DEMAND-RESPONSIVE TRANSPORTATION SYSTEMS

Special Report 136

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FOREWORD

Leon M. Cole
Professor and Director, Graduate Program in Community and Regional Planning, University of Texas at Austin

Research on demand-responsive transportation concepts began in the 1960's and was first widely reported in "Tomorrow's Transportation: New Systems for the Urban Future," the summary report of extensive studies on new systems of urban transportation conducted by the U.S. Department of Housing and Urban Development and published in 1968. That report identified demand-responsive transportation as the most promising new concept that could be implemented in the relatively near future.

The Massachusetts Institute of Technology, a major contributor to the early research of such concepts, sponsored the First Annual Conference on Demand-Responsive Transportation Systems in the summer of 1970. That was a 1-day conference at which M.I.T. researchers presented their findings. In September 1970, the Highway Research Board's Committee on New Transportation Systems and Technology and Purdue University sponsored a 2-day conference that brought together both researchers and operators of demand-responsive transportation. By the summer of 1971, 3 demand-responsive systems had been implemented and several other systems were planned for implementation during the next year. Reports were given on these systems at the Second Annual Conference on Demand-Responsive Transportation Systems, a 2-day conference sponsored by M.I.T. in the summer of 1971.

Because interest in demand-responsive transportation continued to increase and because conferences served as one of the best communication channels between operators and researchers, the Third Annual Conference on Demand-Responsive Transportation Systems was held in June 1972. This special report contains the presentations and discussions of that conference. The Massachusetts Institute of Technology and the HRB Committee on New Transportation Systems and Technology were joint sponsors, and the Ann Arbor Transportation Authority and the Highway Safety Research Institute of the University of Michigan also participated. More than 125 persons from transit and taxi industries, labor unions, manufacturers, government, consulting firms, and universities attended. In addition to papers and discussions, field trips were scheduled to inspect the Ann Arbor demand-responsive system and also the work being done by Bendix, Ford, and General Motors.

The Committee on New Transportation Systems and Technology is pleased to sponsor this publication of the conference proceedings. It is the second in a series of reports on demand-responsive systems and services. The first, "Demand-Actuated Transportation Systems," Special Report 124, contains the proceedings of the 1970 Purdue Conference. We are aware of the widespread current interest in information about changing developments in demand-responsive transportation. The material in this report, prepared by such a broad cross section of people who have been gaining experience and learning lessons in implementing innovative transportation systems concepts, represents the most current information of its kind on demand-responsive transportation installations.

INTRODUCTION

Daniel Roos
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Demand-responsive transportation systems provide flexible personalized point-to-point service in response to individual travel requests. Typically, there are no fixed routes and schedules. Instead, a dispatching center receives telephone calls from customers and assigns vehicles to service the customers. The objective of the dispatching operation is to provide efficient, direct service to each customer, to group customers with similar origin-destination pairs on the same vehicle, and to reduce the cost of service to each passenger.

Demand-responsive transportation systems complement conventional fixed-route and scheduled systems. In low- and medium-density areas, they can provide a total transportation service where conventional, fixed-route buses are not economically feasible. In high-density areas, they can provide feeder service to line-haul facilities and thus fill the existing void between conventional transit and taxi service.

Many different types of demand-responsive service are possible. These include dial-a-bus, dial-a-ride, demand jitney, demand-actuated road transit, computer-aided routing systems, genie, telebus, call-a-ride and taxi-bus.

The l'Ecole Polytechnique, under contract to the Transportation Development Agency of Canada, is preparing a 5-volume manual to aid those interested in the design and implementation of demand-responsive systems. A short report was given at the conference on the progress of that project, and portions of the first volume are included in this Special Report. All but two of the other papers presented at the conference are also included. They can be grouped into two categories: those that deal with implementation of specific systems and those that deal with general issues concerning many systems. Some of the papers were formally written for publication, but others represent transcripts of oral presentations. The latter were edited by the conference committee chairman and by the HRB editorial staff for clarity and conciseness.

Bonsall described the oldest implemented demand-responsive system, which is in Bay Ridges, Ontario. That system is primarily intended to serve as a feeder to the GO Transit commuter railroad, although more recently it has been expanded in the off-peak hours to a general area-wide service. The system in Regina, Saskatchewan, described by Atkinson, primarily serves a feeder function to a fixed-route bus line but also provides a more general area-wide service. Aex discussed the operation of the area-wide system in Batavia, New York, that also replaced a fixed-route bus system. The Columbus, Ohio, system, described by Habig, and the Buffalo, New York, system, described by White, are examples of demand-responsive transportation in Model Cities areas. Oxley reported on several demand-responsive systems that are operating in or proposed for cities in England.

Two papers are included on the federally sponsored demonstration project in Haddonfield, New Jersey, a community served by the Lindenwold Hi-Speed Line. Gwynn and Simpson discuss the operation of the system, and Medville describes a user survey conducted by the technical monitors of the project.

Three papers on the Ann Arbor system include one by Lax, the city attorney, on the legal aspects of demand-responsive transportation, and his discussion will undoubtedly be helpful to others who are involved in implementing similar systems. The other two papers contain reports by Urbanik on the operation of the system and by Berla on the public's response to the system.

The general papers include one by Elliot on the relation of the transit workers' union to demand-responsive transportation, one by Guenther on the role of private industry, and one by Gustafson and Navin on the results of surveys of user preferences.

All of the implemented systems are currently manually dispatched, and for that reason the two reports by Cherry and Davidson are particularly interesting. They describe computer-dispatching systems that have recently been implemented in their taxicab companies. Wilson and Higonnet further discuss the use of computer-dispatching of demand-responsive vehicles.

The decision to publish the conference proceedings was made for several reasons. First, they contain the most current information on demand-responsive transportation systems. Second, the conference had an unusual cross section of participants and ideas representing many different organizations concerned with transportation. Third, the experiences gained by those who have implemented demand-responsive systems are valuable for the implementation of similar or new systems.

The presentations were made by drivers, owners, and operators of various implemented systems. Their intent was not to present scholarly papers but rather to explain their systems from their perspectives. One of the principal objectives of the conference was to bring together people from many different orientations to focus on an area of common concern. Therefore, there is a wide variation in the approach used for each presentation. An attempt was made during editing not to destroy the original flavor that each author wanted to convey.

The Fourth Annual Conference on Demand-Responsive Transportation Systems will be held in September 1973. Those interested in attending or presenting a paper should write Daniel Roos, Room 1-181, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

DIAL-A-BUS: GUIDELINES FOR DESIGN AND IMPLEMENTATION

> This is part of a 5-volume manual that is being produced to aid those interested in the design and implementation of a dial-a-bus system. The manual will contain information on all aspects of dial-a-bus from concept to operation and is being prepared by l'Ecole Polytechnique de Montreal under contract to the Transportation Development Agency of the Ministry of Transport, Canada. This portion of the first volume is included in this report to provide background information on demand-responsive transportation.

