is requested. All logging can be switched to either of the two line printers, and backup facilities can be inhibited if one disc or disc drive should fail. In such a case, the system will carry on unaffected using only one disc. It is not necessary to use this routine to switch printing for paper change, ribbon change, or so forth. The only time the supervisor need use the system-status routine and must switch printers is in the case of a physical breakdown of one printer.

The daily bulletin is a 128-character free-form message that can be transmitted to one, some, or all buses or stored for transmission at some future time. Vehicles cannot request that a bulletin be sent automatically. It must be transmitted from the supervisor's console.

As has been mentioned before, dispatchers are responsible for selected dial-a-ride vans. The supervisor makes these assignments from the dispatcher-to-bus assignment display. As the supervisor makes these assignments, the bus numbers appear on the bottom of the dispatcher's screen. Once a vehicle is assigned to a particular dispatcher, all status messages from that vehicle are directly transmitted to the console screen.

HARDWARE

What we have been discussing up to this point are the various software techniques that we are using to produce an efficient and meaningful way to solve the dispatching problems encountered when dealing with a highly sophisticated demand-responsive transportation system like the one we have in Ann Arbor. I think we should now take a look at some of the hardware that ties everything together.

The radio system uses high-quality two-way base and mobile radio equipment operating in the UHF spectrum. This system includes mobile fixed-message reporting equipment, mobile selective calling, and mobile data-display equipment, as well as two-way voice equipment. This combination in each vehicle enables information to be entered directly from the buses into the central system and, in the other direction, messages are transmitted under computer control and displayed in the buses by means of the light-emission diode (LED) display for the driver's attention.

The radio is equipped with a six-pushbutton channel selector even though, in fact, there are only three channels used in this system. All three channels are used for both voice and data transmission, with channel 3 reserved for express buses and bus-to-bus voice communication. When a particular channel is being used for voice transmission, all data being sent on that channel are held in storage until the channel is cleared. Conversely, when the driver or dispatcher wish to go to voice transmission, the speakers in the bus must be activated from the central system. All voice transmission is muted; that is, only the bus cleared for voice transmission will receive the message.

The status panel contains an LED display-page switch, three call-sign binary plugs that denote vehicle number, two thumbwheel switches that are used to enter "ten" codes (two-digit numeric codes that have specific predetermined meanings), and the call and transmit light buttons. The transmit button is depressed whenever a driver wishes to send a message. If another message is being sent simultaneously, the message will be stored until the channel is cleared. Upon satisfactory receipt of the message by the system, the transmit button will go off, signifying that the message has been properly registered. After the voice button has been depressed, the transmit button will light and go off to inform the driver that the dispatcher is ready for vocal communication.

The LED displayed is a 128-character message-display unit divided into four lines. Each of these lines displays two 16-character trips per line. There are two pages to the display, however, so that the total capacity of the display is 256 characters. The normal procedure is for a driver to signal that he is ready for the next tour, at which point, if the time is suitable, the tour information is displayed. The first 16 characters of the display are reserved for such tour information as the number of passengers and the number of trips, from which the driver can determine whether there is more information than appears on the first page of the display. If it is required, the driver can, by means of the paging switch on the status box, display the next page of information. The information remains on display until the driver signals that he is ready for the next tour and receives the information relevant to that tour. The display contains pickup and drop-off information for each trip on the roster, along with the number of passengers on each trip. The status box is also equipped with a dimmer switch that adjusts for brightness and contrast on the LED display for easy readability.

SUMMARY

Automatic assistance in the order-taking, dispatching, and transmission of information between buses and the dispatching center offers many advantages. There is immediate accessibility of tour and tour-roster information.

The use of data transmission rather than voice whenever possible results in efficient use of radio channels. The provision of comprehensive supervisory facilities simplifies overall control of the system and helps to achieve optimum deployment and efficiency of buses. There is improved trip-to-tour matching and virtually no loss of any trip request, which increases the public's satisfaction with the service. The automatic logging of all transactions handled by the system and the automatic handling of advance and standing orders leave more time to handle increased demand and ridership.

The AATA's Teltran Communications and Dispatching System represents a combination of advanced hardware and software techniques that are particularly suited to the complexities of an urban mass transportation operation.

Automation of Paratransit Fare Computation and Dispatching

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This paper examines the historical evolution of paratransit services and discusses a generalized fare-calculation system for paratransit operations. The prototype system is designed to reduce or eliminate a number of software and hardware constraints that have hampered the taxi industry's efforts to provide a full spectrum of paratransit services. Software constraints are analyzed in terms of regulatory and political processes that have evolved with the taxi industry. Hardware constraints are analyzed in terms of a lack of incentive for product improvement, since at present there is not a sufficient U.S. market for metering and dispatching systems and only a small market for specialized vehicles. In addition, innovations in hardware are hampered by the fact that implementation depends heavily on the relationship between new technologies and existing regulations. The purpose of this paper is to discuss the need and mechanisms for change and to describe a prototype fare-calculation and dispatching system currently being developed at Carnegie-Mellon University.

Paratransit is generally defined as the range of public transportation systems between the private automobile and mass transit. Given this broad array of transportation options, taxi operators, perhaps more than any other group of private or public agents, can play a significant role in providing paratransit services. The fact that the taxi industry has not fully realized its potential in the paratransit market can be attributed to a number of limitations on software and hardware. At the same time, this unfulfilled potential results in part from attitudes of skepticism toward technological innovation within the taxi industry itself.

Clearly, there is a need to alleviate constraints on the development of software and hardware for paratransit systems. Constraints on software include those imposed by regulatory and political processes, as well as those related to specific managerial and operational problems. Similarly, constraints on hardware have continued to exist since there are no strong incentives for technological innovation or product improvement. At present there is not a sufficient market for metering and dispatching systems and only a relatively small market for specialized vehicles. In addition, even if there were a reasonable market for paratransit-related technological innovations, implementation would still be hindered by the fact that hardware developments are inextricably related to a variety of regulations that cover paratransit services.

In this regulatory and technological context, the public as well as government agencies must be convinced that innovative paratransit services will also entail changes in related regulatory and political processes. In many respects, mechanisms for initiating change in the paratransit industry can be compared to those used for initiating changes in agricultural operations when our society was more agriculturally based. The agents of change belonged to the agricultural research establishment, which provided delivery of technology to the public through its extension service. Many of the problems faced by the agricultural experiment stations at land-grant colleges were the forerunners of problems now faced by technologists in the urban society. Agricultural research and development prospered only after the services overcame their credibility gap by delivering products that society perceived as useful. In contrast to the case of research and development in the aerospace industry, the client for both urban and agricultural technology is the public at large. In fact, most major aerospace developments placed citizens in roles as spectators rather than participants. Consequently, technologists who developed their professional competence in the aerospace era must now adapt themselves to operate in an urban environment in which they must not only design and monitor experiments but also continuously interact with that environment. Thus, an agent of change in the paratransit industry must first determine a useful goal and then convince a skeptical society that there is a better way.

HISTORICAL PERSPECTIVE

Considerable evidence indicates that the taxi industry evolved in a variety of fashions. For example, a person who owned a car began to haul friends and neighbors and subsequently began charging a fee to help cover the costs of the car. These jitney services existed in the early 1900s and competed directly with buses and trolleys; with few exceptions the jitney systems were eliminated by legislation supported by private transit lobbies. In general, it seems that formerly there were more classes of paratransit systems than exist today. Thus, to enhance the range of current paratransit services we must determine how and why such operations were curtailed.

Possible causes include undue political pressures proposed by special interest groups, labor organizations, and so forth, along with hardware deficiencies and inadequate responses to abuses by operators.

In different regions and different cities, the automobile for hire was regulated by a variety of methods. In most cases, society sought to remedy abuses of privilege by placing more restraints on operators and limiting the territory or number of vehicles in attempts to restrict competition and to maintain a healthy industry. The requirements for insurance, safety inspections, checks of police records of drivers, various marking devices on vehicles, and meters all stemmed from issues of public safety or equity in price and availability. Clearly, it is difficult to make trade-offs among such factors as limiting the number of vehicles, providing a full shift of employment, and supplying a service that is characterized by heavy fluctuations in demand. Through the political process, society limited the taxi system to a portion of its potential. It is highly probable that metering, dispatching, and even vehicle-locator technologies did not provide the necessary system-command and control structures to successfully avoid such limits.

Within the taxi industry the introduction and impact of the meter closely parallel the evolution of the cash register in modern retailing. The basic cash register began as simply a drawer with an audible signal, so that an owner could step into the back room occasionally and yet still know when the cashbox was being opened. Eventually, the technology for cash registers (i.e., the hardware and software support systems) allowed the customer to help maintain the integrity of the system, first with numeric indicators and later with printed receipts. (The stipulation that returns or refunds are not made without a receipt may have as great an impact on keeping the original transaction honest as it does on permitting reasonable adjustments to be made after purchases to ensure customer satisfaction.) In other words, a system of managerial and customer monitoring of retail transactions evolved as the relationships among human and organizational systems increasingly exploited the technological innovations that became available. The taxicab industry has been hampered in its growth into the various classes of paratransit service by the fact that it has not had the equivalent of the cash register to provide an accurate, auditable record of all the possible paratransit transactions.

Traditionally, taxi hardware components have included the four-door sedan, the two-way radio, and the taximeter. Basic meter technology may date back to antiquity when someone marked a spoke on a chariot and then counted the number of revolutions of the wheel to record the for-hire service. Present-day meters are devices that compute a fare based on an established rate per distance traveled and per minute. The meter simply accumulates the greater of the time rate or the distance rate, plus a fixed amount for the so-called flag drop (the surcharge put on the trip as an initial availability cost). In some areas, charges for extra luggage, trips to special places such as the airport, or extra passengers may be added to the meter fare by using an "extra" button to indicate the additional charge.

Although the mechanical meter records data for exclusive-ride fares (one origin and destination for a vehicle at a given time), it cannot record data for shared-ride fares (multiple origin or destination pairs in a vehicle at a given time). Recent announcements by several suppliers of taximeters indicate a trend toward meters with shared-ride capabilities; yet these meters penalize a customer already in the vehicle if route deviations are required to pick up additional customers. One of the greatest deterrents to public confidence in the taxi industry relates to trips that take more than the shortest distance between the origin and destination points. Since the shortest time path, the shortest distance path, and the least cost path are not always the same, there is always a potential for drivers to shortchange customers or management.

Various hardware systems, such as seat-occupancy sensors, have been used in attempts to guarantee activation of the meter, but the effectiveness of these methods has been limited by the ease with which they can be subverted. The zone-fare concept is a software system that attempts to alleviate customers' fears of being overcharged because of circuitous routing with a meter. Unfortunately, for short trips within a zone the customer feels cheated and for long trips within a zone the driver or management feels cheated. With rare exceptions (Washington, D.C., being a notable one), zone fares exist primarily in small cities and rural areas because the zone boundaries in large cities are not easily recognizable to the public. Thus it seems reasonable to assume that the almost-guaranteed inequities inherent in zone systems have been perceived by customers as outweighing the possible benefits of not being overcharged on a circuitous metered trip.

PARATRANSIT FARE CALCULATIONS

Any fare-calculation system must be concerned with the basic issues of equity and efficiency for customers, drivers, and management. Obviously, the fare charged should accurately reflect the costs of providing a given level of transportation service. In turn, any cost analysis requires support systems that are capable of monitoring operations and providing management and regulatory personnel with information on which to base decisions about pricing. Clearly, an important trade-off exists between continuously changing fares to reflect current conditions and providing customers with assurance that fares will be reasonably consistent from hour to hour or day to day. Specifically, a generalized system that would accommodate both exclusive and shared rides should

1. Compute fares as a function of time and distance, but without additional costs for shared-ride route deviations;
2. Permit using different rates during different times of the day, perhaps for different areas of the city and for different classes of service;
3. Be consistent in results, to provide the pricing confidence otherwise found in zone-fare systems;
4. Provide accurate and continuous monitoring capabilities to permit audits by regulatory agencies and management; and
5. Be easily understood by the public and difficult to subvert by drivers.

In other words, an individual's fare should be based on the travel time, distance, and number of persons in the vehicle during any segment of the trip, subject to the constraint that no fare for any specific trip should ever exceed the fare that would be charged for exclusive-ride service for that trip. In some cases, it may be desirable to simply give a flat-rate discount to passengers in shared-ride situations. In any event, the fare-calculation system should also specify whether fares are based on passenger trips, vehicle trips, or some variation of these measures. One consequence of this conceptual framework is that fares may be computed, displayed, and perhaps even collected prior to a trip, although issues then arise with regard to differences between actual and predicted distances and times. In addition, this

framework permits substantial flexibility with regard to automated billing for institutional clients or regular users of the paratransit system.

PARATRANSIT DISPATCHING

Another consideration in the operation of paratransit systems is the dispatching function. Since human intervention is required for all of the systems currently envisioned, small operations will still require some full-time employees; thus there is little to be gained by attempts to completely automate dispatching. Furthermore, there must always be at least one person present because of FCC radio regulations and because of the need to monitor operations in the control center. Even partially automated systems implemented by using large computers are far too expensive for the average taxi company or unsubsidized paratransit company.

There is a major philosophical disparity between the large-computer approach and the small-computer approach with regard to paratransit dispatching. The large-computer approach assumes that the dispatching problem is tractable, albeit complex, and that it simply requires additional programming to include all the exceptions. The small-computer approach assumes that there will always be some aspects of dispatching that cannot be automated and that the appropriate strategy is to automate functions that are highly repeatable and systematic, taking the most tedious or error-prone tasks first and then slowly adding more design features.

Operating experience indicates that dispatching includes making a variety of nonroutine decisions. The dispatcher serves as a safety officer, an information retrieval specialist (often relying only on memory), a message-processing center, and in some cases must make instantaneous moral or ethical decisions. For example, consider the problems of programming the value judgment inherent in the following situation. In the middle of a severe snowstorm a wealthy regular customer requests exclusive service to get some cat food, while at the same time an unknown person is calling from a phone booth complaining of chest pains and requesting a trip to the nearest hospital. Any number of equally complex decision-making situations can be fabricated to further exemplify the futility of attempts to program a large-computer system for all possible circumstances.

In contrast, a small-computer system can be effectively used to aid (but not replace) the dispatcher. The same mechanism that is used to compute fares can also be used to indicate several of the lowest cost (i.e., closest) vehicles available to service a request. The end points of all current trips can be stored, along with the estimated time before each vehicle becomes free. Given this information, the dispatcher can then make a final vehicle-allocation decision using additional nonprogrammed information about the current state of the entire system.

PROTOTYPE AUTOMATED SYSTEM

In 1971, a group at Carnegie-Mellon University decided that a Pittsburgh taxi franchise that had become available would be a useful experimental facility for studying urban transportation problems. A fundamental premise was that hands-on experience would facilitate better understanding of the taxi industry, a system of urban transportation service that has a larger annual revenue than the whole of mass transit in the United States. Furthermore, it became apparent that such a system could emulate a variety of public transportation options. One could simulate the operation of service systems ranging from car pools to dual-mode travel and personal rapid transit without large capital expenditures.

The first experimental focus has been on dial-a-ride, since it was viewed as a necessary evolutionary step toward making society more aware of future public transportation possibilities so that new line-haul and (eventually) fully automated networks could evolve. The taxi approach to dial-a-ride became even more important as the ramifications of the Haddonfield project became clearer. The Haddonfield experimental design required measuring the impact of dial-a-bus on the taxi industry and resulted in a mechanism for assessing damages to the private sector. The full impact of this process has probably not yet been realized. The basic point to be learned is that the possible consequences of an experiment must be analyzed several steps in advance to attempt to predict the potential consequences.

In order to provide an urban-experiment station for these investigations, the Peoples Cab Company of Pittsburgh was acquired by the Center for Entrepreneurial Development, a nonprofit corporation affiliated with Carnegie-Mellon University. From 3 vehicles initially, the fleet has grown to 20 by using operating revenues. In part, the experiments are designed to explore the taxi industry's potential for continued growth as a viable business enterprise that provides a much-needed transportation service.

Although no proposed levels of service are entirely new, using a combination of modes to provide multipassenger taxi service raises important questions concerning market development, market aggregation, and potential economies of scale. If these issues can be satisfactorily resolved, the capability to shift dynamically from conventional taxi service to multipassenger service would significantly improve operating efficiency. Since taxicabs represent an important paratransit mode, any improvement in taxi service and efficiency would produce substantial direct and indirect benefits for the entire paratransit industry. In particular, a pricing mechanism that would maximize fleet utilization would also reduce congestion and operating costs while allowing the customer to choose a level of service between taxicabs and buses.

The current paratransit research program primarily involves the design, development, and implementation of an experimental demand-responsive paratransit system with multiple origins and destinations. Basic objectives are the design and development of prototype hardware and software to compute and display in advance fares and estimated trip times for exclusive-ride taxi trips. These hardware and software packages are collectively termed the Ride-Shared Vehicle Paratransit (RSVP) system and are designed to be upwardly compatible with virtually all paratransit systems.

The system currently includes a control center and its hardware (computer, terminals, disc storage system, radio communication equipment), the hardware for vehicles (electronic fare meter, display, radio communication equipment), the vendor-supplied software, and the data-based management system (data files, message processing, command interpretation, fare-calculation programs). In subsequent development, more sophisticated control-center and vehicle hardware will permit continuous monitoring of RSVP system operations, and additional data-base management system modules will provide a real-time management information system for evaluation of performance. A prototype RSVP system consisting of a control center and one mobile unit is currently operational and is being tested.

Fares for exclusive-ride trips are calculated on the basis of estimated travel distance and travel time. Zone-to-zone time and distance data are obtained from a Time/Distance File originally developed by the Southwestern Pennsylvania Regional Planning Commission (SPRPC) as an aid for transportation planning. The file contains

shortest time path distances, travel times during uncongested periods, and travel times during congested periods for trips between all possible pairs of traffic zones. The street names and street segment files, also developed by the SPRPC, associate plane coordinates with all street addresses in the service area. The time and distance for a trip from a specific origin and to a specific destination are obtained by adjusting the zone-to-zone time and distance in the Time/Distance File by a correction factor based on the information available from the street name and segment files. The time and distance data for a number of actual taxi trips have been collected and statistically analyzed. The fare-calculation procedure is also being validated by comparing computed fares with actual fares obtained from taxi manifests.