In January 1971, W. G. Atkinson, transit manager for Regina, Saskatchewan, suggested to Harry Walker, Mayor of Regina, that some of the city's most pressing transportation problems could be solved by a new mode of public transit that could substantially reduce the transit deficit. He pointed out that the new system could improve transportation in areas of low population density, eliminate waiting outdoors for buses (Regina winters often have subzero temperatures), pick up passengers at their doorsteps, take them to their destinations quickly and comfortably, cost each passenger only 10 cents more than a regular bus ticket, operate at low cost during both peak and off-peak hours, cover most of its operating expenses, require a relatively small capital outlay, and create more jobs than other transit alternatives.

By the end of 1971, after 4 months of experimental operation in southwest Regina, dial-a-bus surpassed many of the objectives originally established for it in the Regina telebus feasibility study. Passenger revenues are close to covering operation costs. The system has carred a winter average of about 1,200 passengers daily and as many as 2,200 on some bitterly cold days. The summer average is lower, about 650, but that is to be expected.

The dial-a-bus concept is no longer an abstract idea. Since 1964, it has been implemented in more than a dozen municipalities in North America and Europe. Though dial-a-bus is still in its experimental phase in Canada, Regina has not been the only city to start such a system. Bay Ridges, Ontario, has experimented successfully with it, and this transit option might well succeed in your community.

DIAL-A-BUS IS DESIGNED TO FILL A GAP

Dial-a-bus is basically a hybrid between a bus and a taxi system. It is designed to fill a need not met by other available transportation modes. It combines the door-to-door flexibility of private automobile travel with the economy of public transit, and it provides a greater mobility to persons who would otherwise lack the opportunity to travel.

An additional advantage is that it can be implemented as a primary system in small communities that do not yet have a transit service. Or it can be grafted onto existing systems either by replacing some bus routes suffering from low patronage or by adding more convenient feeder access to other conventional lines. Unlike less flexible transit modes, dial-a-bus needs no fixed routes, and, because small buses can be used, narrow winding streets are not out of bounds.

HERE'S HOW IT WORKS

When a person wants to go somewhere, he phones the dial-a-bus number and gives a dispatcher his address, destination, and the time at which he wants to be picked up. The dispatcher passes the information on to one of the bus drivers assigned to the area. The driver prepares his route from a list of customers' addresses and picks up each passenger at or near his doorstep.

For a guranteed pick-up time, a passenger can phone for a dial-a-bus up to, say, 20 minutes before his planned departure time. The amount of advance notice needed depends on the length of the route. The bus arrives at the passenger's door within a few minutes of the time set by the dispatcher. When he steps on board, there is usually a seat waiting for him.

Regular subscribers who use the system are assigned to the drivers in advance and are given priority over casual users.

A passenger can phone for a dial-a-bus with less advance notice if he is willing to take a chance that a bus is en route near his home. Each bus is radio-equipped, and a driver can handle occasional last-minute requests radioed to him by the dispatcher, if they do not disrupt the route.

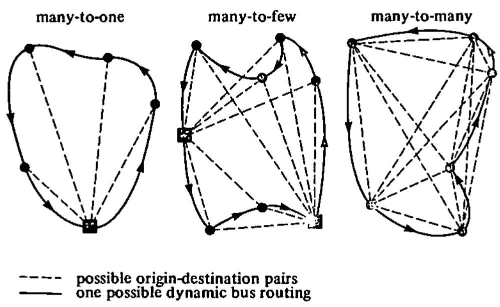
Dial-a-bus is adaptable to a wide range of routing and scheduling possibilities. For example, the Ontario community of Bay Ridges has set up what is called a many-to-one (many origins, one destination) service between commuters' homes and a commuter rail station. Regina provides an example of a many-to-few service, which connects directly to schools, nursing homes, shopping centers, and main bus routes. A many-to-many (many origins, many destinations) service is offered in Batavia, New York. These service patterns are shown in Figure 1.

FLEXIBLE BUT SIMPLE

From the customer's point of view, the attraction of dial-a-bus is its simplicity: It is convenient and easy to understand. From the planner's viewpoint, the system's attraction is its flexibility: Nearly all the elements are adjustable. The buses can be small, medium, or large—anything from an 11-seat modified van to a 42-seat bus. They can be modestly appointed or furnished with luxuries such as indoor-outdoor carpeting, air conditioning, and music. Not only can the routes be planned to satisfy demand, trip by trip, but the level of service can be easily adjusted without the customer's being affected or even being aware of the change. Dial-a-bus can operate a fleet of 2 vehicles or 200. The dispatching system can be manual at first and computerized later as fleets become larger.

If there is a computerized dispatching and monitoring system, the customer, instead of requesting a bus from the dispatcher, can phone the dial-a-bus number, dial a few additional digits, then hang up. The additional digits signal the size of his party, the time at which he wishes to be picked up, the address of his destination, and a user identification code. The call is routed directly to the central dispatching computer. The computer determines which bus is best able to serve the customer and assigns it to pick him up.

Figure 1. Dial-a-bus service patterns.



ADDRESSES URBAN SOCIAL NEEDS

So far we have been enumerating certain advantages particular to dial-a-bus systems. Although dial-a-bus is flexible, simple to use, and somewhat superior to conventional bus service, these are not the only attributes that justify its implementation. The real case for dial-a-bus emerges as one examines the social and transportation problems that now face the contemporary urban community, for it addresses social needs in a manner that conventional modes are hard pressed to match. The following 4 sections are devoted to a more detailed discussion of this subject.

The Low-Density Fact

The number of people living in low-density fringe areas is constantly rising (Fig. 2). While the size of the city proper (high density) stays nearly constant, low-density development covers an increasing percentage of the metropolitan area (Fig. 3). About 80 to 90 percent of Montreal, Toronto, and Ottawa is low density.

Transportation often appears to be an afterthought in the planning and development of low-density areas. There are a number of reasons for this. Costly transit systems developed for use in large cities cannot easily be adapted to the growing needs and limited budgets of smaller towns. An additional problem is that even complex transit systems cannot maintain the quality of service offered if they operate in sprawling suburban areas. Such overextended systems are characterized by inflexibility, high costs, and unsatisfactory service, all of which have made public transit a poor alternative to the private car.

Figure 2. Population distribution in urban areas.

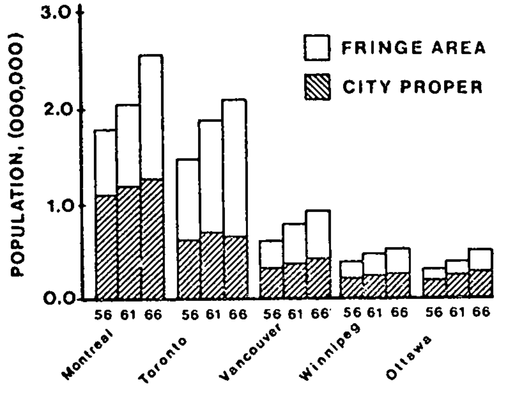


Figure 3. Population distribution in urbanized areas.