The control center of the RSVP system serves as the focal point for all operations. Its basic hardware consists of

1. The central computer, its monitor console, and a cartridge disc-storage unit;
2. An operations console for entering trip data and displaying system information;
3. A dispatching console that provides back-up manual dispatching capabilities; and
4. Vehicle communication hardware for transmitting and receiving messages to and from vehicles.

In the control center, one person currently does the telephone answering and dispatching; however, operations consoles can easily be added as the number of service requests increases.

The communication and control hardware in a vehicle consists of a six-digit display, an electronic fare meter, and digital radio-transmission equipment. The display shows the trip fare and estimated trip time generated by the central computer or the fare determined by the electronic meter, in the event of a computer failure. Thus, although the RSVP mode is the standard operating mode, the electronic fare meter provides back-up capabilities. The meter can be adjusted to accommodate virtually any fare structure. Digital radio transmission, with unique vehicle-addressing, error-checking, and command-control capabilities, will permit efficient computer-assisted control of a taxi fleet. The basic software includes a vendor-supplied operating system and the RSVP data-base management system.

The data-base management system provides a control structure that links processing modules and data files. It currently includes the Time/Distance File, the street name and street segment files, a processing module for computing fares and estimated travel times, and a processing module for interpreting and executing commands. The Time/Distance File developed by the SPRPC has been adopted without modification since authenticity of time and distance data can best be established by a public agency. The street name and segment files were also developed and validated by the SPRPC. The command module interprets commands, executes commands, and controls vehicle communications. It also formats the operations console display, checks input data for validity, and provides internal buffers with valid data. The fare module calculates fares and estimated trip times and places the results in a communication buffer for further processing by the command module.

Service is requested from the RSVP system either through a customer's telephone call or by a radio message from a driver. The operator enters trip data by using the operations console and initiates a routine that calculates the fare and estimated trip time. The fare and time are displayed on the operations console and communicated to the customer; if service is desired, the operator specifies which vehicle will provide the service and initiates transmission of trip data.

POTENTIAL APPLICATIONS AND IMPLICATIONS

In former times, our free-enterprise society collected private risk capital to experiment with canals, trolleys, railroads, automobiles, and airplanes. Perhaps by default of those private institutions or by defects in the patent system, there is now an apparent willingness for society, through government, to bear some or all of the financial costs of experiments. Bearing the political risk, however, seems to be another matter, since agencies of government are usually formed for protectionist reasons and thus tend to avoid risks. In contrast, the institutions that are and have been agents of change must be knowledgeable and willing to take risks. Thus an urban-experiment station affiliated with a university should perform the change-agent tasks of formulating hypotheses, testing them, obtaining experimental permission from regulatory agencies if necessary, performing experiments, and disseminating information about useful results. Success should and will be measured in the context of the size of experiments and the time, talent, and finances available for undertaking them.

Although a variety of demand-responsive systems have attempted to promote and provide paratransit services, few can be regarded as unqualified successes. They have often required substantial subsidies, have not developed the appropriate technology, and have not adequately resolved institutional and regulatory problems. In view of previous experiences, those interdependent issues have been addressed simultaneously in the development of the RSVP system. However, only experimental operation of the system's hardware and software in a realistic institutional and regulatory setting can ultimately demonstrate the validity of the system.

The prototype RSVP system described in this paper represents a significant advance toward understanding some important and heretofore unexplored aspects of hardware and software technology for paratransit operations. The system has a promising potential for application to a variety of paratransit vehicles in different modes of operation, and its implementation should have profound implications for many transportation-related issues.

The RSVP system has inherent monitoring capabilities to make operating data available for management control and for regulatory reports and audits. Software development has thus far focused on a generalized fare-calculation system that computes fares by using a specific algorithm, a well-defined coordinate grid system, and a travel-time and travel-distance data base. In addition, the software provides both a control structure and the necessary foundation for a management information system to monitor and evaluate the entire RSVP system. The system is upwardly compatible for selective application to future paratransit vehicles and modes of operation. The hardware can function either as a remote computer display or as a back-up electronic taximeter. Additional hardware, such as vehicle-status monitors (for location, occupancy, and mechanical condition) and destination displays outside the vehicle, will be added to further enhance the system's capabilities.

The automation of telephone answering is another direction of development that may prove significantly more fruitful in terms of labor saving than automated dispatching. The experience of the Peoples Cab Company, which operated in Pittsburgh with a fleet of 230 vehicles in the late 1950s, provided some insight into the problem. At that time, the dispatching office consisted of six tele-

phone operators and one dispatcher. The telephone operators wrote small notes and showed them to the dispatcher, who would then survey all of the demands and direct the vehicles. It seems clear that reducing the number of telephone operators would reduce costs more than attempting to eliminate dispatchers. This incremental automation of the telephone answering could be accomplished by providing regular users with a dial-in scheme that will activate a regular trip. In its final form, such a system could include general-purpose routines for voice answering and the capability for requesting trips by a touch-tone telephone call.

The introduction of the RSVP system for paratransit services may change the basis for driver incentives. By moving from commission to hourly wages, depending upon the availability or lack of availability of a point-of-sale cost-calculating device, paratransit growth may also affect the efficiency of taxis. It is interesting to note that, in spite of our free-enterprise background, there are few marketing systems in which the commissions approach the 50 percent that is common in the taxi system. For lack of sufficient foresight to determine the effect of eliminating large commission incentives, plus the expected tips, the evolution of new paratransit systems may mandate that a fare-display system be provided. The consequences of having taxi productivity drop in the manner common to mass transit systems when they become publicly operated would create severe problems. The fact that many of the poor and handicapped are totally dependent on paratransit systems would further aggravate this potential problem. The issue of providing contract services to various subsidized paratransit agencies must also be carefully scrutinized.

Displaying calculated fares in advance will permit customers to know the cost of a trip at the time of boarding and thus should alleviate distrust of the driver. At the same time, the collection of fares in advance (which is common in all other mass transportation services) would remove any doubt about the customer's ability to pay, though it may also significantly affect tips.

In conclusion, there remain a number of institutional, regulatory, and technological barriers that must be overcome before paratransit systems again become fully integrated with existing urban transportation systems. Clearly, a significant aspect of any such integrator will entail developing pricing policies and payment procedures that are considered workable by all the affected parties. As these mechanisms evolve, additional data will become readily available for use by management and regulatory authorities to improve the level of service and lower the operating costs associated with paratransit operations. In the long run, these benefits should provide additional impetus toward resolving the general urban transportation problems of mobility, energy consumption, and congestion.

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UMTA's Paratransit Vehicle Project

Wilhelm Raithel, Urban Mass Transportation Administration, U.S. Department of Transportation

The Paratransit Vehicle Project was undertaken to produce a design for an improved paratransit vehicle that would be accessible to wheelchair passengers. Two steam-powered vehicles are currently being tested to evaluate their performance characteristics and suitability for taxicab service.

During the last 10 to 20 years we have witnessed a trend in the design of passenger cars whereby they became lower, sleeker, and perhaps more appealing to the eye, with the result that they also have become difficult to get in and out of, particularly from a sidewalk of above-average elevation. Since the greater part of a taxicab fleet consists of passenger cars, the trend has affected taxicabs. This makes the average taxicab one of the few commercial vehicles that is not especially designed for its purpose, an important aspect of which is easy and quick entry and exit of the passengers. If we consider the more than 13 million elderly and handicapped persons in the United States, this situation becomes a matter of concern. This concern found its expression in the Congressional Appropriations Committee's report of June 15, 1973, in which funds were provided "for the development of an improved, efficient, quiet, nonpolluting taxi." This became the start of the Paratransit Vehicle Project.

We referred to it as a paratransit vehicle because we wanted to cover the requirements of the broad part of the paratransit spectrum that includes the taxicab sector and extends beyond it in several respects, particularly in regard to use by the handicapped and shared-ride service. We hoped it would even cover a part of the dial-a-ride requirements. Our primary design objective was to make the vehicle accessible to a wheelchair passenger while he or she is seated in the wheelchair. In addition to the wheelchair passenger, the vehicle should have the capacity to carry two other passengers comfortably. As it turned out, the prototypes will be able to carry three additional passengers instead of the two we asked for. The wheelchair access is provided by a ramp that is extended immediately after the door opens. The operation of door and ramp is power actuated and controlled by pushbuttons in the driver's compartment. This makes it possible for wheelchair passengers who are able to board without assistance to do so if they so desire. This design we called configuration A. Since vehicle cost is strongly influenced by production rates, we wanted to make use of the same body design for another configuration. Configuration B should be able to carry five passengers in somewhat less comfort and without a wheelchair. The intent was to provide a wider use for the basic vehicle and thereby provide a larger market, resulting in a lower production cost for both configurations. Configuration A, which we actually contracted for as the more difficult one, was to be easily convertible into configuration B and back.

These were the broad objectives regarding passenger accommodation and accessibility. In generating the details of the vehicle specifications, we relied heavily on work done by others—the Pratt Institute's work on the urban taxi, which had been going on for a number of years; the work of the New York Taxi and Limousine Commission and its consultant, Ron Adams; and information from the Museum of Modern Art in New York City, which had pulled together data from these and other sources for the vehicles to be displayed in their City Taxi Exhibition in 1976. Without this help we would not have been able to get going with our procurement as fast as we did.

In considering the terms "efficient, quiet, nonpolluting" in the committee's report, we made "nonpolluting" the key issue, reflecting the environmental concerns of that period. Since total absence of pollution was (and still is) beyond the limits of technology as a practical matter, we specified that the vehicles had to meet the emission requirements initially mandated for 1977 and now postponed to 1978—carbon monoxide = 2.1 g/km, hydrocarbons = 0.25 g/km, and oxides of nitrogen = 0.25 g/kg. We realized that this was a very demanding requirement and were willing to accept reasonable levels of fuel efficiency and noise with these constraints.

In May 1974 we requested proposals and in March 1975 we awarded two contracts, one to AMF Advanced Systems Lab in Santa Barbara and the other to Steam Power Systems (SPS) in San Diego. Both companies proposed the use of steam engines in order to meet the stringent emission requirements. SPS offered an improved version of the engine it had developed for the California Clean Car Project and AMF offered an im-

proved version of the engine that Jay Carter Enterprises had developed and installed in a Volkswagen Squareback. Both were to be delivered to the Urban Mass Transportation Administration (UMTA) by 1976. Their expected characteristics are shown below.

Characteristic	AMF	SPS
Curb weight, kg	1450.0	1450.0
Length, cm	463.0	437.0
Width, cm	183.0	183.0
Height, cm	178.0	224.0
Floor level above road surface, cm	29.0	29.0
Acceleration (0-72 km/h), s	11.5	11.0
Turn diameter, m	10.7	10.7
Fuel consumption, km/liter	7.0	4.3

On June 17, 1976, the City Taxi Exhibition opened at the Museum of Modern Art in New York. The museum's Architecture and Design Department organized this exhibition to serve as a focal point and forum for innovation in urban taxi design. One of the cosponsors of the exhibition was the International Taxicab Association. Our two vehicles were displayed there as the only entries from the United States.

After the exhibition ended, the two vehicles were to be taken over by the Transportation Systems Center of the Department of Transportation and subjected to a series of tests to determine and evaluate their performance characteristics. We have asked the International Taxicab Association to assess the suitability of the vehicles for taxicab service and they have expressed their willingness to do so. Our plans will depend a good deal on this assessment as well as on the response of the user community and the motor-vehicle industry. Also, we have asked the two contractors to study what could be done to reduce the cost of the cars in production. As they now are, these two vehicles are not ready to go into production without redesign. This is beyond the scope of the present contracts.

In essence, the present phase has established the feasibility and practicality of three issues.

1. Space utilization. A vehicle of subcompact size can be designed to accommodate four passengers (one of them in a wheelchair) in comfort.
2. Accessibility. A wheelchair passenger can board the vehicle without assistance, if he or she so desires.
3. Emissions. Such a vehicle can meet the most stringent emission standards without the use of catalytic mufflers and at fuel-consumption rates equal to that of the average 1975 gasoline engine.

The impact of emission standards on the vehicle's design depends on what emission standards will become mandatory in the future. But even if future emission standards no longer require steam engines, I am sure the demonstrated space utilization and accessibility are of interest to a great many people, particularly but not only the 13 million elderly and handicapped in this country who find it difficult or impossible to use currently available mass transportation services and for whom today's standard-model taxicab is not the ideal solution either. More than 7 million of these elderly and handicapped persons are estimated to live in urban areas. To put these numbers in perspective and to provide an appreciation of the size of the potential transportation market, it seems useful to remember that this is about the same number of people in the United States who use urban buses on an average weekday. This does not include such people as those with baby carriages and shopping carts whose transportation problem is not unlike that of the elderly and handicapped.

Vehicles of the type and capability discussed here would be useful in general taxicab service, but particularly in providing a new dimension of mobility to the elderly and handicapped and other people who find it difficult or impossible to use available transportation systems. It could provide door-to-door service, feeder service for regular mass transit, trips for health care, trips for shopping, and so forth. It is difficult to assess the level of demand for these services. But the probability is high that, once this new degree of mobility is offered, a large number of people who now do not have adequate mobility will want to make use of these services. UMTA's Paratransit Vehicle Project is designed to generate a type of vehicle tailor-made for the purpose.

Durability of Vehicles: What Is That?

F. W. Walker, Jr., Transportation Systems Division, General Motors Corporation

This paper seeks to describe the type of vehicle or vehicles that are required for paratransit services in terms of features and specifications, with emphasis on durability.

Some time ago, when Robert Aex and I were discussing what a bus for paratransit service should be like, we got stuck on the subject of durability. It is said that ordinary vans do not have sufficient durability; on the other hand, a small version of the transit bus, designed for a 20- or 30-year life expectancy, is too heavy and expensive. So what is right; what is really desired?

Great distances have been driven in thousands of vehicles at the General Motors Proving Ground. The data bank established from these tests permits us, given a service profile and desired life expectancy for almost any proposed vehicle, to prepare a design that will provide a performance that closely matches the specifications. With an in-house inventory of vehicles ranging from the lightest to heaviest passenger cars, from vans to the largest transit coach, from the smallest to the largest highway trucks, and even off-highway vehicles and locomotives with a carrying capacity of up to 320 Mg (350 tons), there must be something somewhere in the line that can approximate the requirements and be the base from which a suitable vehicle can be built.

The question is, what is required? What are the dimensions in terms of passengers carried, speeds, and so on, and, finally, what is the desired life expectancy? What is durability—5 to 10 years at a lower original cost and traded to stay current with technology, or 20 to 25 years at a higher original cost and less frequent change? What is best?

Paratransit service is by nature flexible. It provides the flexibility needed to feed fixed-route systems and to meet transportation needs that cannot be met economically by regularly scheduled service. How much flexibility is needed in the vehicle? Each city needs its own measured combination of transportation modes to have a balanced system, but not every operation can afford special equipment from the ground up.

Although a lot has been written about the purpose, function, audience, operating methods, and so on, of paratransit service, there are few real data on what a vehicle has to do to be a real winner in this service. Some think the ideal paratransit vehicle should be the size of a normal car; others think it should seat 9 to 12 passengers. With the expansion of paratransit into use in larger cities, the desired vehicle size may expand to 15 to 19 passengers in just 2 or 3 years.

Purchasing priorities seem to be aimed at the initial cost of the vehicle and vehicle performance. How do we weigh these priorities? We have been told that external vehicle design is not an important factor in vehicle selection, yet we have also found that the more attractive vehicles continue to be more in favor.

We are attempting to find the answers to many questions. For example, what distance traveled per year can be estimated for a vehicle in paratransit service? It could be as low as 16 000 km (10 000 miles) per year, or it could be well over 80 000 km (50 000 miles) per year.

And what about durability? Will the daily duty cycle be light or heavy? How heavy will the loads be? Will all passengers be seated or will there be some standees? Can we expect a high rate of acceleration and frequent stops?

When an operator makes a vehicle evaluation and selection based on performance criteria, what is he looking for specifically in the area of durability? What about the life expectancy of brakes and chassis components, and how far should a paratransit vehicle travel between maintenance checks? And how about engine life? Are we talking about a conventional gasoline engine or are we speaking of a diesel engine? Are we speaking of ease of service or are we speaking of average engine life?

We have managed to assemble some information and have given our engineers some of the basic data we have found. In February 1974, the GM Transportation Systems Division put its first experimental vehicle on the road for evaluation. This vehicle went through a series of dial-a-ride demonstrations in Rochester, New York; Midland, Michigan; and Mt. Pleasant, Michigan. In Midland, it was also in charter service. In Mt. Pleasant, dial-a-ride service included rural conditions. While it was on loan to these various cities, the experimental vehicle was fully instrumented to provide data to be incorporated in the vehicle design. This information

was specifically aimed at the functional requirements of the intended service—to develop a service profile rather than to evaluate the vehicle.

Specific items measured included speed and acceleration profiles, operating time, brake system use, door use, and operating loads for the chassis and steering system. Regular measurements for each of these items were recorded in the memory bank of a computer. For example, during the time the bus was operating in Rochester, it was actually moving 54 percent of the time, which means it was idling 46 percent of the time. Although the median speed was 48 km/h (30 mph), the average speed was only 29 km/h (18 mph). The brakes were applied 10.1 times/km (6.25 times/mile). In Midland, the idling time was only 34 percent of the total operating time. The doors were opened 2.9 times/km (1.8 times/mile) in Midland and 1.3 times/km (0.8 times/mile) in Rochester. Average ridership in both Rochester and Midland was 8 passengers/km (5 passengers/mile).

In our search for the answers, we have looked into the responses of the drivers. They were told to drive the vehicle just as they would normally drive it in transit use. The drivers were given time to get used to the vehicle so that there was no distortion in the testing. Simultaneously, a rider response survey was conducted regarding such items as comfort, ride quality, and appearance inside and out, as well as safety and security. We also recorded passenger reactions.

Prototype vehicles have undergone additional testing at the General Motors Proving Ground in Milford, Michigan, including extensive chassis vibration, shake analysis, and operational durability tests. These tests included running the vehicle for 14 500 km (9000 miles) over the Belgian block road, on which 11 300 km (7000 miles) are comparable to 322 000 km (200 000 miles) in transit service. Of this 14 500 km, 6400 km (4000 miles) were run at the rated load and 1600 km (1000 miles) were run overloaded. Special tests were also run on such components as the step mechanism, the door, and seating to evaluate and verify their transit-worthiness.

We are not sure this is the right vehicle yet, although we believe it may be a breakthrough. We are continuing to examine the broad spectrum of interested parties for every indicator we can find. One area for continuing discussion is the needs of those who are transit dependent. Limited mobility is an important factor for paratransit consideration, but to what extent should paratransit vehicles be equipped to satisfy these needs? Again, we are seeking answers.