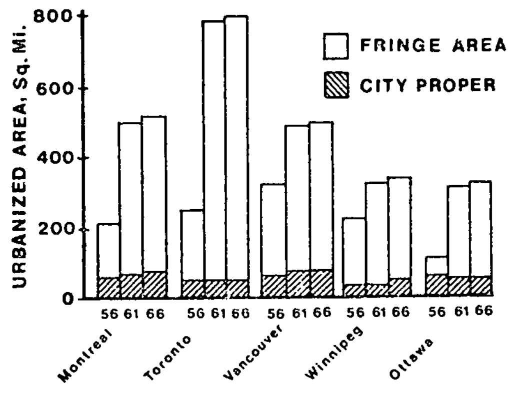
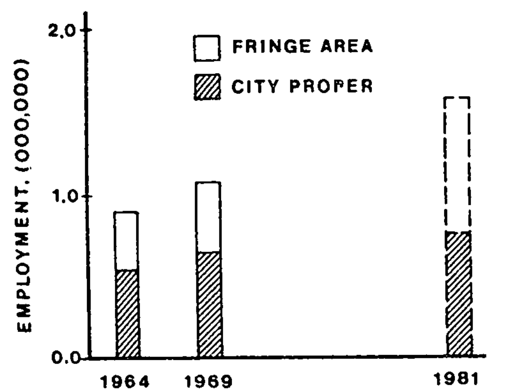


Figure 4. Employment distribution.



The Transportation Challenge

The emergence of low-density areas has significantly altered the shape and the structure of the cities. Of particular interest are the new travel patterns that have in many cases made existing systems awkward and incomplete.

The largest single demand made of local transit still occurs in the daily mass shuttle between home and work. Yet current trends point less and less toward trips to and from the downtown core (Fig. 4). Urban travelers are now likely to travel from home to work and back without ever leaving the suburban fringe. Now that urban populations are becoming dispersed over a greater area, the downtown region has ceased to be the only employment center. Most administrative offices remain downtown, but new factories and other commercial establishments are appearing in the fringe areas. The result is a complex and diffused pattern of trips to and from work.

The same helter-skelter effect is reflected in traffic patterns during leisure hours, as people make more trips to new shopping and recreational facilities in low-density communities. These diffused trips are increasing in number as people have more leisure time.

The work, shopping, and pleasure trips discussed above may be regarded as the noncaptive transit market. A group that presents an even greater challenge consists of people having no alternative to public transit. Included here are the young, the poor, and the aged. At the present time, people who are concentrated in places such as homes for the handicapped or retirement villages are frustrated in their travel desires. Trips to visit friends are inconvenient and expensive, and, in many cases, the work trip is an impossibility.

Social Objectives and New Markets

Dial-a-bus has shown it can trim transit deficits incurred by serving low-density areas. However, it should not be viewed solely as a means for reducing losses. It may be equally important to achieve objectives such as service improvements in transit and mobility for the captive riders as we have shown above. Another feature of dial-a-bus of considerable social importance is that it is labor intensive—a desirable characteristic in an era of spiraling unemployment.

Obviously a large city's transportation system cannot be totally converted to dial-a-bus. The latter is intended as a collection and distribution system for low-density and low-demand areas. Yet, even within a large city, its flexibility allows it to reach passenger markets that traditional transit modes could never serve. It is adaptable to sporadic and infrequent demands such as late night travel. A nighttime dial-a-bus service in downtown areas could attract customers who hesitate to step outside the door because of the rising crime rate and the prospect of waiting on a street corner for the infrequent bus service. Dial-a-bus could also cater to special occasions and needs such as ferrying people home from parties—a solution to New Year's Eve travel!

In Step With Urban Planning

New transportation systems generate commercial, industrial, and residential development. When transportation expansion lags behind fast-paced urban development, the result is haphazard and unplanned growth along its route. Consequently, private developers often seem by default to determine the city structure. However, even if the city were

Figure 5. User locations related to fixed-route service.

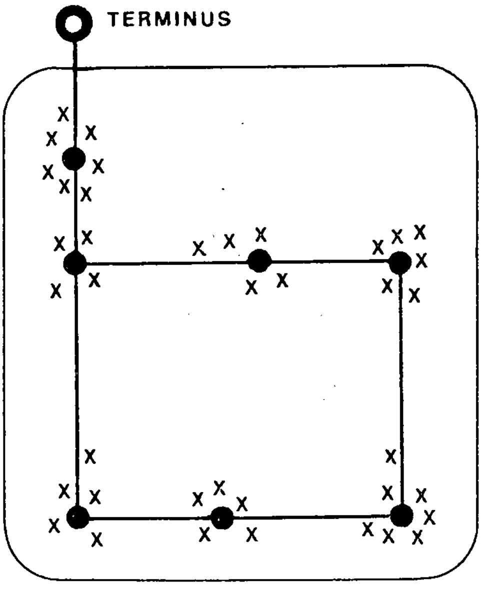
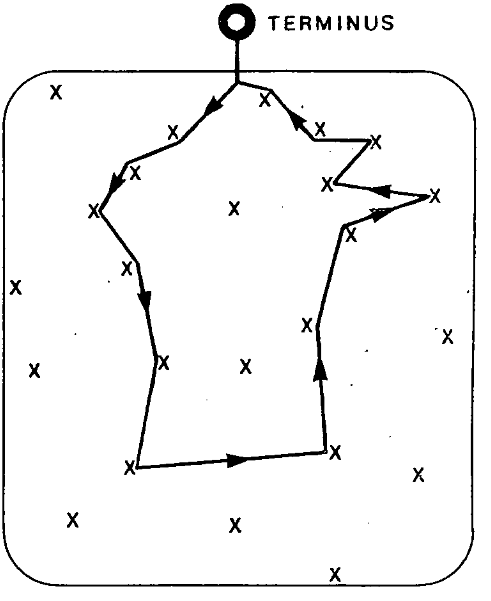


Figure 6. User locations related to demand-responsive service.



given control of developments around transportation routes, existing modes of public transportation would inhibit the ability of planners to establish an urban infrastructure. Dial-a-bus could be a more malleable tool. Because it is flexible enough to serve existing urban housing patterns and can also help structure new communities, it can promote the orderly expansion of cities. Examples of user location related to types of transit service are shown in Figures 5 and 6.

A TESTED SOLUTION

Dial-a-bus is no longer a figment of some planner's imagination; it is a tested system that has already proved itself workable in about a dozen municipalities in North America and Europe.

As early as 1964, the first demand-responsive bus system operated in Peoria, Illinois, as a weekday subscriber service to take workers from their homes to factories in the morning and back again at night.

In 1969, in Mansfield, a town of 60,000 in Ohio, a private transit operator experimented with a dial-a-ride service that linked a residential neighborhood to the town's business district. Via a radio-telephone hookup, passengers whose homes were off the regular route could arrange to be picked up by dialing directly through to the bus driver, who doubled as a dispatcher.

In July 1970, the Ontario government introduced a dial-a-bus experiment in

Bay Ridges, a residential community of 15,000. Dial-a-bus serves as a feeder system for the GO Transit commuter rail line and has succeeded not only as a feeder system but also as this community's first internal public transit system.

The experiment in Regina, Saskatchewan's capital city, was sponsored jointly by municipal, provincial, and federal governments. The city has a population of 145,000 and a typical low density of 5,000 persons per square mile. Dial-a-bus was introduced in 1971 to replace some bus lines where sagging patronage was creating large deficits.

Both Bay Ridges and Regina have high levels of automobile ownership, and the fact that those 2 experiments work indicates that drivers may leave their cars at home if they are offered a good alternative.

CAN EXISTING SYSTEMS ADAPT?

The problem of declining population densities underlines the need for a transportation system flexible enough to serve areas with a scattered range of origin and destination points. It is, therefore, clear that, if public transit is to succeed, it must be able to evolve with the city's growth and remain responsive to its future needs. Yet most conventional modes fail to meet this criterion. It is interesting to see in what respects existing modes are inadequate.

Rail transit (either commuter rail or subway) can carry a high volume of passengers at a low fare. Trains are comfortable, dependable, and fast. But they have no routing flexibility: Their tracks can neither shift with changing transportation patterns nor service more than a few primary arteries of heavy traffic flow (usually in and out of the city center). To the extent that railroads are geared to meet the needs of the white-collar commuter, ridership is concentrated in the rush hours. However, large installation costs and high ridership requirements make it impractical for small- and medium-sized cities; low-density growth areas on the outskirts of large cities limit its practicalness there. Even where rail is required to serve high-volume corridors, there remains the need to collect and distribute passengers to and from the stations.

Bus systems with sizable patronage can provide a high level of service at a low fare; capital costs comprise the purchase of vehicles and garage facilities. Buses have a medium capacity, have some routing flexibility, and can travel on most city streets. However, in new low-density areas, winding street patterns preclude systematic coverage by bus. More important, because demand is more spread out in those localities than in the older high-density areas, service is less convenient. Many homes in fringe areas lie so far from the scheduled stops that the bus does not offer residents a practical alternative to the private automobile. As a result, its passenger volume suffers.

Automobile travel is comfortable, accessible, and reasonably fast. Because its route is almost unrestricted, it offers the most flexibility. But it does not provide a very economical solution to urban transportation problems: The average car in urban use carries only 1.4 persons per trip. Many trips involving 2 passengers or more are made for persons other than the driver. Children who are chauffeured to and from school are in this category. Forty-five percent of Canadians are nondrivers. These include those who cannot afford cars and those who because of age or physical disability cannot drive them. For both groups, taxis provide little alternative because fares are too high to permit their regular use.

No published data have been found on the total number of taxis operating in Canada. However, it has been estimated that some 25,000 are in service. Though it is a highly personalized service, the high costs involved do not, in general, permit regular taxi travel.

Though dial-a-bus systems can offer similar services at a lower cost to the user, the taxi business will not necessarily suffer from this competition. First, there will be individual transportation needs that can only be met by the faster, more flexible, and more personalized taxi service. Second, even in small towns, dial-a-bus serves a market quite different from that of taxis because it is designed to lure drivers out of their private automobiles and to replace inefficient bus routes. Further, taxi companies can act as operators of dial-a-bus systems. A number of shared taxi services already embody some aspects of dial-a-bus.

Even this brief account has demonstrated the inadequacy of existing modes. The inflexibility of rail and bus lines, the high costs of taxis, and the shortcomings of the private automobile—all of these weaknesses argue for an alternative that incorporates the strengths and avoids the pitfalls of conventional transit options.

DIAL-A-BUS IS A DEMAND-RESPONSIVE SOLUTION

The private automobile is the mode over which the user exercises the most direct control. Though it is convenient, parking usually presents a problem, and, where the vehicle is shared by a family, it is not always accessible. Dial-a-bus is an attempt to create a form of public transit that is controlled by its users—transit that is demand responsive. It is for this reason that dial-a-bus can compete with the private automobile. Every driver has been subjected to the frustrations that set in when no one is moving. But a traffic jam is nothing more than an overflow of individual drivers acting autonomously in a demand-responsive manner.

Dial-a-bus is demand responsive in a broader sense. By coordinating their requests through a dial-a-bus dispatcher, commuters may ultimately do away with the sort of traffic congestion that private automobiles are responsible for. In addition to reducing pollution and congestion, dial-a-bus can serve those sections of the population that do not have access to private cars.

DIAL-A-BUS EXPERIMENT IN BAY RIDGES

John A. Bonsall
Operational Planner, Ontario Ministry of Transportation and Communications

The Bay Ridges dial-a-bus experiment was planned and designed and is currently being operated by staff of the Ontario Ministry of Transportation and Communications. The experiment was implemented in July 1970 to demonstrate the potential of a demand-responsive transportation mode as a feeder service to a commuter rail facility. The decision to implement a feeder service demonstration project may be traced to an original recommendation of the Metropolitan Toronto and Region Transportation Study, which was conducted during the mid-1960's. This study lead to the establishment in May 1967 of a commuter rail service (GO Transit) linking several suburban communities with downtown Toronto and to a limited experimental fixed-route feeder bus experiment in Bay Ridges, the eastern terminal of the commuter rail system.

Bay Ridges was chosen as the site for the feeder bus experiment largely because it was a well-delineated community with no existing transit service. Therefore, unlike most other communities served by the commuter rail service, there was no existing transit franchise to complicate the implementation of the experiment.

This fixed-route feeder system was operated from May 1967 to March 1968 when it was discontinued because of the low level of its patronage. There was thus no internal transit system operating in the community during the 2 years immediately prior to the introduction of the dial-a-bus service. Ridership on the commuter rail service, however, flourished during this period; 52 percent of the 800 or so daily person work trips originating in Bay Ridges and destined for downtown Toronto were made on the rail system. The 20-mile trip to downtown Toronto takes about 40 minutes whether by road or by rail, and a recent household survey in the community showed that the average driver estimates his trip cost, excluding parking, to be about 82 cents, which is almost identical to the train fare. For those drivers who do pay for parking in downtown Toronto, the same survey showed that the average daily parking cost is about 80 cents.

Bay Ridges itself is typical of many modern Canadian middle-income subdivisions; 94 percent of 3,000 dwelling units are single-family houses serviced mainly by a street system of crescents and cul-de-sacs and, therefore, lacking the through streets necessary for an efficient fixed-route bus system. The gross area of the community including Frenchman's Bay is about 1,200 acres, but the actual occupied area is only 800 acres and houses a population of approximately 14,000. It is not a self-sufficient community, for there are almost no job opportunities available in the area.