Options can be made available, but to what extent? Automatic doors? AM/FM radios? Fixed carpeting? Or will the basic vehicle, with minor variations in options, serve the needs of the majority of operators of this class of vehicles?

The next, all-important questions are, what will these vehicles cost and how can they be paid for? First, if an operator wants a vehicle that can run 64 000 km (40 000 miles) before the brake linings need to be replaced and 16 000 km (10 000 miles) between maintenance checks, with heavy-duty, long-life chassis components as original equipment, could it be produced at an affordable price? Second, under today's existing federal procurement policies, are operators free to purchase the types of vehicles they want and need? Are they able to purchase those vehicles that are lowest in total-life cost instead of just lowest in original price? And, most importantly, can manufacturers fulfill the desires of the passengers and still meet the required government specifications? If purchasers were the passengers, would vehicle features change?

We believe that the paratransit concept has a bright, promising future in many areas of transportation systems planning. And we were heartened to hear C. K. Orski of the Urban Mass Transportation Administration say at a conference on paratransit in Williamsburg, Virginia, on November 9, 1975, "We are satisfied that there is a strong and convincing case to be made in favor of active federal support of paratransit." As a division of General Motors, we are taking a careful look into this relatively new and exciting form of transit. We came to this conference not as sellers of finished products, but as seekers of ways to develop our research program. We are interested in being a part of this important advancement in transportation, and we welcome reactions to this effort.

Part 5
Relation of Public and Private Agencies

UMTA's Policies and Programs Related to Paratransit Services

Robert E. Patricelli, Urban Mass Transportation Administration, U.S. Department of Transportation

This paper deals with the Urban Mass Transportation Administration's policy toward the development of paratransit services, its veiw of the relationship between paratransit and traditional public transit, and its current grant and planning policies and explores some problems to be faced in the future.

This was the sixth conference on demand-responsive transportation systems and other paratransit services, which demonstrates that the concepts of demand-responsive and paratransit service are here to stay. The fact that so many came to this conference is an indication of the increasing popularity of the set of concepts associated with paratransit. This popularity means that the Urban Mass Transportation Administration (UMTA), for its part, needs to be as clear as possible with regard to its formal policies on paratransit.

I have organized my remarks under four headings: first, the policy context within which UMTA sees its posture toward paratransit developing; second, our view of the relationship between paratransit service and more traditional patterns of public transportation; third, an enumeration of our current grant and planning policies that bear on paratransit; and last, an enumeration of some areas of both difficulty and promise for the future.

POLICY CONTEXT

The mass manufacture and proliferation of the automobile have provoked enormous policy issues for American society, not the least of which confronts those of us concerned with mass transit. The burgeoning use of the automobile, supported by a huge highway-building program, set the pattern for metropolitan development in the middle third of the twentieth century. Low-density land use patterns have challenged the ability of public transportation to cope with current trip demands. We in UMTA feel that demand-responsive and paratransit services may permit mass transit to adapt to these changed land use patterns to challenge the automobile for ridership in low-density areas.

Further, our special concern for providing transportation service to the elderly and handicapped—a concern written directly into our authorizing legislation—has also directed attention to demand-responsive and paratransit service. For those whose access to the normal transit fleet is limited, special services must be devised.

I would note here, parenthetically, that I do not agree with those who believe that the major remaining justification for public transportation is to provide service to those who are transit dependent. That in itself is a commentary on the lowering of our expectations about mass transportation that has occurred as a result of living in the era of the automobile. (In fact, transit dependency seems to refer to the state of being unable to use the private automobile.) While I support the need for a special emphasis on service to the transit dependent, the policy of UMTA will be to challenge the use of the private automobile wherever and for whomever public transit can provide a more efficient, environmentally sensitive, and energy-conserving transportation solution.

Our formal attitude toward demand-responsive and paratransit systems is that they are worth exploring as part of our pursuit of balanced urban and rural transportation systems. As stated most explicitly in our policy statement on major mass transportation investments—the so-called alternatives-analysis policy—UMTA favors an integration of modes across the urban landscape, with patterns and modes of service tailored to the particular travel demands of each portion of the urban geography. Within that rubric of trying to encourage the service that makes the most sense in each particular area, paratransit has its role to play.

We mean it when we say that UMTA plays no modal favorites. Our expectations with regard to the evolving paratransit service pattern have to be realistic. I do not believe that we can count on any significant near-term impact by paratransit in the central cities. There are major institutional and organizational barriers that will first have to be overcome, and even then it is hard to predict the impact of paratransit on traditional peak-hour-oriented public transportation service. In rural and small urban areas, in suburban communities, and in terms of service to the elderly and handicapped, we do hope for quicker immediate impacts from paratransit, and we have already seen a great many. The point I wish to make here is that our rhetoric and expectations

should not outrun the realistic prospects of near-term impact. There are problems enough in government without adding to them by creating unrealistic expectations.

RELATIONSHIPS TO TRADITIONAL FORMS OF PUBLIC TRANSPORTATION

This brings me to my second point, which is the need to build a constructive relationship between those interested in demand-responsive and paratransit services and the providers of traditional public transportation services. And the obligation runs both ways—there is need for better bridge building from the direction of the transit industry as well.

I see encouraging signs that some of the initial hostility toward paratransit expressed by transit authorities is diminishing as understanding of the concept improves. For example, the American Public Transit Association (APTA) was an active participant in the 1975 TRB Conference on Paratransit, and I thought the address at that conference by Stokes (1) was very pertinent. Moreover, under Stokes' leadership, APTA has set up its first committee on paratransit to provide an institutional mechanism by which the transit industry can influence and profit by paratransit developments.

Part of this improving atmosphere is related to a matter of definition. Some public transit operators have been encouraged to think of paratransit only as an effort to substitute mass jitney service for a part of the traditional transit operations, as in Manila, Istanbul, and other Asian cities—a prospect that is entirely out of the question in this country.

For my part, I would advise the transit industry to actively pursue and embrace those aspects of paratransit service that can support the efficient and effective provision of public transportation. One key area in this regard is the possibility of using demand-responsive forms of feeder service to commuter bus lines and line-haul rail transit. Use of the automobile as a feeder device to transit is not a satisfactory or complete solution in the long run. Only when transit service improves to the point at which a second car in the family is not necessary will some of the real dollar trade-offs and cost advantages of public transportation come to fruition. Paratransit services can therefore be used to help build ridership on line-haul public transportation.

Second, I believe it to be in the self-interest of transit authorities to explore the use of paratransit services to provide special services that cannot be met in a cost-effective way by the traditional methods and vehicles of public transportation. This is not a matter of skimming off the profits; if anything, it is more a matter of skimming off the deficits. For example, there may be situations in which late-night owl or holiday service could be better met by shared-ride types of paratransit service than by the use of regular transit buses. Similarly, door-to-door service for the elderly and handicapped is not easily accommodated by normal transit buses. Some paratransit service that has the effect of reducing peak-hour loads might also be financially helpful to public transit authorities, since it is the heavy peak-hour capital and operating costs that upset the financial balance in most public systems.

If there is any direct conflict between transit authorities and paratransit, it should logically revolve not around the question of patterns of service but around who manages and controls paratransit operations. If a number of mass-transit operators were competing for overlapping markets, that could indeed be disruptive and counterproductive, but it need not happen. Public transit authorities can themselves manage and operate paratransit service on a purchase-of-service basis. For example, the transit authority could purchase shared-ride or taxi service to supplement its base fleet and act as a broker between the customer (the transit user) and a variety of service providers. This is the pattern that is currently being tested through an UMTA-funded demonstration in Knoxville, Tennessee. To me, it makes a lot of sense for transit authorities to move in the direction of becoming full-service institutions, buying or directly operating a variety of services with a variety of vehicles. In this regard, a transit authority could serve as a systems manager as well as a direct provider of traditional bus and rail line-haul service.

In summary, I think paratransit offers more by way of opportunity that is in the financial self-interest of transit authorities than it does disruptive competition. UMTA will be seeking in the months ahead to help the transit industry exploit these opportunities.

UMTA GRANT AND CAPITAL SUPPORT

UMTA is backing its interest in paratransit by making available both capital and operating assistance and by establishing new planning requirements. Funds for capital and operating assistance are available to assist communities to acquire paratransit equipment and to pay operating expenses in urban areas with populations greater than 50 000. Under this authority, and under section 16b of the Urban Mass Transportation Act, UMTA can support a variety of publicly and privately owned and operated paratransit services, including dial-a-ride, jitney, shared-ride taxi, community minibus, and other flexible and personalized paratransit services. UMTA funds can also be used to assist cooperative ride-sharing projects such as commuter van pools, subscription buses, and other cooperative services for the transportation of small groups. We estimate that about $30 million in capital funds will be spent in support of paratransit in fiscal year 1977.

About two-thirds of this amount will be forthcoming under the section 16b2 program. This provision makes funds available to private nonprofit organizations to provide transit service specifically for elderly and handicapped persons. In fiscal year 1975, we awarded more than $20 million to more than 1000 nonprofit organizations to provide such transit services.

For the second-year program under section 16b2, UMTA has set aside some $22 million for funding in fiscal year 1976. There are certain procedural changes in this year's program that should greatly strengthen its operation at the local level and enhance coordination with the existing service providers. On the one hand, we are requiring that public transit authorities have a full opportunity to participate in the planning and execution of the section 16b2 program and that they be given the chance to provide the service. Similarly, the new procedures require that private paratransit operators—taxi companies—be afforded a "fair and timely opportunity to participate to the maximum extent feasible in the... provision of the proposed special transportation services." In other words, we intend to give the local taxi operator a chance to bid for the services.

In both cases, our intention is to give existing public and private service providers the chance to meet the need and to use the public funds available before new special-purpose transit organizations are funded. If existing operators can do the job, they should have the first option to provide the service. It is in no one's best interest, certainly not that of the elderly and handicapped, to fragment services and undercut the responsibility of existing operators to meet special needs.

UMTA's planning requirements are also being strengthened in a way that encourages the appropriate deployment of paratransit services. Urbanized areas are now required to evaluate the potential for paratransit services in developing the transportation systems management element of the local plan. Our policy on major mass-transportation investments encourages metropolitan areas to plan for community-level transit services, which are a logical application for paratransit, as well as for line-haul commuter systems. Our final regulations on the provision of service to the elderly and handicapped, which will be published shortly, will include requirements with regard to the level of service that must be provided to meet the needs of these transit-dependent groups; these planning requirements will also stimulate local consideration of paratransit mechanisms.

Finally, UMTA intends to maintain an active program of research and development for paratransit to help make this type of service a more important option for urban and rural areas. On the one hand, the purposes of this program are to develop and test improved vehicles and technology. In this connection, we are supporting the development of two paratransit vehicles with low levels of pollution and are continuing the development of automatic vehicle-monitoring systems that can help to deploy vehicles operating in a demand-responsive mode. Further, the Service and Methods Demonstration Program is continuing to develop innovative and exemplary applications of paratransit and demand-responsive services, and funding for this program activity is scheduled for an almost three-fold increase in the budget for fiscal year 1977.

PROBLEMS AND OPPORTUNITIES

No review of the state of the art in paratransit service would be complete without some examination of the next steps. I am hopeful that in the coming months the UMTA program will pay special attention to three problems that complicate the proper evolution of paratransit service.

First, it is clear that federal support of paratransit raises complex labor-protection issues. Some applicants feel that the full application of section 13c to the paratransit industry would have a severe impact on the potential cost effectiveness of this form of service. We will be exploring this problem in the near future. At this point, I can only agree with Orski (2) as he said at the Williamsburg TRB conference in 1975 that a family of transit and paratransit services, well planned and coordinated, can benefit all sectors, including organized labor, transit operators, private enterpreneurs, and the riding public.

Second, we are going to have to sharpen our attention to the need for reform of institutional and regulatory barriers to paratransit service at the local level. We are now in the process of beginning a research study on those barriers.

Finally, I hope to improve the quality of our dialogue with the taxi industry to make sure that the interests of private operators are safeguarded. It is clearly against our policy to subsidize publicly owned companies or nonprofit organizations in wasteful competition with private operators. As I have already mentioned, the section 16b2 program has been adjusted so that private operators will have a full opportunity to offer their services in a competition for use of the federal funds available under that program. The same policy will apply to all other UMTA-funded paratransit services. The particular arrangements by which private operators might bid for the provision of local paratransit services would continue to be up to local leaders, but UMTA would review these processes as part of the annual certification and program approval, to ensure that private operators are given an opportunity to participate in the provision of such services "to the maximum extent feasible," as required by law.

The private taxi industry now serves more fare-paying passengers on an annual basis than all rapid transit systems. I can imagine no worse eventuality for transit authorities than the disappearance of private taxi companies and a resulting pressure on public authorities to provide similar kinds of service with public subsidies. There is simply not enough public financing capacity to support public transit if the authorities must also serve the population and trip purposes that are now served by the taxi industry.

Establishing Contractual Relationships for Demand-Responsive Transportation Services

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As interest in demand-responsive transportation systems has grown, increased attention has focused on making use of the experience and resources of the private sector in providing these services. Recent experiences have shown that establishing satisfactory relationships between public agencies that want to foster these services and private operators may be difficult because of the different constraints and objectives that characterize the public and private sectors. An important part of such relationships is the contract that binds the two parties. The authors review recent contracting experiences; identify the goals, objectives, and constraints that characterize each sector; and suggest a contract framework that seeks to reconcile potentially conflicting objectives of the two sectors.

It is widely recognized that demand-responsive transportation (DRT) is not a new service concept. Private taxi operators have been providing demand-responsive service for a considerable number of years. It is only during the last decade, however, that there has been increased attention to DRT within the public sector. DRT is being viewed as a cost-effective alternative to conventional fixed-route transit services in certain contexts and as an effective means of meeting the needs of those whose mobility is restricted.

Traditionally the taxicab, which generally serves a single passenger group at one time, has not been considered a form of mass transportation. But even ride sharing is not a new concept. The jitneys might be considered an early example of a shared-ride service with some demand-responsive characteristics. The regulations that forced the jitneys off the road at the behest of the street railway companies have influenced the regulation of taxicab companies to this day. With a few exceptions—including Davenport, Iowa; Little Rock, Arkansas; Nassau County, New York; Madison, Wisconsin; and Lowell, Massachusetts (1, 2, 3)—prohibitions against ride sharing exist in most U.S. cities at the present time. Such regulations have hindered those taxi operators who are both interested in using taxis in other ways than the premium-service mode and able to put up the necessary risk capital to establish an innovative form of taxi service. They also constrain any natural evolutionary tendencies within the private sector.

The recent interest in shared-ride DRT service has primarily come from the public sector. Although in some cases there has been a desire to operate a break-even service, in most cases the objectives associated with the implementation of a DRT system have focused on the quality of service rather than on economic self-sufficiency. During the earlier phases of DRT development, it was generally felt that these public-service objectives could best be attained through direct public control over the operation. Furthermore, a sometimes unsubstantiated belief prevailed that the public sector could provide DRT service efficiently and, because of a lack of the requirement to show a profit, inexpensively. As a result, public authorities seeking to implement DRT services generally sought to provide the service directly rather than through contracts with the private sector. For their part, private taxi operators, traditionally a conservative group and a group whose objectives were logically based on economic factors, were typically only too willing to stay clear of these DRT innovations. Indeed, of the major new DRT services implemented during the late 1960s and very early 1970s, only the Buffalo Model Cities system was operated by a private taxi company under contract to a public authority (2).

In August 1970, a completely taxi-based DRT system was implemented in Merced, California; that system is now publicly operated (2). In the implementation of the Ann Arbor, Michigan, system in mid-1971, the local taxi companies declined to bid on a contract for operating the service and instead chose to seek an injunction against the service. In that case the judge dismissed the suit, ruling that because a single passenger did not control the DRT vehicle "these vehicles are expressly exempted from the definition of taxicab" (4).

During the years since the early new-generation DRT systems were implemented, there has been a shift in attitude on the part of both the private and public sectors. In general, the changing economic climate and, in particular, the sharp increase in costs experienced by taxi operators have made that industry more sensitive to factors that have a potential impact on revenue. The past few years have seen the emergence of national taxicab organizations that are representative of a much wider taxicab constituency. These factors have combined to make taxi operators more interested in exploring new sources of revenue and more aggressive in seek-

ing new opportunities. The earlier lack of interest in the development of DRT displayed by the taxi industry has been replaced by a keen awareness of these developments and their potential and an awareness of such related factors as the overall regulatory framework of urban transportation that could influence the taxi business. The taxi industry is now proclaiming that it has always provided demand-responsive services, that it can and does provide such services at a much lower cost than the public service, and that it has the necessary experience and expertise to operate future paratransit services (5).

The public sector, for its part, has by necessity become more concerned with making the most efficient use of its own resources. Some costs within the public sector, in particular labor costs, have risen at a faster rate than have costs within the private sector. As a result, the public sector may be more willing to consider using the economies possible within the private sector in a free-market competitive system. Also affecting the public sector's decision on public or private operation of DRT services has been the growing set of regulations, on both the federal and state levels, that restrict the use of public capital to compete with private transportation operators. Although these restrictions have traditionally been interpreted to apply to private mass transportation or bus operations, there has been growing pressure to include the private taxicab operations within the protection of these statutes (6). Finally, there has been growing recognition that existing taxicab services may be seriously affected by the introduction of a subsidized DRT service. The extent of that impact is a function of the characteristics of the taxi and DRT services involved, and there are opposing arguments that state that taxi service actually benefits from the introduction of any new (marketed) transportation service. Nevertheless, the potential for a negative impact on taxicab operations does exist.

Because of all of these factors, a number of the major DRT services implemented in the past few years have involved private taxi companies contracting with the public sector to provide the service. If present trends continue, we can expect this form of contractual relationship to become even more prevalent during the next few years. However, some of the factors that inhibited the development of these relationships just a few years ago have not completely disappeared. Specifically, the development of contractual relationships between public agencies and private operators is complicated by the conflicting objectives of the private and public sectors. Economic efficiency and service quality are generally sought by the public sector. These objectives are often in conflict with the profit maximization and risk-avoidance objectives present in the private sector. This conflict may be intensified in the case of DRT, where the quality of service is highly sensitive to transportation supply and hence to cost.