The dial-a-bus service designed for Bay Ridges comprises 2 basic components. The most important is the many-to-one feeder service that operates on 20-minute cycles during peak periods and 60-minute cycles during off-peak periods. These cycle headways, of course, are governed by the commuter rail headways. Hours of service are from 5:30 a.m. to 1:00 a.m. the following day. The second service component is an off-peak many-to-few system that has a limited many-to-many capability centerd on the local shopping center and operating from 8:00 a.m. to 4:00 p.m. This service was inaugurated in February 1971 to utilize some of the spare system capacity during off-peak hours. The cycle time for this service is 30 minutes.

Neither the feeder nor the local services require very sophisticated dispatching techniques. In the case of the feeder service, a potential rider simply phones the dispatcher a minimum of 1 hour before he requires service. His request is recorded by the dispatcher in a specially prepared log and then transferred either manually or by radio to the map used by the driver. The driver uses this marked-up map to plan his route through his particular zone. People requiring service from the station simply board the bus at the station and give the driver their destination addresses as they do so. Hence, as he leaves the station, the driver has in his bus a map marked with both pickups and drop offs he must make before returning to the station at the next train-arrival time.

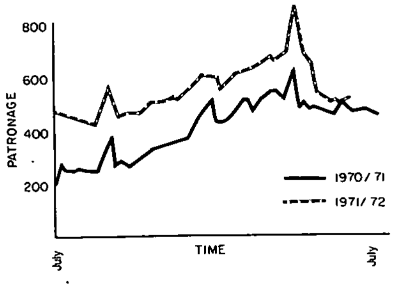
In peak periods a total of 4 buses are allocated to the service; each one covers 1 of 4 zones. This equipment requirement is reduced to only 1 vehicle in the off peak except when the local service is operational. During this latter period the addition of 1 further bus allows the operation of a 30-minute-cycle service that meets at both the station and the local shopping center. Each bus is assigned to one-half of the community and sweeps its assigned zone every 30 minutes before returning to the shopping center where a passenger can make a free transfer to the bus allocated to the other zone. The call-in time for this service is ½ hour as opposed to the feeder service's requirement of 1 hour. Apart from this, the service's operation is essentially similar to that of the feeder service.

The buses used in Bay Ridges are basically a special conversion of a Ford Econoline van costing about $7,500. Perimeter seating for 11 passengers and details such as the raised roof and lowered entrance step are provided. Our experience in Bay Ridges suggests that the 11-seat vehicle used there is too small and that a 15-seat arrangement would have been more appropriate.

Figure 1 shows the total average weekday patronage experienced by the experiment during its first 2 years of operation. Although typical seasonal variations and the influence of special events in Toronto are apparent, a continuous growth in patronage is exhibited. The current annual average daily patronage is about 530 although a high of 980 was reached last March. The patronage of the local off-peak service, which represents about 20 percent of the total daily patronage, has been analyzed as to the percentage of true many-to-many trips made. It would appear that only 24 percent of the trips can be so classified. Overall operating statistics for the experiment show that the average trip productivity per mile is 1.5. Interestingly enough, this figure is fairly similar to that exhibited by the Regina telebus service.

Inasmuch as a fixed-route service was operated in the community sometime prior to the introduction of the dial-a-bus, it is interesting to compare the operating characteristics of the 2 types of transit service. It should, however, be noted that the fixed-route service was was limited to peak service only. The route system was a 1-way loop typical of that provided in many low-density subdivisions. The fare was initially 10 cents

Figure 1. Weekday patronage.

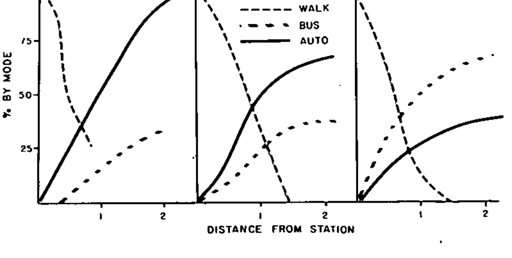


but was raised to 20 cents, and both use of fixed stops and flagging of the bus were encouraged. A survey done at the time showed that 60 percent of the riders could be classed as captive to the system. When a comparison is made between the trip productivity per bus mile of the 2 services, it is apparent that dial-a-bus often exceeds the productivity of the fixed-route system.

Figure 2 shows probably the most significant result of the Bay Ridges experiment, which is the change in the use of the 3 modes used to reach the GO station. Seven months after implementation, dial-a-bus had become the most popular means of getting to the GO station. The significance of this result is underlined by the situation in Bay Ridges of free parking at the station and an average dial-a-bus fare at the time of the survey of 22.5 cents. This same survey showed that some two-thirds of the present dial-a-bus patrons can be considered as noncaptives. Since the data shown in Figure 2 were compiled, there has been a further increase in dial-a-bus riders.

The magnitude of the impact of the dial-a-bus service on trip-making within Bay Ridges may be explained partly by the high level of service offered. As an example, the average trip time on dial-a-bus is 6.7 minutes,

Figure 2. Access mode to station.



which compares very favorably with that of the private automobile. In terms of coverage, dial-a-bus by its very nature covers 100 percent of any community being served. For a fixed-route system, current thinking suggests that the catchment area extends about $\frac{1}{8}$ mile on either side of a bus route. Applying this parameter to the situation in Bay Ridges shows that the original fixed-route service was within this distance of the majority of the community's residents. The considerable increase in transit riding on dial-a-bus, as compared to that on the fixed-route bus, must, therefore, be largely a function of the door-to-door service provided.

Analysis of the current ridership by time of day and direction shows the very peaked nature of the service demand. Approximately 64 percent of all riding occurs in the morning and evening peak periods. The directional split shows greater riding from the station than to it. The household survey determined that it was the availability of a ride in the 1 direction that accounted for the majority of this imbalance. Only 8 percent of the 1-way riders stated that the inconvenience of making the phone call was the reason for their unequal use of the service. The implication of the directional nature of the trip-making and also of the fact that 80 percent of the trips to the station during the morning peak are actually prebooked on a weekly basis is that there is considerable spare dispatching capacity within the existing system.

We have analyzed the dispatching demand and have determined that the practical limit for a 1-man system is about 50 calls per hour. This means that the present Bay Ridges dispatcher could handle a 50 percent increase in trip-making before a significant increase in dispatching manpower was required. Incidentally, our analysis of the dispatching demand also showed that even after several months of service about 4 or 5 information calls on the average per hour are still made.

The analysis of annual costs and revenues showed that about 50 percent of the costs are now being covered by revenue. The pertinent data are summarized below.

Costs	
Fixed	$ 2,000
Semivariable	13,000
Variable	
Drivers	42,000
Dispatcher	18,000
Vehicle	8,000
	83,000
Revenue	41,000
	$42,000

The current deficit of $42,000 is for a 6-day-a-week, 20-hour-a-day service, which is significantly more service than communities of the size of Bay Ridges usually have. If evening service were curtailed after 8 p. m., the deficit could be reduced to about $30,000, which is not out of line with the deficits of many of the smaller transit operations in Ontario. These figures must be viewed with some caution, however. The driver's wage rate of $3.64 per hour is below that of many public systems, and the impact of increasing this rate may be judged from the fact that 72 percent of all costs are attributable to the driver's wage rate. Further examination of the trip-making and associated costs by time of day shows that, if all capital and other fixed costs are charged to the peak-period trips, the cost per trip varies from 50 cents for the peak to $1.36 for trips made on a Sunday; the average is 55 cents. Better dispatcher utilization could reduce this figure, for some 31 percent of off-peak costs are attributable to the dispatcher. Costs average 80 cents per bus mile of which 24 percent is dispatching cost.

Unfortunately the homogeneous nature of the Bay Ridges community has precluded any investigation of the influence of socioeconomic factors on dial-a-bus ridership. The only factor of any significance that was determined from the household survey was the predominance of 1 car/2 driving license households among the population using dial-a-bus as compared to the total community population.

As a result of an evaluation of the dial-a-bus system that was carried out in July and August 1971, certain operational and service changes were recommended. These changes included the elimination of Sunday service, the curtailing of evening dispatching and its replacement with an answering service, and the raising of the fares from 25 cents cash and 20 cents ticket to 30 cents cash and 25 cents ticket. The changes were all implemented in May 1972. Since then, costs have obviously been reduced by the elimination of the Sunday service and the reduction of evening dispatching. Our initial impression of the changed dispatching system suggests that its effect on evening ridership is minimal. The evaluation of the fare increase impact on the other hand is complicated by the larger influence of seasonal ridership variations. A comparison of the ridership since the fare increase with that during the same period last year shows no decrease in the dial-a-bus patronage. Further analysis is required to determine what impact the fare increase might have had on the overall growth in patronage.

The following initial conclusions can be drawn from the Bay Ridges experiment.

1. Dial-a-bus can compete successfully with the private automobile for work trips in low-density areas;
2. Dial-a-bus is a premium service that will tolerate a premium fare in middle-income areas; and
3. For line-haul transit, dial-a-bus must be considered as an alternative or supplement to park-and-ride service.

For the Bay Ridges design, the minimum average trip cost is about 50 cents.

INFORMAL DISCUSSION

Question: Is weather a significant factor in dial-a-bus ridership?

Answer: The winter of '71 made people start using the dial-a-bus system. But the important point is that once people used it they stayed with it. Two-thirds of the people who use it say that they are not captive to the system but have alternative transportation. Nearly 70 percent of the people who used the old fixed-route system were captive to it; that is, they had no car. Why has this happened? One factor is trip time. The average trip time on dial-a-bus is about 6 minutes and on the fixed-route bus was about 12 minutes. The latter time did not include access time. That 6 minutes compares quite favorably to the time it would take you to get into your car and drive it from the station to your home.

Question: Is that the time in the vehicle?

Answer: That is the time from getting off the train to getting off the vehicle at your home.

Question: Is any of that time spent waiting for the vehicle?

Answer: No, the vehicles are there. You get off the train, walk a few yards, and get on the bus.

Question: What happens if you do not use the train?

Answer: The time is slightly longer, but you wait in your own home. And, if you are a regular user, you, of course, design your schedule around the regular vehicle-arrival time.

Question: What is the average wait per passenger?

Answer: We require a 1-hour calling time, but on the local service we reduce that to ½ hour. We do not advertise that we will accept people on a shorter calling time than that; but, if there is capacity on the bus and it is in the right place, we can pick up people within a few minutes of the call-in time.

Question: What is the average trip time to the train station in the morning?

Answer: About 2 or 3 minutes for those who have booked regular service to meet the train.

Question: Do the buses, then, essentially pick up the same people every day and carry them to the same place?

Answer: During the morning peak, 80 percent of our riders are regular riders who are booked by the week.

Question: How many hours is each bus driver on duty?

Answer: We use some part-time drivers for the peaks, but those who are full time work for 8 hours.

Question: What share of the households have used dial-a-bus at any time?

Answer: Our household survey indicated that about 70 percent of the households have tried the dial-a-ride system.

Question: Has any consideration been given to a subscription service to eliminate the dispatcher?

Answer: We have discussed this but feel that there is enough work for the dispatcher because there are enough trips being made that are not on a regular basis.

Question: When the weather is bad and there is an extra heavy load of people so that the driver cannot make his rounds in time to catch the train, what happens?

Answer: The dispatcher has the final say in controlling the buses, and he can, in those circumstances, reallocate his own boundary. For instance, a zone 1 bus might pick up some people in zone 2 if there is a heavy demand. If there is a heavy demand throughout the community, we do have a standby bus that we can use if necessary.

Question: How many dispatchers do you have?

Answer: We have 3; 2 are on duty during the day.

Question: What is the average fare?

Answer: Before the increase, the average fare was 22½ cents. Now it is about 26½ cents.

TELEBUS PROJECT IN REGINA

Wallace G. Atkinson
General Manager, Regina Transit System

Regina is the capital of Saskatchewan and has a population of about 140,000. It is located approximately 600 miles due north of Denver and was built on the prairie; every tree in this city was planted, for there are no natural trees. The downtown is relatively new, and most of the large buildings have been built in the past 10 years.

The Regina system and the one in Bay Ridges are quite similar in that they are manually dispatched, and they provide neighborhood service to few destinations (55 percent of the riders go to the central business district). The difference is that the Regina system is fully integrated with an existing transit operation. The telebus system carries about 5 percent of the total transit patronage in the city. In addition to CBD trips many other services are provided; 35 percent of our passengers go to local destinations, and about 10 percent go to schools within the area. So, it is roughly 10 percent many-to-many, about 35 percent many-to-few, and about 55 percent many-to-one. Telebus serves about 6 major destinations in the area—the government complex, 2 hospitals, and 3 shopping centers. The Regina ridership curves are not quite so steep as those for Bay Ridges; there is heavier off-peak usage of the Regina system.

On September 7, 1971, the telebus pilot project was put into operation (Fig. 1). After 4 months of operation, serving an area of about 3 square miles and a population of 18,000, the public's reaction to the tele-bus system had already guaranteed its future success. On Thursday, January 27, 1972, the pilot project was slightly more than 4 months in existence, and no fewer than 2,200 people traveled by telebus in a single day. By March, some 100,000 passengers had been carried on the new service.

Telebus begins with a phone call from your home. The dispatch office radios the driver in your area, and the driver includes your address in his route. You are picked up and delivered to your door when you want to travel.

All kinds of people use telebus: teachers, nurses, housewives, businessmen, and grade-school and high-school students—every segment of society. For the first time, the aged, the handicapped, and the young are able to travel on their own without assistance from friends or relatives.

Regina's version of telebus is designed as a feeder system. Passengers are transported to a transfer depot where they board a full-sized bus to travel to their final destinations. They return to the transfer depot by the connecting service and continue to their homes by telebus. The answering service receives calls anytime during the day or night. Regular customers may book service in advance and thus eliminate the necessity of making daily phone calls. The telebus then simply arrives at its specific time each day, and the service becomes as routine as getting out of bed. You find yourself getting to know the driver and the other regular customers on your route, and soon you are traveling with a

Figure 1. Regina telebus.

group of friends rather than total strangers.