If a satisfactory relationship between the private and public sectors is to develop, it is important that each side understand the concerns of the other side. The forum for expressing these concerns and protecting the interests of each side is in the development of the actual contractual arrangements. There are a number of possible contractual relationships between the private and public sectors. The purpose of this paper is to discuss these contractual relationships and suggest contract forms that can reconcile the conflicting objectives of the public and private sectors.

OBJECTIVES

The Public Sector

Before entering into a contractual relationship with a private operator, the public agency responsible for a transportation system must identify and define its own objectives. Typically the public sector will be concerned with economic efficiency and quality of service, as noted above. However, there are other factors to be considered. For example, is the public sector willing to subsidize a transportation service? If it is not, it must be prepared to identify a methodology for ensuring unsubsidized operations, which is not a simple task given present cost levels. If it is willing to subsidize a transit system, there remains the question of how large a subsidy the public is able and willing to provide. Another set of objectives might deal with who is to be served. If there is interest in serving a particular target group—for example, the elderly and handicapped—it might make more sense to subsidize that group directly rather than to subsidize the system. This, in fact, is a concept being pressed by segments of the taxi industry at this time (7), and the Urban Mass Transportation Administration (UMTA) is currently sponsoring such a subsidy program in Danville, Illinois, to determine its impact. Any subsidy to users that involves a simple direct subsidy for regular taxi service, however, would be in direct conflict with the objective of economic efficiency; the fact that regular taxi service serves only one passenger at a time implies that such a service does not make maximum use of its resources.

One of the underlying reasons for contracting with a private operator is to keep costs at a minimum. The taxi industry has been quick to note that it currently provides service at a cost per passenger that is significantly below that of most publicly operated DRT systems (5). This, of course, is less the result of inherent efficiencies in taxi operation (the productivity of taxis is generally lower than that for most DRT systems and productivity for shared-ride taxis is not significantly different from that for public DRT systems) than the present basic differential between wages for taxi and public transit personnel.

This differential is largely attributable to two factors: an unaccounted (and largely untaxed) wage received by drivers in the form of tips and true differences in the quality and productivity of the labor force. The (untaxed) cash flow to drivers in the form of tips is often overlooked in evaluating wage differentials between the sectors. The labor force for taxis is frequently part-time and of exceptionally uneven quality, which may not meet the performance standards for public-sector operators. When taxi drivers are suddenly placed in the context of public-service DRT operators, performance expectations are increased significantly and the untaxed cash flow is eliminated. This should eliminate the difference in wages over the long run. Short-run wage differentials may continue to exist in the near-term planning period.

One of the reasons for contracting with a private operator is that the profit motive can help keep costs at a minimum. By contracting with the private sector for a service that makes more efficient use of its resources (e.g., a shared-ride service) and by requiring certain levels of service, the public sector can attempt to obtain a given level and type of public transportation service at the least possible cost. In addition, since taxi companies are at present generally profitable, it is conceivable that a more efficient shared-ride service, using either an existing fleet of passenger cars or a fleet of larger van vehicles, can be developed through the natural

evolution of existing taxi services with no continuing public subsidy required.

The Private Sector

The private sector, due to entirely natural circumstances, may have a different orientation toward the provision of service than the public sector. The private sector's concerns center on protection or enhancement of any equity interests it may have as a result of existing operations, as well as on a realization of fair and equitable wages and benefits for services performed. Other concerns focus on adequate return on investment and long-range economic security. The private sector will also be concerned with maintaining the satisfaction of customers and the labor force and keeping labor demands and costs at a reasonable level. Quality of service is recognized as a key ingredient to successful operation in the freely competitive market, but it is probably not as important a consideration to the private operator as it is to the public sector, since it is viewed more as a means than an end. In an area where there is a single operator or where an operator works under a safe and secure contract or franchise from a public agency, the natural incentive to maintain high-quality service that exists in a competitive market may be diminished.

Reconciling the Objectives

The private sector has a natural concern about its economic security; given the marginal nature of many small taxi operations, this may translate into a vested interest in the status quo. If the public sector wishes to modify that status quo, it must recognize these concerns about security and deal with them adequately. However, this will frequently bring the two sectors into conflict. The public sector cannot and should not guarantee the existence of a private operator. However, without certain guarantees pertaining to his future economic security, the private operator may not be interested in cooperating with the public sector at all. Conversely, the public sector normally (and properly) resists the creation of a monopoly situation that would destroy the advantage of the free marketplace.

An important and parallel corollary to these points is the entire concept of risk management. As the private sector evaluates opportunities, it will balance risk against return on investment; the greater the risk involved, the greater will be the anticipated returns necessary to draw out participation by the private sector. However, the public sector would like to place as much risk as possible on the private operator, while holding down the price of purchasing services to the minimum. Clearly, these two goals are in conflict, and it may prove difficult to satisfy both simultaneously.

The public sector must also be prepared for different levels of cooperation with different private operators. Some private operators may view DRT as a way of expanding their markets and, hence, of increasing their profits. Others will view participation with the public sector as a necessary evil—necessary in order to prevent the public sector from providing competitive service. These attitudes will also affect the contract terms that will be sought by the private sector.

Can a contractual relationship between private operators and public authorities be structured in a way that reconciles these conflicting objectives satisfactorily? We believe that a middle ground can be found. Contract structures that appear to satisfy these requirements are currently being proposed in applications for the UMTA Service and Methods Demonstration Project filed by two public transit agencies. These structures are based on the concept of minimum levels of service (established as a condition of payment) and financial incentives for maximizing efficiency of service.

ELEMENTS OF CONTRACTUAL RELATIONSHIPS FOR DRT SERVICES

Minimum Levels of Service

A fundamental component for any contract between the public and private sectors for the provision of demand-responsive service is the definition of minimum standards of service quality that must be met if the contractor is to be in compliance with the provisions of the contract. This component should be structured so that failure to meet these standards could result either in penalties being imposed on the contractor or in complete withholding of payment. Logical provisions for the standard of service will relate to such elements as the average waiting time, the average riding time, and the statistical variance in those factors; the driver's courtesy, safety, and appearance; the vehicle's safety, comfort, and cleanliness; and so forth. The public sector should realize, however, that the imposition of such standards will increase the risk perceived by the private contractor. In order for that risk to be acceptable, the standards must be reasonable and the private contractor must have the management flexibility to meet them without penalizing himself financially. Additional profit incentive may also be required in some cases.

Types of Contractual Arrangements

As a prelude to introducing the contract form that has been proposed to deal specifically with the problems raised earlier in this paper, it is appropriate to briefly review certain characteristics of the most generally applied contract forms. Standard contracts for procuring services can be divided into three general classifications—fixed fee, cost plus fixed fee, and fixed cost per unit of service. As we shall see, each of these traditional approaches has serious deficiencies in this context.

The fixed-fee contract form offers the advantage of allowing a public authority to know exactly the total cost of providing service in advance of signing the contract. This is clearly desirable from the standpoint of fiscal control and budgetary planning. However, a fixed-price contract based on specified standards for the level of service implies that all risks are borne by the private operator. This may be acceptable where service is ongoing and the costs and level of resources required to meet the demand and any service standards can be accurately predicted. However, in the context of starting up new services it may be extremely difficult to predict the demand for DRT service, which makes it very difficult to accurately predict costs beforehand. Thus, at best, a very steep price would be necessary to induce the private operator to take such a risk. It is more likely that an operator would simply not accept this type of arrangement or that the cost of such arrangements would be viewed as excessive by the public sector.

A contract for cost plus fixed fee is one of the most common types of contractual forms under which the public sector purchases services from the private sector. The cost-plus nature of this contract form significantly reduces the level of risk that must be borne by the private entrepreneur. This, in turn, would reduce the risk-based profit that must be paid to the private operator. The fixed fee might be just that (a fixed amount) or it might be a fixed percentage of costs. In the latter

case, unless a ceiling is placed on the fee, the operator is provided a clear incentive to increase the cost base on which his profit is calculated, an undesirable situation from the public sector's point of view. Even in the former case, however, there is no incentive for the operator to keep costs at a minimum, since his fee is not contingent on efficient performance. Thus, the public sector's objective of attaining maximum efficiency is not directly promoted.

Probably the most common type of contractual arrangement that has been used by the public and private sectors for the provision of demand-responsive services falls into the third category, fixed cost per unit of service. In this case, the profit is built into the fixed cost. Since a transportation operator frequently figures his costs on the basis of a unit of service (e.g., cost per distance traveled), this is a natural structure to establish.

There are two basic ways to establish this type of contract. First of all, the operator may be reimbursed for his services on the basis of distance or time. This type of arrangement is in effect in a number of communities in California, including La Mesa (8), and in a number of communities in Michigan, including Livonia (9, 10). Revenues in these systems may be collected by the operator or be passed directly to the public sector. This type of approach minimizes the level of risk experienced by the private sector; unless costs rise significantly above the expected level, the operator will make a profit. However, under this framework there is no incentive for the operator to provide the most efficient service. In fact, the reverse is true; the greater the distance or time recorded, the greater the profit for the private operator. This type of approach, therefore, does not meet certain efficiency objectives of the public sector.

An alternative methodology would be to pay the private operator on a per-passenger basis. This approach, essentially a form of indirect subsidy to the user, is currently being used in a number of communities, including Huntington Park and El Cajon, California (11). The approach increases the risk to the private operator somewhat, since the operator may be required to keep a minimum number of vehicles and drivers in operation at all times, even if ridership is fairly low. Of course, the operator can make adjustments to his operation once ridership levels are known, so this should not be a severe problem. This fact serves as the incentive (missing in the earlier approaches) for the operator to provide the most efficient service and thus to keep his costs at a minimum. As long as requirements concerning the level of service are imposed on the operator, this contracting approach should result in a fairly efficient high-quality service.

Perhaps the major problem with this approach, from the public sector's point of view, is that any cost reductions are not passed on to the public. The risk level perceived by the operator may make it necessary to set an arbitrarily high cost per passenger and, if subsequent economies are achieved through efficient operation, only the private operator benefits. In Orange, California, a combination of cost plus fixed fee and cost per unit of service is employed. The private operator is provided a fixed percentage fee, plus a fixed subsidy per passenger to serve as an incentive. Above a certain level of patronage, a higher rate would be provided. As a control on total costs, there is a ceiling on the total cost plus fee that will be provided. The incentive fee is paid only until the total cost level is reached. Thus the operators do have some incentive to keep costs down. Of course, if the operating contract is awarded on a competitive basis each year, the operator is provided with an additional incentive to keep costs down, and economies will be passed on to the public sector.

The most desirable contracting form would simultaneously

1. Assign to the private operator risks that are commensurate with anticipated return,
2. Provide incentives to the private operator to maintain acceptable service levels,
3. Provide incentives to the private operator to maximize the efficiency of the service, and
4. Provide a mechanism whereby economies in operation pass through to both the public and private sectors.

One approach that offers the potential for meeting these criteria is a variation of the cost-plus-fixed-fee contract that might be described as a cost-plus-variable-fee approach. Since the public sector seeks accessibility, quality, and efficiency of service, while the private sector seeks profit maximization and avoidance of risk, it seems logical that the fees be directly tied to vehicle productivity, number of passengers carried, and quality of service. These three factors can be used to determine profits to the private sector through the establishment of profit incentives tied directly and independently to these factors. Profit can be simultaneously determined as a function of productivity and passenger volume; profit can be paid for each passenger carried, while the rate of profit per passenger can be determined by the system's productivity. In other words, the fee per passenger would increase with increasing productivity. Factors of service quality can be used as criteria that must be met for full payment of profit bonuses. The cost-plus nature of the contract minimizes the risks for the private operator and therefore allows the profit incentives to be offered at a level that is reasonable from the perspective of the public sector.

Since all costs (as verified by the public sector through a postaudit) are reimbursed, the risk to the private sector is minimized under this approach. The scheme differs from a cost-plus-fixed-fee contract because incentives are inherent elements of the fee structure. By awarding the fee on a per-passenger basis, the private operator has the incentive to attract more passengers. By tying the rate of fee to productivity (i.e., increasing the rate with increased productivity), the operator is provided with an incentive to maximize productivity and therefore to minimize the cost per passenger of operating the service. Since the public sector pays only the actual cost of operation, economies achieved in operations are passed through to the public sector. Under this strategy, higher productivity or higher ridership will each, independently, increase the profit available to the private operator while simultaneously allowing for improved operating ratios within the public sector's accounting. An extension of this approach would be to tie the rate to the number of passengers, with the fee per passenger decreasing with increasing ridership. This would serve to protect both the private and public sectors. At very low levels of ridership, the private sector would receive an increased profit per passenger, which makes the system more worthwhile for them; at very high levels of ridership and productivity, the public sector would not have to provide quite as high a profit margin.

This approach sets up a structure whereby benefits from economies and gains in productivity achieved through efficient management are split between the private entrepreneur and the public sector. Through a careful structuring of the fee schedule, the private operator will have an incentive to fine tune the operations of the system to the point of maximum productivity.

The most difficult element in this approach is establishing the fee level, as well as the curve of fee versus productivity. The fee must be high enough to attract the private operator who fears that the profits from his existing service will be diminished. The fee levels may be negotiated after an operator is chosen. One approach that could be used in a competitive bidding situation would be to solicit bids on the maximum cost per passenger; i.e., the operator would be guaranteed reimbursement (per passenger) up to a maximum level. To keep the level of risk low, this limit could be maintained for a specified time period and then increased if conditions warranted it. For example, the bid on maximum cost per passenger could be binding on the bidder for six months and then adjusted upward (or downward) automatically in direct proportion to changes in the Consumer Price Index (CPI) or specific components of the CPI, based on a negotiated formula in the contract. Once experience has been gained in operating the demand-responsive service, it will be easier to establish both cost-reimbursement levels and the fee schedule.

A similar type of incentive structure can be established for drivers. Taxi drivers who work on lease or commission are well known to hustle for extra work. DRT services can similarly be structured to reward drivers with productivity bonuses. Experience in the taxi industry suggests that the presence of such an incentive structure significantly improves a driver's productivity. The workability of such an incentive program would clearly be contingent on the faith of the drivers in the equity of the control room's dispatching decisions.

Of course, under this approach, as well as any of the other approaches, the payment of profit or fee should be tied directly to the quality of service through minimum criteria for service standards. This is necessary protection for the public, particularly when the operator will have an incentive to maximize productivity, since one of the characteristics of demand-responsive systems is that, beyond certain levels, increases in productivity may be obtainable only through deterioration in the quality of service. The public sector should be prepared to monitor such measures of the quality of service as waiting time and traveling time and to establish reasonable minimum levels of service. If service deteriorates below these levels, the fee should be reduced accordingly. Therefore, specification of procedures for collecting data on the level of service, including the identification of statistical levels of confidence, confidence intervals, and testing procedures, will be a necessary and appropriate component of a contract. In any contract the public sector should also specify the basic requirements for liability insurance, driver qualifications, vehicle maintenance and cleanliness, and vehicle safety that will be binding on the private sector.

APPLICATIONS OF COST-PLUS-VARIABLE-FEE CONTRACTS

To date there have been, to our knowledge, no actual applications of the cost-plus-variable-fee contracting relationship described in the preceding section for the provision of DRT services. However, there are plans to employ different versions of this procedure in two areas; in each case, the contract framework is included in applications for UMTA Service and Methods Demonstration Projects. The two projects in which the cost-plus-variable-fee contracts have been proposed are based on different objectives of the public sector.

In one area, the public sector wants to provide a less expensive public transportation service to the community by increasing the efficiency of an existing shared-ride taxi system, but it does not wish to provide a continuing transit subsidy (there is already a substantial subsidy for fixed-route bus operations). The public agency involved hopes to increase the efficiency of the existing service by (a) purchasing larger vehicles (seating 10 to 12 passengers) and leasing them to the operator, (b) introducing automated dispatching equipment, (c) reducing fares and providing a seed subsidy until a break-even operation is achieved (fares would be set at the break-even level after 1 year of operation), (d) marketing the service, and (e) providing incentives to the operator to maximize productivity at all times. (At present, shared riding is used primarily in a many-to-one, rather than many-to-many, mode.) The cost-plus-variable-fee contract is to serve as the major incentive to the operator to maximize productivity, given the constraints on the quality of service. By maximizing productivity and therefore reducing the cost per distance traveled, the public sector hopes to reduce the (unsubsidized) average fare for shared-ride service from $2.25 to $1.35. Local social service agencies that are currently paying for taxi service for their clients have agreed to provide a subsidy per user to make the new service less expensive for those clients. At present, the local taxi companies have agreed to join together and bid for this operation as a consortium. In this manner, no single operation stands to be hurt by the competition provided by the new service.

In the second area, the contract framework is incorporated into an overall integration plan that seeks to bring together fixed-route bus services and a range of shared-ride and route-deviation paratransit services that are offered by a number of different operators. The plan seeks service integration through the development of a comprehensive range of complementary system components. The great majority of services will be offered through contracts with the private sector, with the public agency serving as a kind of glue that can coordinate and integrate a complex set of services offered by a number of private entrepreneurs. This demonstration is also unique in its attempt to consolidate a multioperator environment (two taxi companies, two social-service-agency DRT services, and a private school bus operator) into a single centralized control room and operating plan (12).

The centralized control concept has been put forward as a strategy for improved overall system performance for many years. However, a principal stumbling block to its implementation has been the issue of equity and how the public sector can protect the equity rights of the private sector as it moves toward centralization of control-room services. The proposed solution is based on the formation of a new private corporation that would operate all the private-sector services to be contracted for by the transit district. Equity in the new corporation—actually a transportation company to be formed to provide a range of DRT services—is to be divided among the existing private operators on the basis of their existing market shares. These operators will then be free to sell this new equity to other interested parties. Since this equity represents the rights to guaranteed service contracts with low risks and a reasonable return, it should be a marketable asset. It should be noted that this strategy is workable because of the marginal economic nature of the existing taxi operations in the area. The use of service contracts appears more favorable to the private sector than the current environment, which makes this evolutionary process possible. In other contexts, where private operators have a greater existing equity, additional protection or compensation may be necessary to induce such an evolution within the private sector.

PERSPECTIVE

This paper has addressed itself to the ways in which contracts may be structured between the public and private sectors for the provision of demand-responsive services. Since this is a narrow subject area, we have not dealt with a range of crucial issues and questions that need to be addressed concerning the efficacy and impact of the integration of the private sector in the provision of demand-responsive service.