To transit management, telebus is an exciting answer to the growing needs of an expanding city. Because telebus replaces more costly fixed-route buses and provides better service, it is receiving enthusiastic support from city councils. But the greatest response of all is from the passengers—the people who have found their kind of transit service. They love it, and they will tell you so.

Our total transit system carries about 8 million passengers per year. Usage in the city on the regular system is about 60 rides per capita annually. This usage is considerably higher than that in a comparable city in eastern Canada or in the United States because of the past history of transit service. The Regina system has been city-owned and -operated since it started in 1911, and, with the exception of a few years in the 1920's and a few years in the 1940's, it has always been subsidized. As a matter of policy to keep the fares as low as possible, it is subsidized at the rate of one-third the cost of providing the service, which roughly covers the capital and administrative overhead. Our fares are similar to the Ontario fares but are lower than those in most large cities in Canada and in the United States. Because of subsidization policies in western Canadian cities, transit fares have been kept low and usage has remained high. On the telebus, an adult pays a 35-cent fare and gets a free transfer to the regular system. Coming back on the regular system, he pays 25 cents and another 10 cents when he gets on the telebus with the transfer. So, one can go anywhere in the city for 35 cents. Statistics on operations, fares, and costs per revenue-mile for both the telebus and the fixed-route systems are given in Tables 1, 2, and 3. Additional statistics on initial and increased telebus operations are given in Table 4.

In summary, I would like to say that the public votes with their feet! In Regina, we have 400,000 votes for telebus. In Bay Ridges, and in Ann Arbor, there are similar responses. Cities that have put

Table 1. Fares and ridership for 1971-72 winter.

Item	Fixed Route	Telebus
Fares, cents		
Adults	25	35
Students	15	25
Children		
Cash	10	15
Tickets[a]	6.7	11.7
Senior citizens	16	26
Public passes[b]	18	25
Avg	19.5	29.0
Percentage of riders		
Adults	47.3	58.4
Students	13.0	8.3
Children		
Cash	6.0[c]	11.1
Tickets	6.0	3.5
Senior citizens	11.8	8.3
Public passes	15.9	10.4
Total	100.0	100.0

[a]Plus 5 cents.
[b]Surcharged 10 cents on July 1, 1972, but not included here.
[c]Estimated.

Table 2. System operations for 1971-72 winter.

Item	Fixed Route	Telebus
Operating vehicles	66	6
Operating hours	164,000	16,200
Operating mileage	1,710,000	183,000
Annual passenger trips	7,575,000	305,000
Population served	122,000	15,200
Trips per capita	62	20
Area served, square miles		2.75
Demands/bus hour	46	18.8
Demands/square miles/hour		21
Schedule speed	10.4	10.7
Passengers/mile	4.42	1.76
Operating speed	—	12.6
Average vehicle tour, miles	—	4.0
Capacity utilization, percent	80	50
Transfers, percent	22	54

Table 3. Costs per revenue mile.

Item	Fixed System	Telebus
Operators' wages	0.55	0.52
Fuel and maintenance	0.18	0.18
Capital	0.17	0.12
Overhead	0.21	0.37
Total	1.11	1.19

Table 4. Initial and revised telebus operations.

Item	Winter 1971-72	Winter 1972-73
Area served, square miles	2.75	
Peak		2.75
Off peak		5
Population served	15,200	
Peak		18,000
Off peak		32,000
Future addition		30,000
Service interval, minutes		
Weekday peak	15	nc
Weekday off peak	20	nc
Week night	40	nc
Saturday	20	nc
Hours, a. m. to p. m.		
Weekdays	6:30-11:35	6:00-11:35
Saturday	6:45-9:35	nc
Number of vehicles		
a. m. peak	6	12
Off peak	3	8
p. m.	6	10
Noon	5	8
Night	1	2
Saturday peak	5	7
Passengers per day		
Avg	1,200	2,000
Maximum	1,955	3,500
Demands per bus hour	20	22
Avg fare, cents	29	32
Vehicle tours, minutes		
Peak	30	nc
Off peak	20	nc
Nights and Saturday	40	nc
Scheduled speed, mph	10.7	nc

Note: nc = no change.

in an integrated system have had similar successes and are still on a growth curve. I estimate that Regina has only tapped 50 percent of the market in the initial system. We are expecting to go to about 3,000 passengers per day during the 1972-73 winter in the existing area.

We had had a tremendous amount of publicity across Canada, and it is filtering into the United States. The public is absolutely demanding this kind of service. They are asking for it in London, in Ontario, in Winnipeg, in Vancouver, in Pasadena, in Hollywood, and anywhere the public has seen any publicity. Sit down with any person that has never heard of this system before, and in 10 minutes you have a wildly enthusiastic passenger. It is an automatic reaction: "If we had that kind of bus service in our community, I would ride." And they do. We proved that they do; many people who ride the telebus were never on a bus in their lives before. We are getting people who could not start their cars on a cold morning and took the bus and then continued to take it. We are getting the young children who had to be driven everywhere by their parents but who can now safely ride the telebus. There are children on the system who are going to day nurseries. How many 3- and 4-year olds can ride a regular transit system safely? We have handicapped people who cannot walk to a bus stop. We have people with cystic fibrosis, muscular dystrophy, asthma, and other handicaps so that they cannot walk to a bus stop, cannot stand in the rain, or cannot walk on a dusty day. We have a door-stop service for these people. We are also catering to all sorts of other special needs. If the system has any trouble, we can call the passengers at home and tell them what happened.

Our biggest problem at the moment is that we cannot get the equipment manufacturers to build the type of equipment we need. This applies to both the buses and the communications systems. This is where the big hold-up is going to be in expanding these systems. The software has been developed, but the hardware is limited. I hope that we can put as much pressure on as many city councils, politicians, and equipment manufacturers as we can so that they will get busy and develop and implement the system that the public is demanding. I think the public has already voted for this system. The revolution is coming! And if transit managers do not get involved, it will roll right over them like a steam roller. That is why we got involved, and that is why other transit people are getting involved.

INFORMAL DISCUSSION

Question: In the peak hour, does one have to walk to a station? What is the walking distance?

Answer: People have the option of walking to the main-line station or being picked up by tele-bus at their doors. There are about 1,500 apartments within 3 blocks of the main line to which tele-bus passengers transfer. We have people who ride as few as 2 blocks on a rainy day and are quite willing to pay 35 cents to do so.

Question: What are your thoughts on carrying school children on the telebus system?

Answer: Carrying school children puts a peak load on top of the normal work-trip peak load, although shifted somewhat. The work peak occurs at 8:00 in the winter and at 7:30 in the summer, when we go on earlier work hours. School trips peak between 8:30 and 8:45 (school starts at 9:00), and we can accommodate that peak with buses that have finished carrying work trips. But serving the school peak load is expensive. It requires more equipment, and, of course, the children's fares are only 15 cents. But we think we have to provide a total service to the community.