What impact does the introduction of a publicly operated or subsidized DRT service have on existing taxi services? Can federal funds be used to subsidize a DRT system in an area served by private taxi companies, given the present urban mass transit legislation? Should public subsidies to private operators who provide DRT systems under contract to the public sector include vehicle purchase? What are the implications of such a strategy on the federal capital assistance program?

Is it in the public interest to foster competition for contracts to operate demand-responsive service or is it better to develop a single operator representative of all local operators? If a single operator is not obtained, what are the implications of the competition between the contract service and regular taxi service? What impact will new DRT service have on regular taxi service that may still be provided by the DRT operator(s)? What impact will such service have on the existing equity of the private operator, particularly those with equity in licenses or medallions?

What is the role of taxicab owner-operators (as opposed to fleet owners) in DRT service? How will they be affected? What will be the short-term impact on private-sector labor? What impacts will changes in work rules and elimination of tipping have on wage rates and the quality of the labor force?

None of these questions is easily answered; each will be addressed as more and more communities introduce demand-responsive services operated by the private sector.

This paper has focused on the reconciliation of often conflicting objectives prevailing within both the public and private sectors. It is our contention that this type of conflict can be resolved if the parties involved recognize and understand their counterparts' needs and objectives, accept them as rational behavior patterns, and seek a mutually acceptable common ground. We hope that this discussion has shed some light on the path toward that common ground.

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Exclusive-Ride Taxicab Service

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This paper discusses the problems faced by taxicab companies in coping with regulatory restraints and the absence of subsidies while they provide demand-responsive transportation through exclusive-ride taxi service.

Problems with exclusive-ride taxicab service involve the medium-sized and large cities in which the fleets of taxicabs and limousines capable of furnishing paratransit services are to be found. Smaller cities and communities, of course, have exclusive-ride taxicab service available (in most, it is the only public transportation), but each has its own problems and unique solutions and their paratransit service can, for the most part, be tailor-made.

In June 1975, at the Spring Research Meeting of the Urban Mass Transportation Administration (UMTA), I had the occasion to comment on the future of the fleet taxicab industry that provides most of the exclusive-ride service for the larger cities of the United States. At that time I viewed the state of the industry dimly and described it as faced with a crisis, largely because of the huge increases in such tax-oriented costs as gasoline, unemployment and workmen's compensation payments, and the like that cannot for the most part be passed on to the passengers.

I have said that paratransit is here to stay and that taxicab operators, with their superior experience and equipment, are the logical ones to be given the opportunity to provide that service (1). Unfortunately, regulatory constraints have nearly universally prevented it (2). At the fifth annual conference, in 1974, it seemed to me that the attitude of many students of the paratransit concept was one of disappointment at the painfully slow progress being made—a handful of heavily subsidized, comparatively small operations that showed signs of success and several notable failures (3), virtually all in small and medium-sized communities. Among the larger cities only a few had paratransit operations then and few new ones have come to my notice since (4).

A year later I ask, "What's new?", and from every direction the answer is the same, "Nothing is new; it's only more of the same." And I ask myself, "Why?" I have looked at the larger and medium-to-large cities for possible answers because their fleets of taxicabs should logically be able to provide, or at the very least experiment with, paratransit. As so many writers have observed, here are the vehicles, the operating expertise, the dispatching experience and facilities, and in some cases computers. Yet practically nothing has happened to further the progress of paratransit through the providers of exclusive-ride transportation service. Why?

REGULATORY RESTRAINTS

It would take a long time to list all the local regulatory restraints that inhibit the full scope of paratransit operations. The same old rules that prohibit shared rides and multimodal use remain in force unabated; and with these inhibitory regulations comes an ever lengthening list of taxes, fees, and government-imposed expenses, the amounts of which grow annually in quantum leaps. Kirby (2, p. 15) has pointed out:

> The regulation of taxicabs has a profound and complex effect on the type and quality of services they provide . . . ; limitations on the services taxicabs may provide appear to deprive the public of needed services with little discernible benefit. In our judgment, substantial improvements in mobility could be achieved in many U.S. cities by . . . permitting taxicabs to offer a wide range of services, including dial-a-ride, jitney, package delivery, and perhaps others.

Of course, the most insidious form of inhibitory regulation lies in the fixing of rates of fare at a point too low to pay the ever increasing costs of operation. In Chicago, for example, a unique ordinance in the Municipal Code sets forth the manner in which the City Council shall fix the rates of fare in relation to the ratio of income to expense, a scheme that is well received by those who are not destined to live with the reality of the regulation. A recent application in New York City for an increase in rates of fare was rejected on the ground that it was not fair to make the public pay more for a ride. Constraints of this sort exist nearly everywhere and, quite obviously, prevent any taxicab fleet from engaging in any sort of innovative transportation service, even if it were legal. Every rate-making body should keep in mind a very appropriate comment made a few years ago by George A. Avery (5, p. 13).

It was not understood that those powers [to control standards of service] are of little avail where the carrier is so preoccupied with maintaining a basic viability that seeking to extract innovation or a bold approach to risky new ventures is completely unrealistic.

In the large cities there are mass transit systems of great size and complexity, massively subsidized by every conceivable source and in every manner from direct grants to tax rebates. Could it be that pure inertia prevents these city governments from relaxing their inhibitory regulations? Could it be that there is a bias against demand-responsive transportation? Or could it be that they want to save paratransit and all of its potential for employment and subsidies for the more politically oriented regional transit authority (RTA)?

The Office of Technology Assessment of the U.S. Congress recently suggested (6) that transit planning tends to overreach because of the lack of centralized leadership and a desire to serve political considerations and that planners were often more concerned with a choice of plan (such as bus versus rail) than with providing alternatives. The report suggested that UMTA has encouraged cities to submit large plans in order to obtain their share of the funds. It might well be noted that, until very recent times, no one had paid much attention to the plight of those who were excluded from the automobile as an alternative to mass transit: the aged, the handicapped, the poor and the young (7). It is almost inconceivable that cities, despite decades of pleas, did not (until section 16b2 of the Urban Mass Transportation Act made them believers) care about the welfare of these groups. If they did care, why did they ignore their obvious needs?

ABSENCE OF SUBSIDIES FOR DEMAND-RESPONSIVE TRANSPORTATION

That subsidy for our industry is notably absent is not as surprising as it might seem. Alone among the providers of public transportation, we have been paying our own way for so long that we have been overlooked, and the mechanism for help has become lost in a maze. Consider that transportation funding comes under no less than 32 federal agencies, 7 House committees with 20 subcommittees, and 5 Senate committees with 13 subcommittees. It has been said (7) that

Urban transportation policy over the past 15 years has been highly inequitable. Government money has favored highways over transit and transit commuters over transit dependents. The result is an automobile system that works very well for most people, a transit system that works fairly well for CBD [central business district] commuters, and a nonsystem for everybody else. The next round of investments should be directed not to the highway system that serves automobiles, not to rail and fixed-route bus systems which serve CBD commuters, but to those door-to-door systems that are necessary for everybody else to get around with some degree of mobility approximating the automobile.

The difficulty, as Orski aptly described it (8, p. 22), rests squarely on the Urban Mass Transportation Act, particularly on sections 3 and 5, and the fact that participation must be through an areawide transportation improvement program. He sounded a note of danger when he observed that the taxi industry could well be excluded from receiving federal funds by an RTA: "Inevitably there may arise differences of opinion as to whether there is a need for paratransit services and who is best qualified to provide them." He added a ray of hope:

We will, however, in accordance with the intent of this act, review the plans and programs to ensure that they have given proper consideration to improvements in local transportation and that private operators have been given a fair and timely opportunity to participate in any arrangements for the provision of community paratransit services.

Orski's apprehensions concerning this apparent danger were expressed in an earlier speech (9) when, after describing the ways in which paratransit could complement mass transit rather than compete with it, he observed: "Thus, we think the present guarded attitude of the transit industry toward paratransit is unfounded and, we hope, will be dispelled once the service attributes and the operating environment of paratransit become better known." Kirby (2, p. 19) recognized that "Federal subsidies which are used exclusively for capital expenses for bus and rail services will certainly not encourage (and may actively inhibit) other forms of public transportation."

Why should this be? The answer to that question is as simple to state as the background to the existence of the question is complex and the implementation of solutions is complicated. The Urban Mass Transportation Act could be amended as easily as the inhibitory local regulations, given the will to do so, but the lack of such will is evident from the absence of amendments to benefit or implement paratransit.

It is difficult to believe that the potential users of paratransit, who are estimated to constitute 25 percent of the population over age 10 (7), are so politically unimportant. Altshuler has noted (10) that leaders of the transit industry have been extremely skeptical about the potential of dial-a-ride although, since they depend on broad political support for their financial sustenance, one might have expected great enthusiasm for a new service concept that could extend the traditional base of transit patronage. Parenthetically, it is of interest to note that, when the enactment of section 16b suddenly sensitized these leaders to the needs of the elderly and handicapped, mass transit leaped in with expensive buses, not paratransit.

Another possible answer to the question is to be found in section 13c of the act. There is not time to dwell on the many facets of this complicated issue, but differences between mass transit and paratransit on the issue of labor, especially in the big cities, have become severe. There is fear that public funds will be used to change traditional relationships in the transit industry. Due to the way section 13c is administered in both the Department of Transportation and the Department of Labor, there is little chance of any federal funding of paratransit through the taxicab industry. The reasons are many, including the fact that taxicab drivers are, to a high degree, part-time, tip-oriented, moonlighting people who are prone to high rates of turnover and, most important of all, who want to lease their cabs rather than enter into the traditional employer-employee relationship. As Altshuler said (10, pp. 99-100),

UMTA's policy to date has been as follows. It has refused to fund the purchase of taxis, and it has sought to avoid funding paratransit in ways that would raise new issues of labor protection.... In short, any future inclusion of taxi employees under section 13c seems likely to impose vast new complexity on transit program administration.

On the question of leasing taxicabs, one report (2, p. 17) has stated:

The taxicab industry offers an excellent environment for part-time labor, including students, low-skilled workers, moonlighters, and so on. Further, many taxicab operators... are changing from a wage and commission scheme of operation to leasing their taxicabs to drivers under certain constraints regarding central dispatching and maintenance. This mode of operation allows the driver considerable freedom to operate as a private entrepreneur in seeking patronage, completely relieves the operator of minimum wage problems, and has resulted in increased driver productivity.

To the unions, it is union busting. To the fleet operators, leasing their vehicles to the chauffeurs eliminates such tax-oriented expenses as social security, unemploy-

ment compensation, and workmen's compensation payments, which probably come to 15 percent of gross fares; all are escalating at a shocking rate. Fringe benefits usually account for more than 5 percent of gross fares. The impasse is all too simple to calculate. On a commission arrangement, chauffeurs frequently receive 50 percent of the gross fares. This leaves 30 percent to pay for the vehicle, its maintenance, its insurance, fuel, and all the other costs of transportation and administration—an obvious impossibility.

The cities regulate the rates of fare, theoretically in order to achieve a balance between proper and reliable service and a reasonable return to those who provide it. However, they are invariably asked why independent cab operators who do not pay those employer-employee expenses do not want a rate increase, while fleet operators claim that they will become bankrupt if they do not get one. They face the political problem of choosing between the nonunion independent contractor at significantly lower costs and the economically impractical rates necessary to support the habit of the employee relationship.

PARATRANSIT VERSUS REGIONAL TRANSIT

The first motor-driven demand-responsive transportation appeared after the turn of the century, usually furnished by one or two fleets and some independent drivers. The fleets rendered the call service; rates of fare were fixed to provide a reasonable return; licenses were issued so as to provide for the public convenience and necessity; the numbers of vehicles remained stable. The fleets traveled on steady and parallel courses for a half-century or more, while mass transit went from private ownership to bankruptcy to public ownership to RTAs. In the contest for financial assistance, the providers of demand-responsive transportation and those who are dependent on their services have been the losers to mass transit. In the large cities, the fleets are generally organized by unions and do not lease their cabs; there has been very little paratransit.

New York City, the nation's largest city, with the greatest transient population, is the largest taxicab market. Its 13 700 licensed taxicabs (as distinguished from about 15 000 gypsies) were divided by law into 8000 fleet cabs and 5700 individuals. There has been little radio dispatching and no paratransit. All public monetary assistance has gone in a vain effort to salvage the city's mass transit system. By union contract, the fleets are forbidden to lease their cabs. The fleets once included several with more than 1000 cabs; today there are two with about 500 each and the total number of fleet cabs is about 4500 and declining daily as the fleets become fragmented, partly because of skyrocketing costs and partly because of a recent refusal of an increase in rates of fare.

Chicago is one of three cities that is still served by more than 1000 cabs (in 1960 there were 10 such cities); its 4600 cabs are divided into two fleets and 934 individuals. There is an RTA with the Chicago Transit Authority as its ward. The deficits have outpaced all available subsidies, and the proposed gasoline tax could make providers of demand-responsive transportation subsidize the RTA to the tune of $750 000 a year. That no subsidy for paratransit can be expected except by the RTA is made evident by a case in point. The city has a services and methods demonstration grant to study the feasibility of providing service to the elderly and handicapped in one area of the city. Although the proposal says that they will consult the taxicab operators, they have not, and a representative of the Chicago Transit Authority has said that they do not intend to use any other source to provide the service if they finally get the operating grant.

Philadelphia, once the possessor of the third largest number of taxicabs and the largest fleet, now has the dubious distinction of being served by a fleet of 614 cabs that are operated by an insolvent company. It is the specter that haunts the operators of fleet demand-responsive transportation in every big city. Unable to change its method of operation, it went down in style. All financial assistance has gone to mass transit.

Detroit's fleets have completely disintegrated, with only a small drop in the total number of cabs. The largest fleet has no more than 50 cabs and the entire industry is in operational and fiscal disarray.

Cleveland has had one fleet providing taxicab and limousine service for 75 years, and it has resisted fragmentation literally to the bitter end; a recent study (11) summarized its rise and fall. Its fleet of 456 vehicles has aged to decrepitude; its ridership has declined 42 percent in the last 5 years. It has recently seen the coming of an RTA (created to rescue the Cleveland Transit System) with tax exemptions and $8 million of operating subsidies in 1975 alone. It operates a small paratransit system in model cities areas, shutting out the only provider of demand-responsive transportation. The study points out that the taxicab operator has been and is being frozen out by subsidies to other modes, perhaps to the point that it constitutes a legal taking of its business, as was argued in the case of Yellow Cab versus Orange County (California) Transit District. The Cleveland fleet is now seeking a merger into the RTA as its last means of survival; if this is not granted there may well be a suit like that in Orange County.

San Francisco has maintained its one fleet intact while the number of cabs has declined to 579 and the rates of fare have soared to the highest in the United States. The Metropolitan Transit District has received all of the subsidy funds. An attempt to lease cabs was recently thwarted by the union and the city.

Los Angeles, the nation's third largest city, once had a fleet of 1200 that has now shrunk to fewer than 600 vehicles plus some suburban companies. It recently acquired the only municipally financed paratransit service to be found in the large cities.

New Orleans has recently seen its only fleet sold to individuals after more than 50 years of service.

Salt Lake City, Houston, and Columbus provide a glimpse of the possibilities available to exclusive-ride taxicab service when there are no political and union pressures. Here leased or franchised cabs provide exclusive-ride service and a wide variety of paratransit services as well. These cities have come through the barrier.

SUMMARY

To sum up and find the common denominators of exclusive-ride taxicab service in the big cities is more depressing than difficult. The fleets that provide exclusive-ride service in the large cities are operating in the employer-employee mode with all of the concomitant escalating expenses, taxes, and union demands for more, from which there is literally no escape. Moreover, each of these cities has an RTA with an insatiable appetite that is destined to use up all of the available subsidy funds, even though that may require entry into the demand-responsive transportation business and even though it may not be as cost-effective. They simply cannot afford to let the money go elsewhere.

Regulatory constraints that hamper entry into the paratransit services add to the difficulty cited above and all taken together dictate that the possibility of subsidy for providers of exclusive-ride service to furnish paratransit services is virtually nil in the large cities. Some

medium-sized cities provide the example of what could be accomplished if the problems of the employer-employee mode were eliminated— exclusive-ride service by fleets that also provide a wide spectrum of paratransit service to the public and profits to the operators at rates of fare no higher than those in many of the large cities. But, I greatly fear that the large cities are in no position to follow the example.

I think the large-city fleets have seen their peaks and are in a state of decline. A recent study (12) predicted a one-third reduction in orders for replacement vehicles for taxicabs during the next few years, by which time the fleets will be leasing or there will be no fleets. And everywhere, exclusive-ride service will have greatly diminished.

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Paratransit Development: Search for an Appropriate Labor Policy

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The potential of the various paratransit modes for serving urban transportation needs is as yet largely undetermined. An informed and equitable labor policy would greatly assist all current efforts to explore the market potential of paratransit. Group ride-sharing paratransit forms, such as car-pool incentive programs, van pooling, shared-ride taxi service, and special services to the handicapped provided by sources other than conventional transit, raise difficult issues of labor policy. Where shared-ride services are to be integrated into the regional multimodal public transportation system in accordance with current planning requirements and policy directives, an appropriate labor policy should minimize political confrontation and labor conflicts. Labor ought to be involved at the outset in the planning and policy- and decision-making process. A good labor policy requires recognition of existing job equities and wage standards for transit labor. A successful labor policy will minimize unfair labor competition and jurisdictional conflicts between unions and groups of workers and require continued collective bargaining without government intervention. When adverse effects on the existing labor forces in the public transportation industry are unavoidable, they should be cushioned by job allowances, including job retraining and relocation expenses.

The Amalgamated Transit Union (ATU) has long been actively involved in the promotion of new forms of transportation as a useful part of the total transportation network. We ask only that the rights and interests of our members be properly protected before these services are operated. We look with particular favor on any form of paratransit that promises to improve the quality and reach of our traditional transit systems and services. Conventional systems that provide a vital network of line-haul services on a regularly scheduled basis over fixed routes will, for the foreseeable future, continue to be the heart of any effective regional system of urban mass transportation. To fulfill its proper role, paratransit need only be integrated and coordinated into the overall transportation structure so that each mode does what it does best and none detracts from the performance of any other element of the total system.

Before proceeding to a further discussion of paratransit, I want to make a few brief comments in regard to the current status and priorities of the programs of the Urban Mass Transportation Act. We feel that both the federal government and transit management have failed to deal effectively with the real-world problems and needs of our industry for improved productivity through increased ridership per distance traveled and higher system speeds. These, when combined with demand-responsive concepts and paratransit elements, could make some form of public transportation available to everyone in the urban community at reasonable cost. We think that far too little attention and money have been devoted to immediately attainable ways and means of improving the productivity of the total transportation network so that an ever increasing number of trips can be served by public rather than private transportation. Notwithstanding the often desperate immediate needs of our urban communities for additional public transportation services, federal transportation funds have all too often been spent for capital improvements that offer neither immediate nor long-term relief to the needs of our citizens for a public-transportation alternative to the private automobile.

As a native West Virginian and long-time international and local union representative of transit labor in that state, I need only mention, as an example, the Morgantown People Mover project as an illustration of my point. The Urban Mass Transportation Administration (UMTA) spent millions of dollars in Morgantown on a project whose value, even to that community, is limited. By comparison, only a pittance has been spent in preserving and improving conventional bus transit services in such cities as Charlestown, Huntington, and Wheeling, where the transition from private to public ownership has been very difficult indeed and often marked by long periods of suspended service. We in the ATU would like to see the federal government spend far more of its total transportation dollar on improving conventional mass transit through the introduction of such innovations as fare-free transit and demand-responsive services tied into the regular schedules and route structures, as they are in Rochester, New York. Other service changes should be designed to meet new market demands and to improve the system's speed and efficiency. On the other hand, it is obvious that conventional transit alone cannot serve the public transportation needs of the entire community. The various paratransit modes clearly have their own contribution to make and proper role to play.

The potential of the various paratransit modes for serving urban transportation needs is as yet largely undetermined. A lot of experimentation and testing will be

required before these somewhat specialized forms of public transportation can be evaluated and assigned their proper place in the family of transit services. Obviously, an informed and equitable labor policy would greatly assist all current efforts to explore the market potential of paratransit to serve all kinds of urban travel demands. In the longer term, such a labor policy will be an essential part of the overall institutional framework within which each paratransit mode must be allocated its proper role and functions. Moreover, such a policy will certainly go far to determine which labor-cost factors must be cranked into the cost-benefit analyses of the policy makers. Unfortunately, it appears that to date little or no progress has been made at the federal level in the shaping of an appropriate labor policy for paratransit. In such circumstances, it has been very difficult for us, as representatives of transit labor, to address the many thorny issues that paratransit presents for our members. We do have, however, some fairly definite ideas as to what the elements of a proper labor policy should be, and I shall attempt to set them forth here.

DEFINING PARATRANSIT

The term paratransit has been used to cover a variety of services and forms of intraurban passenger transportation that are distinct from conventional, regularly scheduled line-haul transit. These include almost any kind of organized ride-sharing activity—demand-responsive transit service, shared-ride taxicab service, jitneys, subscription buses, van pools, car pools, short-term pool cars (either company-owned or rented), and other special door-to-door services provided to special user groups such as the elderly and handicapped. Each of these paratransit forms may be offered as alternative travel options to conventional transit and the private automobile for both commuter and nonwork trips throughout the metropolitan area. Each type of paratransit has its own peculiar service characteristics and operating requirements depending on the market it seeks to serve and the institutional setting in which it is placed. Manpower requirements, labor costs and contracts, the identity of the working force and unions involved, the nature of the employment relationship, the laws affecting relations between labor and management, basic compensation and fringe benefits, along with the application of particular labor-protection requirements, vary according to the choices made among different paratransit services and their particular applications.

Demand-responsive transit, as a subcategory of paratransit, does not in principle pose any special problems from the viewpoint of labor. On a number of public occasions, we in the ATU have gone on record in support of transit dial-a-ride services, which we have looked upon as an attractive improvement that offers increased ridership and productivity to the fixed-route transit system. We still feel that the dial-a-ride concept offers to the transit industry a real opportunity to open up new markets in the lower density areas and, in general, wherever trip origins and destinations are too widely dispersed to permit service by conventional line-haul transit. In fact, Elliott (1, pp. 77-78) stated our conviction, at the TRB conference on demand-responsive transportation, that

> a public transportation system, using a proper mix of demand-responsive and fixed-route techniques, can succeed in replacing the private automobile as the preferred means of transportation for many urban trips. Such a user- and demand-oriented system, because of its increased patronage and productivity, should be far more economically viable than conventional route-oriented transit. Whether or not it can fully pay its way, such a system will better serve the community and, in our view, is, therefore, more deserving of tax support.... We see no reason why demand-responsive techniques should present any special collective bargaining problems for our members or for the industry....
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> As we see it, any special labor implications of demand-responsive service, which may require adjustments in wages, hours, and working conditions, are properly left to the local collective bargaining process. These can and should be worked out on a consensual basis by the local management and union bargaining committee in terms of the services to be provided and the needs of the parties.

Unfortunately, the fiscal pressures on the transit industry have been extreme, and in many applications the transit dial-a-ride service has proved to be a high-cost, low-revenue-producing operation that has created widespread public demand for service extensions and generated new funding requirements, which could not be met. Accordingly, transit managements, except in such places as Rochester and Santa Clara County, California, have been very slow to take advantage of demand-responsive concepts and to revise fixed-route services. This has created what we regard as unnecessary and undesirable pressures for the introduction of new transit-competitive paratransit systems.

We recognize, of course, that transit labor has often been blamed for the industry's increasing operating deficit, which is now in excess of $1 billion annually. We cannot, however, agree with those who have suggested that the worker should accept lower wages, lesser pensions, and more onerous working conditions in order that the industry may cover a greater portion of its operating costs. Likewise, the suggestion that demand-responsive transit services be provided at substandard wages and working conditions, at least until they prove successful, is no less acceptable than any other request that the worker subsidize conventional transit services, whose true cost neither the employer nor the taxpayer is prepared to pay.

Other group ride-sharing paratransit forms, such as car-pool incentive programs, van pooling, shared-ride taxi service, and special services to the handicapped provided by sources other than conventional transit, raise more difficult issues of labor policy that depend on the market served, the potential for competition and loss of riders, and the different labor components required by each mode. Perhaps less difficult to deal with, from the viewpoint of labor, are the car pool, van pool, and other subscription services.

CAR AND VAN POOLS

In the wake of the energy crisis in 1973, great emphasis was placed on the promotion and organization of computerized car-pool arrangements as a means of improving automobile efficiency and reducing petroleum consumption. Although such car pooling may divert patronage from conventional transit in some circumstances, no significant issues of labor policy are perceived, as long as federal assistance is not available for the purchase of vehicles or the payment of operating costs. The major thrust and impact of car-pooling programs to date have been to increase the occupancy of private automobiles and not to detract from any other form of conventional transit or paratransit. We foresee little likelihood that this will change in the years ahead.

Like car pools, van-pooling programs are usually operated to provide commuter transportation for employees between home and work. In the past, these have generally been privately organized by the employer, although federal experiments with so-called brokerage arrangements to provide van-pooling service to multiple employers and other agencies or facilities are now in progress in Knoxville, Tennessee, or on the drawing boards. In most cases, however, van-pooling service

is organized as a self-amortizing project by the employer for his own employees, using vehicles owned or leased by the employer and drivers who are his employees commuting to and from work. Driver compensation is typically in the form of free fare for the trip, along with the right to use the vehicle on evenings and weekends and retention of any revenues collected from passengers above a specified amount.

Experience with van pooling to date suggests that its greatest potential lies in serving low-density areas and long-distance commuters who, but for the van pool, would otherwise have to rely on car pooling or their own private transportation. Other possible uses of van pooling may be more competitive with conventional transit and taxi services and may thus give rise to questions of labor policy, particularly if such van-pooling programs are not self-supporting and issues of labor protection arise under federal or state laws. The attitude of transit labor toward such van-pooling programs will vary depending on the worker's perception of the potential threat to his job and earnings. Transit labor can be counted on to be at least neutral in regard to van pooling only as long as such van pooling is basically noncompetitive to conventional transit or other adequate guarantees to the transit employee and his bargaining unit are provided.

A good example of such protections is to be found in the context of the Knoxville brokerage van-pool demonstration project funded by UMTA under section 6 of the Urban Mass Transportation Act. The section 13c agreement negotiated in 1975 between the transit authority that sponsored that project and the ATU local involved includes a novel 4-year guarantee that the existing bargaining unit of the transit authority will not be reduced in size as a result of the project. The agreement also includes a special arrangement under which much of the routine maintenance work on the vans will be performed by the existing transit maintenance force in the shop facilities of the transit management company. In return for these guarantees, the local transit union officials withdrew their earlier opposition to the project and were willing to eliminate from their demands a number of other clauses restricting the areas of van-pool operations and the markets that could be served. Only time and experience will tell whether this agreement will be a success from the viewpoint of both parties, but clearly the transit worker gained a form of job security and the project applicant gained wider latitude than expected for the introduction of these experimental operations.

The labor issues presented by shared-ride taxi services, especially if operating or capital assistance to such services is provided under the Urban Mass Transportation Act, are even more difficult and complex, because taxi and transit operations are typically coextensive and competitive in their coverage. It has recently been recognized that the emergence of shared-ride taxi services as a form of paratransit eligible for funding under the Urban Mass Transportation Act poses the issue of competition between taxis and public transit in a very direct manner. As Alan Altshuler said at the 1975 conference on paratransit at Williamsburg, Virginia, such group-ride taxi services bring into question the legal and policy definitions of the terms "mass transportation" and "affected employee" that have guided federal policy over the past dozen years. A host of extremely difficult issues are presented, such as how to integrate taxicabs into transit planning, policy on transit subsidies, and publicly subsidized competition. Finding an appropriate labor policy to govern the various applications of such shared-ride taxi services will also be difficult. From the viewpoint of organized transit labor, the introduction of each of these shared-ride services into the various UMTA programs gives rise to a serious concern that the ultimate effect may be to destroy conventional transit jobs and to undercut the transit worker's earnings potential by substituting an unpaid or low-wage, casual or part-time, nonunion labor force for the better paid career- and union-oriented professional transit worker.

DEVISING AN APPROPRIATE LABOR POLICY

What then should the government's labor policy be when such shared-ride taxi services are to be integrated into the regional multimodal public transportation system, in accordance with UMTA's current planning requirements and other policy statements and directives?

It is highly unlikely that an appropriate labor policy in this area can be put together at the outset or in any single policy statement. We would suggest, however, that these issues may best be addressed in a context and by a process that is designed to minimize political confrontation and labor conflicts. In this connection, we would agree with the participants at a recent UMTA-sponsored labor-management research conference who said that both labor and operating management ought to be involved at the outset in the planning and policy- and decision-making processes before a course of action involving transit is decided on. This is especially true of programs and activities that have an impact on or implications for union members and for the day-to-day responsibilities of operating management.

Another essential of an appropriate labor policy is a mechanism that would ensure that shared-ride taxi services and other group-riding activities, such as special services to the elderly and handicapped, not be used as a device to destroy the transit worker's job, to depress his compensation levels, or to worsen his working conditions. In other words, we believe that a good labor policy requires recognition of existing job equities and wage standards for transit labor. It has often been the policy of the federal government to adopt program standards that will not undercut union labor and prevailing rates of pay. We would urge that the granting of capital and operating assistance to paratransit be made conditional on the application of prevailing transit-labor standards where such services are to be provided by the taxi industry or other special providers, if such services are to be subsidized by the federal government. Our own experience in negotiations further suggests that the process of collective bargaining may not by itself permit the development and attainment of such labor standards in the absence of appropriate guidelines and criteria that have the full support of legislative or administrative policy makers.

In my judgment, the process of free collective bargaining is still the best available means to deal with most emerging issues that affect the transit industry's labor force. Any effort on the part of the federal government, in the context of section 5's operating assistance program or otherwise, to establish governmental guideposts or standards for determining fair wages, hours, and working conditions for transit labor will be a serious infringement on the collective-bargaining rights of our members and is certain to lead to serious labor conflicts. The recent bus employees' strike in New Jersey, which involved the majority of employees of private bus carriers throughout the state, was directly caused by the state's calculated effort to inject itself into the collective-bargaining process for the stated purpose of destroying the principle of cost-of-living raises and removing or capping the full range of cost-of-living contract clauses enjoyed by our members.

SUMMARY

I would like to sum up these thoughts about an appropriate labor policy that might contribute to the further development of paratransit. I believe it is clear that all interested parties, including transit labor, should work constructively together to establish arrangements for such services that are fair and equitable to all. A successful labor policy will be designed to minimize unfair labor competition and jurisdictional conflicts between unions and groups of workers. Those entrusted with the development of policies for UMTA programs should seek to tailor their projects to achieve full employment of the existing working forces and economic growth and expansion of all segments of the public transportation industry. Successful labor planning also requires that continued collective bargaining and labor representation be free of government intervention in determining fair wages, hours, and working conditions in public transportation. In funding mass transit, the federal government should refrain from establishing any kind of cost controls or performance standards for labor that would impair the bargaining process.

In addition, an appropriate labor policy must recognize the human factors involved. Workers are people whose lives and livelihoods are greatly dependent on what government does in the field of paratransit. It would be a great mistake to regard these individuals as movable cost factors in an abstract economic equation. These workers are entitled to fair treatment from any federal program. They are not to be selected out or discarded at will. Public transportation policies and programs must assure that all such workers will receive appropriate levels of labor protection. As a minimum, these should provide an equitable sharing of any benefits or burdens flowing from changes in technology, service innovations, and modal shifts. When adverse effects on the existing labor forces in the public transportation industry are unavoidable, they should be cushioned by job allowances, including job retraining and relocation expenses, as provided by section 13c of the Urban Mass Transportation Act.

I do not think that we in the ATU have tunnel vision, as has sometimes been charged, in pursuing our objectives and interests. We recognize that paratransit can provide expanded job opportunites for organized transit labor, both directly, as in the case of the Rochester system, and indirectly, by creating increased ridership for conventional transit services. We also recognize that any fundamental change in the status quo in the transit industry, such as the changeover from trolley to bus, can present serious labor confrontations if nothing is done to avoid them. We are prepared to work constructively with others to establish a labor policy that will be fair and equitable to all in the further development of a strategy for paratransit. We look forward to working with others on these issues as they emerge.

Finally, there is a real need for a complete no-fare demonstration project in this country. In our judgment, such a project would place 90 percent of paratransit experiments on the back burner for some time to come since many people will produce their own paratransit means to take advantage of the no-fare public transportation.

REFERENCE

1. J. M. Elliott. Demand-Responsive Transportation as Seen by the Transit Worker. HRB, Special Report 136, 1973, pp. 75-79.

Part 6
Past and Future

Past Accomplishments and Future Directions of Paratransit: A Discussion

The Sixth International Conference on Demand-Responsive Transportation Systems and Other Paratransit Services concluded with a panel discussion. This is an edited transcript of that discussion. The moderator and panel members were as follows:

Moderator
- Daniel Roos, Massachusetts Institute of Technology

Members
- Robert Aex, Rochester-Genessee Regional Transportation Authority
- Douglas Birnie, Urban Mass Transportation Administration
- Richard V. Gallagher, International Taxicab Association
- Robert F. Hemphill, Federal Energy Administration
- John R. Jamieson, Twin Cities Metro Transit Commission, representing the American Public Transit Association

ROOS: The first question the panelists will address is: What are the three most significant accomplishments to date regarding paratransit?

JAMIESON: In the past decade we've seen quite a transition in the transit industry. It has been difficult to serve the diverse needs for mobility in this country, especially as land development has moved outward from our central cities. It has become costly for the transit industry to try to perform the many needed services, particularly in low-density areas. I think the primary accomplishment of paratransit is that it has identified to the public the wide range of available services that fall between the driver in his private automobile and buses filled with transit patrons. A second major accomplishment is the ability to demonstrate effective paratransit services not only in this country but also in Canada, where they moved early in such fields as dial-a-ride programs. This country took hold of the issue of gasoline shortage and mounted major programs such as car pooling in a way that cut short the standard lengthy process of planning. A third point is that paratransit has appeared just when the federal government has been concerned about the scarcity of capital for the development of major facilities. Various people in the paratransit field have been able to step in and offer their services to fill a gap at a time when a new product was needed.

GALLAGHER: One basic area that I think has been greatly overlooked is that paratransit has been in existence for 50 to 60 years, but we simply didn't have a name for it. I would like to make an observation concerning some happenings that I believe made us more aware of paratransit operations. In 1969 the Massachusetts Institue of Technology (MIT) did a study on computerized dispatching. For the first time the industry became aware of the government's, academics', and consultants' interest in taxicabs. From then on the International Taxicab Association (ITA) became more active in determining its role as far as the government was concerned. Many people forget that the taxicab industry was essentially local until 1966. The services rendered were local in nature and were controlled by local ordinances. Gradually, the state organizations and public utilities commissions are assuming some of the power of regulation. The industry has probably been overregulated and overcontrolled on cost and other items.

The second happening that made a very significant impact nationwide was the energy crisis, which began about 6 months before the embargo, when we saw the changes in gasoline price and method of distribution occurring. But this created federal agencies that became involved in developing concepts that would improve transportation and would conserve fuel. This is still a very vital area to us and we are deeply concerned with improving our productivity and our cost-effectiveness, but I think it has changed all the economics of operations in paratransit modes.

Then there was the establishment of the name "paratransit" with the publication of Paratransit: Neglected Options for Urban Mobility (1) in June 1974. This brought into focus exactly what we were talking about in the area of paratransit. This was followed by the TRB Conference on Paratransit in November 1975, which I think established paratransit as an integral part of urban passenger transportation. I think from this point on we are involved in the roles the various sectors are going to play—the roles of taxis, transit, and government.

BIRNIE: Certainly awareness of paratransit services is now widespread and there is a great deal of support for these kinds of services. One can point to the successful demand-responsive systems in Ann Arbor and the activities in California as well as support on the federal level for car pooling and van pooling. In addition, of course, the federal government, through the Urban Mass Transportation Administration (UMTA), has made both capital and operating assistance available and the various systems are well known now. Kirby has said that in every small town he has gone to he has been able to find a copy of the paratransit book (1). Communities are aware of and receptive to paratransit services and they are now beginning to be implemented. That tells us one thing—that we know there is a market for these kinds of services.

With the growing support for paratransit, we no longer have to write off many parts of the urban area that we previously felt we could not serve—low-density areas, periods of low demand, and late evening hours and weekends. There is now an opportunity to improve the quality of transportation service and having that opportunity in itself is an accomplishment.

I think the most important accomplishment to date is something Roos (2) touched on at the Williamsburg conference—that paratransit is causing us to rethink our transportation systems. I think in the past we thought of transportation in basically two dimensions: the line-haul fixed-route system and taxi operators. But now we are beginning to think of our transportation services in terms of a multidimensional system in which services are going to be better tailored to the needs of the individual traveler. The systems will now become a mix of modes, not only in terms of new services but also in terms of the ways we look at these services. We are in a dynamic period right now, and paratransit has helped to foster this dynamism.

AEX: I will try to touch on a point or two that haven't been brought up by others on the panel. It may not seem an important accomplishment, but it is very significant that a considerable number of private manufacturers are demonstrating the research and development that have been going on in the private sector, not only with regard to vehicles but also in other areas, principally communications. This seems a little trite perhaps, but I think it is an accomplishment that at last the transit industry recognizes that paratransit exists, even though some paratransit operations have been going on for many years, 50 years or more. I think another accomplishment is the evolution of paratransit from a somewhat independent mode to that of an element in a comprehensive transportation plan. As has been pointed out, one of the most visible accomplishments is the extent to which paratransit has enabled the transit industry to step in quite vigorously and provide service for the elderly and handicapped in a way it could not do if paratransit weren't available.

HEMPHILL: I would like to reinforce Birnie's point that a market now exists for paratransit. The idea that Americans are wedded to their automobiles and always drive them individually everywhere is being increasingly disproved. You only have to look at the success of the Reston (Virginia) Commuter Bus, the 3M van-pooling program, or the Knoxville efforts for proof of that statement. The second interesting accomplishment is that people other than transit operators are proving that they can run successful ride-sharing paratransit programs. Programs run by Hallmark Cards in Kansas City, the Aerospace Corporation in Los Angeles, and Government Employees Insurance Company in Chevy Chase, Maryland, have proved to be fairly successful once they got over the corporate stumbling block of getting involved in such operations. Finally, perhaps one of the most heartening things, from the viewpoint of public officials who have to deal with the whole task of getting public resources committed to these programs, is that at least commuter paratransit services are proving to be self-sufficient and in need of virtually no subsidy in terms of either capital or operating expenses.

ROOS: We now go into the second area with a number of brief reports. The first is by John Jamieson on the American Public Transit Association (APTA) view of paratransit and the potential for public and private cooperation.

JAMIESON: You may recall Stokes' speech (3) at the Williamsburg conference, in which he stated forcefully that he was going to stir the transit industry up and get it quite active in the field of paratransit. He immediately followed that up with the establishment of a task force on paratransit that was asked by APTA's board to prepare a report. This report was recently circulated both within APTA and to Roos's committee, as well as to others who have shown interest in reviewing it. Our board has recently taken favorable action on this report. Although the position taken in this report is not a definitive one, at least it gives us a starting point, both within the transit industry and in working with the many other facets of paratransit.

Our basic feeling is that there isn't any single solution; we need rail transit in certain areas, bus transportation in others, and certainly paratransit in many areas. This should not turn into a competition, but into a family of services that includes the many forms of paratransit. Why do we need this combination? We need it because we are faced with increasing concerns over urban sprawl. You cannot chase urban sprawl with a bus or rail system as it moves outward. It is too costly. Additional services are needed, the services that can be provided by paratransit. An interesting long-range concern we have is the matter of petroleum consumption. Given the urban form we have today, a household in the center of a city consumes one-half to one-third as much petroleum as a household in the outlying suburbs. A significant amount of mobility hinges on the consumption of petroleum in the outlying areas. Our objective is to be supportive of the public's needs for improved transportation by sharing the concern that more people use each vehicle.

We believe paratransit can be incorporated into a family of transit services in a way that will encourage cluster development in outlying areas. Paratransit services designed to focus on major centers of activity will cover many nonwork trips as well as promote further clustering of development by providing a variety of services. Paratransit can fulfill transportation needs that larger vehicles normally cannot handle efficiently in low-density areas. Such a system would also extend the reach of line-haul services (either bus or rail) in a cost-effective way. The effectiveness of the total transportation system may be increased by integrating various paratransit service concepts both within paratransit and with conventional transit. Paratransit services such as dial-a-ride or subscription bus service can support conventional transit by feeding line-haul operations. Different forms of paratransit can also be coordinated by using the same fleet to provide various services to meet changing travel demands throughout the day. This coordination will provide a broader range of transit and paratransit service and offers a more attractive alternative to automobile use. For example, if paratransit can serve part of the traveler's needs, that person may use transit rather than his car for the balance of those needs; patronage of

transit and paratransit can therefore be mutually reinforcing. This capability for providing flexible service that enhances the existing transportation system is an appropriate component of an area's transportation systems management plan. This is something you'll hear more about in the next few months.

However, the responsibilities for coordination of transit and paratransit must be carefully defined to ensure equitable treatment for all organizations with an interest in the provision of transportation services. The basic purpose must always be to ensure that appropriate services are designed and implemented to meet demand, that those services are operated by the service provider who can do so in the most effective and efficient manner, and that direct conflicts among service types be minimized. We think the transit agency can be of considerable assistance in a number of fields—planning, the coordination of services, and assisting in securing finances, particularly in dealing with the federal government. The operation of paratransit services should be shared among the appropriate providers of transportation services. Paratransit includes many different types of services, each of which has its own characteristics that, along with local conditions, must dictate who will have the operating responsibility for each service to be provided. The diversity of operating agencies that can exist highlights the need for a single agency to act as coordinator. We believe the transit agency should be assigned this role. The coordinating agency must impartially determine who should have operating responsibility, using the strengths of each potential service provider to its best advantage. If some other agency is to provide service, it may be engaged to do so on a contract basis. In other cases, service might best be provided by the local taxicab company. Definite benefits may be realized by using the inherent advantage of taxis in certain service aspects, e.g., dispatching capability and type of equipment.

There are six points that sum up APTA's position at this time.

1. Paratransit is an important part of the family of transportation services; its various forms, if properly designed and implemented, can assist in meeting our total mobility needs. Paratransit services must be planned in the context of the total transportation system, not be mistakenly identified as substitutes for other established and developing transit modes but rather considered as complementary and supplementary services.
2. Planning for paratransit, like all transportation planning, must conscientiously strive for efficiency and effectiveness and make the implementation of paratransit services an appropriate response to special mobility requirements caused by urban sprawl.
3. Paratransit must also help to promote efficient land use, clustering of activities, and reduced dependence on the automobile. Various forms of paratransit appear appropriate for group transportation in contiguous portions of urbanized areas and free-standing communities at the urban fringe and in certain rural areas.
4. In more densely populated areas, paratransit should be implemented only in ways that would complement the existing transportation system, such as feeders to line-haul corridors, specialized services for the handicapped, and line-haul supplements.
5. Since the integration of all transit services is absolutely essential, a single agency should be responsible for planning, coordinating, and establishing market strategy. In urban areas the logical choice is the transit agency. Depending on local conditions and the type of paratransit being implemented, the operation of the service may be performed by either the transit agency or other providers in a contractual or franchise relationship with the agency.
6. Paratransit performance to date provides no clear picture of the extent to which these concepts will serve various mobility needs or of their impact on urban development. Additional research and further demonstrations are needed to provide more sophisticated data bases, marketing strategies must be developed, and the relaxation of regulatory constraints must be carefully considered. UMTA, together with APTA and its operator members, should share in a definitive program of such activities.

ROOS: Richard Gallagher will speak on the role of the ITA in paratransit.

GALLAGHER: ITA has established a firm position on paratransit, which we stated at the Williamsburg TRB conference (4). I attended a conference sponsored by Northwestern University on planning for 2000 for the Chicago area. I found the academics were quite conservative in their approach to the question of nationalization of transportation services; they decided the railroads were going to be nationalized by 2000. If I were to follow the kind of thinking advocated by some of the speakers here, I would assume the taxicabs are going to be nationalized by 1977. This disturbs us. We have remained in the private sector many years; the association and its parent organization have been around for 56 years. We have publications in our office that show we had shared riding in 1922. We have an ongoing system that generates 3.4 billion passengers a year and revenues of $3.9 billion. We operate in 3631 communities, some of which are supposed to be transportation disadvantaged. We have 262 000 vehicles and we pay our way—this year we will pay $25 million in federal gasoline taxes. When the Highway Trust Fund was originally authorized we pointed out that 85 percent of our travel was over local streets. Now we will not only be in competition with various modes of transportation that are taking important segments of our ridership away, but we will also be subsidizing those modes through our taxes.

We have worked with UMTA on a number of projects, including an analysis of taxicab operating statistics published in 1975, an instruction manual for uniform reporting of taxicab statistics, a program for processing and analyzing taxicab statistics, and a compendium of provisions for model ordinances for regulating public paratransit. We feel that this has been part of our contribution to the base of knowledge that is necessary to develop paratransit to its fullest potential.

I also would like to address the issue of local participation in transit and paratransit operations. A superagency is not the answer to this problem; it would create an overhead burden that would become intolerable. A number of years ago we saw a tremendous move for the consolidation of a great number of private companies in the private sector. The result was an overhead burden that destroyed a lot of small successful companies.

One of the other areas that concerns me is all the rhetoric about section 13c. At times I get the feeling that a number of people in transit think we're out to destroy unions. Section 13c does not worsen the condition of labor with respect to their employment. In fact I do not see this as a bargaining instrument; it is simply a device to protect the employees, whether they are union or nonunion, whether they drive taxicabs or are in transit. I believe it gives adequate protection and should not be misinterpreted or extended into other areas or used as a device to solicit different forms of transportation or create a superagency to perform all the functions. We've heard criticism that the metropolitan planning organizations and the state transportation agencies are inadequate to do the job. But somewhere there must be

an existing organization that can adequately administer a program of transportation for the various municipalities. If we wanted to create a superagency to coordinate all activities—including planning, financing, and marketing for both line-haul transit services (circulation, feeder, and charter service) and paratransit services (dial-a-ride, shared-ride taxi, car pool, van pool, and subscription bus)—it would be faced with a tremendous task, not only in regard to the state legislature but also in regard to the transit authorities of the cities, counties, and municipalities.

I think we in the taxi industry have the know-how and the opportunity to generate additional traffic for both paratransit and transit service. We're in the private sector and we are still paying our way. The major cities in the United States that have large taxicab operations can survive. We are looking to the federal government for the development of a paratransit vehicle. We have been unable in 20 years to persuade a manufacturer to design a vehicle especially to meet these needs. I think there are tremendous opportunities for cooperation between transit and paratransit operations, but I don't believe that one group should dominate the other; I don't believe there is sufficient funding in any federal or state program to administer such an operation. It is well known that transit has very serious financial difficulties. I cannot see how this additional burden would assist them in providing better service to the public, which is what the whole question is really about. I think it is simply time for the taxicab industry to sit down and analyze where it goes from here.

QUESTION: Is the approval of the transit agency necessary for starting a car-pool or van-pool program?

JAMIESON: Each urban area in the United States has an entirely different situation. What I was suggesting was that a transit agency can focus the advocacy of transit in each area. Exactly how it is done will differ according to what mandate is received from the state legislature, the council of governments, or the municipalities. Whether it is a contractual matter or the transit agency simply receives federal funds (either planning or demonstration funds) and assists the operator or interested party, it serves to help out those who want to implement a form of paratransit. For example, if a Red Cross agency wishes to coordinate volunteer services, they may need some federal funding. If the transit agency is making funding applications day after day, it could be the agency the Red Cross would go to for help. We are suggesting that the transit agency, because it is in day-to-day contact with other governmental services, could be the focal point for anybody in the paratransit area to go to for assistance.

QUESTION: What has to be done to deregulate the taxi industry so that they can provide a jitney service?

GALLAGHER: You have to get the support of public transit, which initially backed the establishment of antijitney laws. I think the decision is mainly theirs and not ours.

JAMIESON: Since there are many municipalities in an urban area doing the regulating, it is necessary first to standardize the type of regulation. In that process you can work out where it is appropriate for the shared-ride concept to complement larger vehicle transit. It is as simple as that; I think it can be done. The first step would be to try to bring together in one urban area a standard or model form of regulation.

QUESTION: I am not sure whether your position paper states that all paratransit services must be coordinated or funneled through a transit agency.

JAMIESON: There are varied opinions within the industry. We're going to have considerable difficulty encouraging certain bus operations to be cooperative with different forms of paratransit. We hope to persuade them that the transit agency can serve as a model, an advocate, and that whatever they can do to assist paratransit they should do.

ROOS: One of the issues that came up at the TRB conference in Williamsburg and again here is whether any advocate should be the one to decide in what direction we should be going or whether we should be setting up some neutral organization.

JAMIESON: When you start to look for a neutral organization that is not a superagency, you go through the categories of a state department of transportation and metropolitan planning organization (MPO) and work your way down. If you want to minimize government you make the most effective use of what you have and combine it so that a single agency can represent an efficient organizational concept.

QUESTION: Are you saying that paratransit should be provided through APTA and the transit industry rather than a governmental organization?

JAMIESON: I don't think APTA needs to get into all facets of this. I think there is a very effective taxi industry and we have often seen that taxis and public transportation can complement one another and go after the 90 percent market that both of us are interested in. We want to promote public transportation in place of the individual automobile.

QUESTION: But are you saying that you do not want to have your transit members compete with the taxicab companies for a given sector of paratransit services?

JAMIESON: No, I don't think we want to say that. You have to look at the type of work that has to be done and, if it can more appropriately be done by the taxi industry, so be it.

QUESTION: Will the ITA take a position opposing jitney services?

GALLAGHER: I would say that we would take a position not opposing it. Several of our operators have already proposed jitney services; there is one jitney service that has been operating since 1930 in Jacksonville, Florida. A broad look is being taken at it throughout the country, but it won't be easy because of the existing ordinances in so many communities.

QUESTION: What is the role of the MPO, particularly with respect to the dissemination of information about the type of transit that is available in metropolitan areas?

JAMIESON: The MPO consists primarily of local elected officials making decisions for their metropolitan area. If we can get the information to the MPOs, whether it is from the private or the public sector, that could be an excellent way to make the information available because it goes right back through municipal and county structures. It would be very helpful to use the MPO in this way.

GALLAGHER: We are becoming involved with and we have some representation on MPOs at the present time. The question is what role UMTA will play in determining which agency is going to handle this funding. I think it is a decision that has to be made, and made firmly, by

UMTA. UMTA has more control of this situation, through the allocation of dollars, than we have. We believe that there should be an organization that is responsive to the public and to the communities they represent and that it should be a planning organization. Our major objection is only that the organization that is going to do the planning and funding should not also be the operating agency and the one to determine who is going to supply services at the lower levels and what kind of competition in bidding there will be. I strongly believe that UMTA has to clarify its regulations and take a firm position; the idea of simply passing out dollars as soon as a local area says we can do this or that with them, without giving them a clear-cut opportunity to decide exactly how they can be best invested, is a tremendous mistake.

ROOS: This seems to be an appropriate point to shift into the next set of presentations, which concern the role of the federal government.

BIRNIE: I would like to speak about the role of UMTA and how we think we might effect the delivery of paratransit services. We don't dictate how services are to be provided, nor do we provide services. So basically our role has to be catalytic or assisted. UMTA's interest in paratransit stems from an interest in the opportunity for urban areas to decide how they can best formulate their transit and paratransit systems, with paratransit providing an opportunity to improve mass transportation in that area. We can support paratransit services when they are selected by a community with both capital and operating assistance.

I'd like to touch on some of the other roles we play both for paratransit and for all transportation services, although they have some special significance for paratransit services. I think I should also emphasize at this point that UMTA is not the agency for any one mode. We favor neither coordinated line-haul nor paratransit services; we believe these services should be available as options for communities in producing their own transportation systems. UMTA plays the role of facilitator of innovation at both the local and state levels of government, which don't always have the ability or the resources to examine and implement innovative services. Through the UMTA research and demonstration programs we can examine and explore various aspects of paratransit services, including some of the difficult institutional issues that are before us. We can explore vehicle technology, vehicles, computers, and dispatching equipment; we are also examining the delivery of services, especially the integration of these services. While the technology for paratransit is not particularly new, the integration of these services has given a new dimension to mass transit systems. We help to implement the systems by providing information for the research programs. When we become convinced that there are opportunities to implement services around the country we can, through our demonstration programs, provide 80/20 matching funds to help implement these services in communities.

There is another, quite different way that we can help innovate in paratransit. Since paratransit is not all that new technologically, there is a great opportunity to innovate on the local level. The federal government doesn't have the corner on innovation. The presence of section 5 funds, which are allocated to urban areas, gives them an opportunity to innovate with paratransit services. These services are very flexible and people at the local level are probably in the best position to tailor these services to the individual market, devise new ways to apply these services, and put them together productively. They are also in a good position to deal with the idiosyncrasies of local institutional arrangements. If urban areas can overcome some of these barriers and innovate, the UMTA funds are there to support them. UMTA will continue to provide a center for the exchange of information, especially among the academic community and various providers of transit service. We hope to continue to fund conferences like the one at Williamsburg and to cooperate with TRB on the exchange of information, which is especially vital in the case of paratransit services.

There are smaller roles in which UMTA has a bearing on paratransit services. We are concerned that there be equity in the distribution of services within the urban area. We have always reviewed applications for federal funding to make sure that services are available to the elderly and handicapped and to minority people; paratransit certainly offers an opportunity to serve both of these groups better than we have in the past. UMTA has recently begun to focus on the distribution of services in the urban area. Our new proposed policy on major urban mass transportation investments specifically mentions that in developing their plans urban areas should give explicit attention to community development and local circulation systems; this will be an inducement to the implementation of paratransit services, as will the new transportation system management (TSM) requirement, which specifies that all communities give serious consideration to the delivery of paratransit services. Communities that have regulations that may be an obstacle to the delivery of these services will surely be asked by UMTA to reexamine those regulations. Since the new TSM requirement asks communities to examine their entire transportation systems to see how they can make more effective use of these systems, paratransit must be considered in this reexamination.

Another important aspect of the federal posture is the requirement to develop coordinated systems, which is especially important in terms of paratransit. If we're seeking a multidimensional system that is innovative and reacts sucessfully, the way we develop paratransit services is very important to the success of these services. We must provide a forum where the various providers and the special interests in the communities can come together for a more comprehensive look at the delivery of these services. I believe there could be adverse impacts from merely deregulating the taxi industry and opening up the service completely, without any thought for coordination. On the other hand, I think UMTA's posture toward private operators is another partial inducement to providing service. UMTA has said that private operators must be given an opportunity to compete for the delivery of all paratransit services, whether they are managed or coordinated by the transit operator or by the MPO.

HEMPHILL: To discuss the role of the federal government you have to figure out what the federal government has as its objective for the whole metropolitan transportation issue. Secretary of Transportation Coleman summed it up reasonably well in his national policy statement: "An efficient metropolitan transportation system requires a mix of modes—public and private, properly coordinated and utilizing the relative advantages of each." He went on to say that one of the most important ways to do this is to promote equal competitive opportunity for all forms of transportation. With that as the objective, you have to look at the tools available to the federal government. First, there is funding; second, there is regulation or deregulation using a law or other requirement; and third, there is the development and dissemination of information, which may be less powerful than the other two tools.

In terms of funding, it is clearly recognized that the federal government has a substantial influence on the

development of urban transportation systems, not only through those agencies represented here but also through the Federal Highway Administration (FHWA). I think it is also reasonably clear that there has been an increase in the amount of public funds granted to mass or public transit opportunities in the last 5 to 6 years. I expect this to continue, correcting what many people see as an imbalance between the resources that went to building highways and those that went directly for public transportation systems. It is hoped that these funding patterns will promote something approaching equal competitive opportunity for all modes.

On the question of regulation and deregulation the federal government, at least the Ford administration, is strongly interested in removing economic regulatory barriers. The question is how to do this, because most regulatory barriers to equal competitive opportunity for metropolitan systems tend to be either state or local regulatory barriers. The third tool, the use of information, can help overcome some of these barriers, and others can be overcome with another regulation. I think that, to some extent, is what may be intended by the TSM requirements. A TSM design whose objective is efficient transportation at the local level may make it increasingly clear that changes are needed in some of the local regulatory barriers. The regulations can also be influenced through the federal funding. One part of the guidelines for state energy conservation plans that will be published soon includes a provision for mandatory right turn on red that we think will permit substantial saving of energy.

Finally, in terms of providing information, it is still appropriate for the federal government to educate private providers about the potential of various paratransit alternatives. The Federal Energy Administration is concentrating a large portion of its resources both on the providers and on the state and local decision makers so that they can incorporate some paratransit alternatives in their state energy conservation plans and in their TSM plans. The competitive marketplace works to the advantage of the providers and the users of a metropolitan transit system, perhaps not as well as a thoroughly coordinated system but certainly better than one vast overall agency coordinating everything.

ROOS: Let me give one who represents a metropolitan area a chance to respond.

AEX: It seems to me that we've overlooked the fact that the federal regulations say that each metropolitan area must develop a comprehensive transportation system plan and that the plan must use all of the existing public and private opportunities. I don't think there is any question that sooner or later, just as there was an absolute prohibition against competition with private bus operators, there will be a requirement that those who receive federal money must not and cannot compete with existing private operators; it is inevitable. I am not privy to the inside meetings of such organizations as the International Taxicab Association, but I am sure they are aware of what the National Association of Motor Bus Owners accomplished when they backed legislation that prohibits the receiver of federal money from competing with the bus operator. Most of us don't object to that particularly, especially now that we have had the benefit of some experience.

I hope Jamieson's observation—that one of the deficiencies in the MPO at the present time is that the private operators aren't participating—will be acted on by such private providers as the taxicab people. At a meeting of an MPO there will be the representatives of the federal government, the state, and all of the local elected agencies, but as for the providers, there are only public transit operators, not the private taxicab operator or any of the other private operators of paratransit. I believe they must be brought into the MPO. Then I think we'll get some results.

One of the most important roles for paratransit in metropolitan areas is to assist traditional transit with the problem of balancing the peak and off-peak service to improve the use of resources—manpower and equipment. This imbalance between peak and off-peak periods is the thing that has almost wrecked the transit industry, and will eventually wreck it if we don't find some solution. I think transit will therefore look more favorably on paratransit as time goes by, because paratransit can alleviate some of the problems of the traditional transit industry. Paratransit can also enable traditional transit to go into low-density areas and make transportation available where it is needed. In this country 50 percent of the people live outside of the central city, with little or no public transportation provided, even by the private sector. People often ask me why the taxicabs in Rochester don't object to what we're doing; it's because there aren't any taxis in Rochester doing what we're doing. One of the principal roles of paratransit is to get public transportation out where people need it in the low-density rural and suburban areas.

Feeder service is very important, whether it is a taxicab feeding a line-haul bus or a demand-responsive bus feeding a line-haul bus. The only way people can use a line-haul bus going down a main highway is to have somebody feeding it and this is an important role for paratransit, as is its role in serving the handicapped and elderly, in particular the handicapped. If every fixed-route bus in this country were retrofitted, we still wouldn't be able to serve the handicapped unless the bus could go to the handicapped person. Paratransit can also increase the geographical limits of the labor market, either in the central city or outside, for both the employer and employee.

I think paratransit will be the avenue through which a lot of automation is brought into transit. Transit hasn't had the opportunity to use automation the way most other businesses have. I think the opportunity will present itself more and more through paratransit. I was surprised to learn that taxicabs had been using computers for years—many years before we started thinking of using that tool in the transit industry. To sum it all up, I think the role of paratransit is to aid in the development of an effective alternative to the automobile, particularly on the home-to-work trips.

QUESTION: What are the options or alternatives that are available to private operators right now to enable them to get into paratransit?

BIRNIE: Although we don't protect exclusive-ride taxi service, we have taken a stance to allow providers to come in to new services; if a new service is being developed and it is a paratransit service, you would have an opportunity to show your resources and compete for that service.

QUESTION: Is the transportation authority the final judge on paratransit services?

BIRNIE: UMTA has to determine whether private operators have been included in the program to the maximum extent feasible, so we're the final judge on that.

QUESTION: I am from Arkansas and have been in the shared-ride business for about 30 years; we transport more than 3000 people a day and could transport 6000 a day. We are waiting patiently for the federal government

to make up its mind, but soon we will be incapable of providing paratransit service because we will be broke. Any social organization in town can get funds under section 16b2 and we have no say. Are we going to survive or do we have to sue our own government to protect ourselves?

BIRNIE: I can assure you that we don't want you to sue. That section has been amended so that, before any grant can be made under section 16b2, private operators have to have an opportunity to state that they are willing to provide that service.

QUESTION: What do you do in low-density areas where mass transportation cannot do the job?

BIRNIE: Of course UMTA cannot tell a community what kinds of services to provide. However, we have asked, in the development of plans for low-density areas, that adequate consideration be given to paratransit and we are going to review plans for that. We can't mandate paratransit services but, once paratransit services are selected in urban areas, we say that any existing private operators must have the opportunity to compete for those services. I don't think we can be stronger than that.

QUESTION: I am from Jackson, Mississippi, where the city fathers run the transportation system. They went into the minibus business in 1974. They did not give me the opportunity to do the work although I have adequate vehicles and equipment— everything to do the job without putting additional money into it. I have made proposals to run it for less than half of what they are running it for but they turn a deaf ear. How do you resolve that problem?

BIRNIE: I am aware of your case. I know that our Capital Assistance Office, which will be making that grant, is taking your protest very seriously; in fact I think someone was down there about a week ago.

QUESTION: How can you reconcile the fact that UMTA says that a transit authority should use existing operators to the fullest extent possible before going into business itself, but the Department of Labor won't approve a section 13c agreement unless it includes protection procedures for labor unions, requiring in effect the operation of a closed shop? I see a conflict in policy here.

BIRNIE: I can't speak for the Department of Labor, but I think that whether there will be a demand for a closed shop remains to be tested. We have some cases in which section 13c agreements have been negotiated where that isn't the case. We ought not to be too apprehensive about that. I think we will have to go forward in good faith and see what the products of these negotiations are.

QUESTION: If I am seeking a grant, should I go to the regional office or directly to Washington?

BIRNIE: I think it depends on the matter you are discussing. We handle a number of requests on policy issues, but if you are talking about getting a grant, you should go to the regional office; they know the particulars of your case and can work with you all the way.

QUESTION: What office in UMTA should we communicate with if we do not receive responses to our needs in the region?

BIRNIE: The Office of Policy and Program Development.

COMMENT: I would like to criticize the fact that, in all these meetings, we never bring in the people who have been in the paratransit business— the social service agencies. There are probably more transportation programs and operating assistance funded by the Department of Health, Education, and Welfare than by UMTA. The point I am trying to make is that people keep talking about "urban" and "metropolitan," but 48 percent of the people live in rural areas and have more critical transportation problems than those in urban areas. For them, it is not a matter of making transportation more convenient; it's a matter of providing basic transportation to receive health services and so on. In a lot of areas, where there wasn't even a cab service, these people had to be taken care of by the agency providing the social services. It is only in the last 12 months that UMTA finally woke up to the fact that half the people live in rural areas; I am very critical because I don't think rural needs are being addressed.

ROOS: The next question we pose to the panelists is: What are the three most important short-term objectives with respect to paratransit and how do we achieve them?

JAMIESON: First, in each urban area we should establish effective coordination in the family of transit services, including the many facets of paratransit. There isn't any standard way to do this— each is unique— but in APTA we are ready to cooperate and to do what we can to bring about a total transportation system tailored to the particular area.

Second, we must demonstrate the mutually supportive roles that paratransit and transit can play. I think we've seen Karl Guenther and Bob Aex do these things very effectively in Ann Arbor and in Rochester. But there is much more that can be added to the work they have already started. In areas where there is a high potential for paratransit, if transit is cooperative and plays a supportive role, it can build up the paratransit opportunities.

Third, we must resolve the remaining critical issues we have— insurance issues, clarifying the role of the federal government in the funding of transit and paratransit, and improving the flow of funding to the service providers.

GALLAGHER: I'm not an advocate of administrative law, but I think that the Department of Transportation, and UMTA in particular, must come out with some very sound laws to protect existing institutions that are providing transportation. I feel that one of the greatest needs is coordination of transit services, whether they are in the private or public sector. The taxicab industry believes that car pooling can be a very important operation during peak hours. It can transport people to downtown areas in the central business district and allow them the opportunity to use taxicab or transit in off-peak hours, which is when we want to gain ridership. We have tremendous diversity within the taxicab industry. There is no reason we can't provide feeder service to transit and other services, particularly in the area of package delivery. We have been operating services for the elderly and handicapped for a number of years, mostly with local funding. We often forget that all the California dial-a-ride programs are either state or locally funded. I see no federal money coming into this. If this process continues, it will again be the responsibility of the local government to determine what type of paratransit operations they are going to install in the local area. I see no substantial movement by UMTA to institute these programs except on a demonstration basis.

I agree that the rural programs are very important. West Virginia has a demonstration grant and program

that is going to spend approximately $21 million in trying to establish services for the rural areas. UMTA is sponsoring a number of seminars throughout the country on rural transportation. I think taxicabs are going to play an important part in developing services in these areas because they can provide it at low cost. They can maintain and service the equipment. I believe this is one of the important markets that is opening up for the taxicab industry; it offers new ridership that does not exist at this time.

There is no simple answer to the problem of regulations. I think we have to have a clearer concept of what the regulations should be. There has to be a philosophy developed about the purpose of transportation in the urban and the rural areas. I thought it was very simple—that we're trying to serve the riding public out there. But it gets so complicated with the existing regulations that it becomes almost impossible to continue a high level of service without conflicts.

I also believe strongly that there should be more basic research, especially on ridership characteristics. Gilbert did a study in North Carolina that impressed us because we found that in the lower income brackets we had approximately twice the ridership we had originally estimated. Some time ago Chicago spent more than $1 million on a ridership study by Carroll that was the basis of all planning for the city of Chicago for about 20 years. It seems to me this is one of the areas in which UMTA can provide a very vital service, particularly to the private sector. Perhaps the transit people know the market better than we do; maybe they have conducted more intensive efforts in that area. But this is not a small project. I think it's one that should be developed on the basis of university participation, probably a consortium of universities.

HEMPHILL: I can set out what I see as the next three objectives for paratransit very briefly. First, I think we have to spread the word that it works; more people need to get that message. Second, we have to identify and examine those regulations at both the state and local levels that prohibit or inhibit active car-pooling and van-pooling programs; than we have to eliminate them. Finally, we have to establish reasonable insurance rates for car-pooling and van-pooling situations.

AEX: One of the most important short-term objectives is the recognition of existing privately owned paratransit services. A second objective is the removal of regulations that prevent those privately owned paratransit services from functioning on a shared-ride basis. Third, we must examine the role of labor. Sooner or later someone has got to present a test case for section 13c. Does it in fact prevent an agency that is receiving UMTA money from contracting with a union or nonunion paratransit provider if the paratransit service does not eliminate any union jobs?

BIRNIE: I think the most important short-term objective is to develop an atmosphere in which the providers of paratransit service, public transportation, and even commuter services can come together and cooperate. UMTA has hoped that the MPO will serve as a forum for all these service providers. I think a transit operator should think of his company not just as a provider of service but as an agency that can coordinate services and ensure that people know the services are available. Taxi operators need to broaden their thinking. There is a great opportunity in shared-ride service, and the taxi industry appears to be moving in that direction. At present taxi operators are worried about competition, especially to their exclusive-ride service, which is the heart of their business, but they should also look forward to other opportunities. Transit labor ought to see that it is in its long-term interest that a number of these services be provided on a volunteer basis or by private operators; with the financial pressures on the transit industry today, many of these services must be provided at lower costs if they are to be significant for mass transportation. I think we need to test the interaction among these services in an integrated system and study how things affect one another so that we can put them together successfully to mutually benefit one another.

QUESTION: I think the exclusive-ride providers are not fearful of competition in any sense when it comes from shared-ride modes. I think what we are most concerned about are the inhibitory local regulations. UMTA should be interested in exerting its influence, but in local communities that have such regulations, I think you are going to have to do more than use some kind words.

BIRNIE: TSM element is the key here. We're not telling communities at this point that they have to do anything to change their local regulations. If we are considering paratransit services and local regulations are inhibiting the efficient provision of the services, we'll certainly be asking a lot of questions.

QUESTION: What is being done about the rising cost of insurance, particularly for car-pooling and van-pooling programs, and what is the role of the federal government in regard to insurance?

HEMPHILL: In terms of local regulations, our first problem is that we don't know exactly which states have regulations that will turn out to inhibit various forms of ride sharing. UMTA is funding a study by MIT, but that will only cover a few states. We will evaluate the state regulations that would inhibit ride-sharing activities, but that doesn't cover the metropolitan areas. We don't have the funds or resources to do a survey of every regulatory constraint in the country. In terms of insurance, the problem seems to be that the insurance companies are conservative organizations. They don't feel they have enough data or experience with ride-sharing arrangements, particularly van pooling, to do much about the rates; therefore they have set them high so that all their risks are covered. I think we'll probably have to end up sponsoring a couple of serious meetings with top insurance executives and ask them to give us a fair break. It is difficult at this point because there really isn't much operating experience yet.

QUESTION: Why are you creating, in the MPOs, another obstacle that we have to go through before providing services?

BIRNIE: We think the MPOs are serving a valuable function. They are there to coordinate all the services of the area and to develop those services. They should be impartial organizations and we think that is to your advantage.

QUESTION: How about the use of paratransit for supplementing peak-hour operations? These can be the most expensive operations because of the peak/off-peak imbalance.

JAMIESON: We need to shave the peak or fill in the base; our problem is that we have too many vehicles operating in the peak and sitting idle in the base period. We think paratransit can aid in both areas. Filling in the base is perhaps more difficult, but a shared-ride taxi can help

by working in lower density areas and bringing people in to fill up that base period. This will take a lot of cooperation and more demonstration of techniques, but I think we can work something out between transit and paratransit.

AEX: The way paratransit can assist traditional transit during peak hours is not by taking people out of the buses but by taking them out of the automobile. The way paratransit can assist traditional transit during the off-peak hours is by feeding people to buses that have low ridership, especially in the low-density suburban areas.

ROOS: The final segment of the program will permit each participant to make a closing statement.

AEX: Improved mobility must be the primary goal of transit, and this can only be accomplished if every form of transit is used in a comprehensive way to get people from where they are to where they want to go. The system must use traditional transit and paratransit, which must include the automobile on a shared-ride basis, the taxi on a shared-ride basis, the van with 10 to 12 passengers per vehicle, the jitney, the dial-a-ride vehicle, and all the other forms of transit that provide an alternative to the vehicle occupied only by the driver. The diversity of needs demands a mix of transit modes to effectively meet these needs. Paratransit has already demonstrated that it can enable a transit system to better meet those user needs. Improved mobility at the same time reduces pollution, reduces congestion, and reduces energy consumption. Improved mobility must be our primary goal for all those reasons.

BIRNIE: We in UMTA think that paratransit is more than a promise; it is an emerging reality and we know there is a demand for these services now. Future systems will be multimodal and will be more market oriented. We believe that paratransit services should be carefully and perhaps incrementally implemented; we believe that all parties, providers, decision makers, and the general public have a stake in ensuring that these systems are successfully implemented. If mass transportation is to be successful, we are going to need a full spectrum of public services the public can rely on, both so that those who are transit dependent have full service and so that we can attract more people away from the automobile. We should think in terms of going after the larger share rather than talking about a small piece of the pie and how we are going to serve that.

GALLAGHER: I am in agreement with the statements that have been made in summary here. There cannot be two sets of rules, one for government-owned operations and another for private-enterprise companies. It is hard to imagine putting publicly owned transit systems back in the private sector; neither do the taxicab companies care to become government owned and operated. It seems reasonable that the government agencies involved should seek the most cost-effective method of providing urban public passenger transportation. The taxicab industry believes that, in certain modes of operation, its productivity and cost performance are superior. Therefore, in order to seek an equitable arrangement in public passenger transportation, the industry has advocated that (a) the rider be subsidized, (b) contractual arrangements be entered into for public passenger transportation with the private companies that are the most cost-efficient, and (c) direct subsidies be provided for capital improvements and operating expenses to private companies that are currently providing services at costs below the replacement and operating costs of the new system. The ITA strongly favors the first recommendation and hopes that the additional recommendations will not need to be implemented.

JAMIESON: I think APTA has taken a first step to build a bridge between the transit industry and the paratransit industry. It has encouraged its members to cooperate in this subject and to get the various operators in urban areas to become more involved in paratransit services. I think the transit industry is in a position to provide cooperation in building up the market and serving the public in the spreading urban areas.

ROOS: I must say I'm very encouraged by the closing statements. Although there were tremendous differences in the opinions expressed here on a variety of subjects, the participants seem to be very close together in terms of some general objectives that we are aiming for. It's important that we try to achieve those objectives in a cooperative fashion rather than look for areas of conflict and that we take whatever opportunities there are in areas where little or no conflict occurs.

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