Question: What difference is there between your peak and off-peak service intervals and your peak and off-peak vehicle tours?

Answer: In the peak period, the vehicle tour is 30 minutes. We lap 2 vehicle tours 15 minutes apart, and so there is 15-minute service. In the off-peak, we run a 20-minute vehicle tour, and there is just 1 bus in each area; we provide 15-minute service in the peak period and 20-minute service in the off-peak period. The main-line buses run every 15 minutes in the peak period and every 20 in the off-peak.

Question: Apparently, you have a variety of equipment. Can you say anything about what good luck or what bad luck you have had with this system?

Answer: We operated the system all winter and carried heavy peak loads with a standard 42-passenger transit bus equipped with radio. And about all we did was paint a green stripe on it. Now to do this was pure hell, because it went down to 40 below zero on January 27, and we could hardly steer the bus. The normal transit bus is not equipped with power steering. It became almost impossible to get up and down the crescent streets. But we operated all winter long and carried the peak loading. It was not until March 1972 that we received our small vehicles. The success of the system in severe weather was with the big equipment. We think we will have greater success now that we have the small buses. We have two 14-passenger Dodge Maxi-Vans. They are about a foot and a half longer than the buses used in Ann Arbor and in Bay Ridges. We have in addition a 23-passenger Flxette in service and more 14- and 18-passenger vehicles on order. We are also using a unibus that seats 23, similar to the one used in Bay Ridges. It has a good body shell, but it has been mounted on a truck chassis, and so it rides like a truck. We have had to completely rebuild the suspension system because the people in the back seat were being thrown a foot in the air! If the driver hits a bump, up they go! The kids love it; it is usually full of kids in the back seat. We have had endless problems—broken springs and shock absorbers that keep tearing loose from the frame. I will not mention the supplier, because these problems apply to every piece of truck equipment in transit service today. They are all lousy! We do not have a decent, air-ride, small bus for this kind of service. We expect to buy 7 buses by this winter. Frankly, we do not know what to buy. I think I can safely say, at this moment, there is not a sufficiently reliable small transit bus in the 20-passenger range available. I may get some frowns from the manufacturers, but we have looked at 7 different companies and have not found an acceptable small transit bus. We think there is a real technology gap between the type of equipment that we need and the type of equipment that is available. If anybody can come up with a transit bus in the 20- to 24-passenger range, we will be very happy. We think there is a big market for it.

Question: What is the ratio of buses required to population served?

Answer: Our original feasibility study estimated 1 bus for 700 dwelling units, but we think that can go up with demand. Present demand is 21 passengers per square mile per hour. We think that 1 bus can handle a square mile at a demand level of about 35 per hour. We think that we can run 20-minute vehicle tours and carry about 12 persons per tour, which would be about 36 per hour. At those loading capacities, we would break even on operating costs.

Question: How many months in the winter do you have weather so bad that an automobile would have trouble steering or traveling through snow?

Answer: The write-up we got in Time magazine indicated that it was 20 below in Regina all year round! Actually we have very severe weather from about January 10 to the end of February when temperatures are 35 to 40 below at night and up to maybe 0 in the daytime. This presents problems in driving cars. However, I would not want you to believe that a demand on this system is created because the weather is cold; any bad weather—rain, wind, dust, heat, and so on—affects ridership. If we had a rain shower this afternoon in Regina, the passenger level would go up by 100. When the women get their hair done, they do not want to walk in the wind, and so they get on this system.

Question: Is that another way of saying that if the weather were nice all the time, like it is in Miami, you would not have so many passengers?

Answer: Not at all. People do not like to walk in hot weather either but prefer to ride in air-conditioned buses. The weather is anything but nice for walking around in Miami. And, of course, it rains down there, too!

Question: How do the drivers feel about this system? Are they bidding for this work?

Answer: The drivers do bid for this work. There is a certain amount of status in being involved in the new system. We did not preselect drivers. We let them bid in the order of seniority, but we reserved the right to remove a driver if he were unable to handle the run. Some of them have asked to get off after they tried it because they did not like the barrage of information coming over the radio. Our drivers come from the middle third of the seniority list. The oldest drivers will not touch it (they do not want to learn anything new, for they are waiting for retirement), and the youngest drivers do not get a chance to get at it.

Question: What is your street pattern like?

Answer: The street pattern in Regina is almost identical to the one in Bay Ridges—crescents, cul-de-sacs, and bays. In some cases we cannot get into those bays in winter, and so we phone the people and ask them to come out to the end. But we have operated under zero visibility, under 40-below conditions, and under heavy blizzards. We got a bus stuck in a snowbank one night and had to take everybody's telephone number and radio them to the dispatcher who telephoned their homes to say, "Your daughter (or your wife or your husband) is stranded on such-and-such a street, and we'll get her home when we can." This is a very personalized service, and you can do this sort of thing.

Question: Is the driver self-routed?

Answer: Yes, the driver is completely self-routed and, in some cases, after 2 weeks, he does not even need a map. He keeps it all in his head.

Question: Your services are directed to shopping centers. Is there any special telephone for people to use?

Answer: No, we do not have any, but we have considered installing special telephones. In the heavy-use areas, there are 4 nursing homes: One has 350 employees, another has 200, and a couple are small. We have considered putting direct lines in those. Our system was pretty crude last winter. We just used normal telephones and had no fancy equipment. In October 1973, we are going to triple the system. We are going to have a new communication system—fancy radio-telephone dispatching, direct phone to the bus driver in the off-hours, and a full super-deluxe system with provision for teleprinters and all kinds of computer equipment. We expect to have 60,000 residents on the system by October.

Question: Would you elaborate a little on who is riding the system?

Answer: Everybody is riding. We have children as young as 3 years, senior citizens, and business people. The heaviest riding is coming from the high-income families (average home $40,000 and average income $25,000). Over half of our passengers come from families that own 2 or 3 automobiles. The other half comes from 1-car families. I guess the average car ownership in the area is about 1.6 to 1.7 per household. We have taken pictures at 10:00 a.m. on a weekday at a 3-car home where the garage doors were opened and 2 cars were in the garage and 1 was on the street. The cars stay home unless there is some special need to go across town. I might add that parking in Regina is fairly cheap (about $15 per month), and it is free at the government buildings.

Question: When you take away the fixed-route buses, which are reasonably cheap, and put on the market expensive telebus, what about the low-income people and their attitudes toward this?

Answer: Maybe I should have started out by saying that in Saskatchewan we live in a "welfare state". Furthermore, it is a myth, you know, that transit is for the poor. Certainly, there are poor in our community, and there are people who need assistance. The people on welfare, the people who really cannot afford the fare, and the handicapped people are given a pass that is paid for by the state. They pay nothing on the system, but we get the full value for the pass from the state. The in-between areas where there is high demand from low-income groups will have both fixed-route service and telebus because the demand is high enough to provide both. People in those areas will have a choice of fixed-route service or deluxe service. Anyone in those areas unable to walk to a bus stop will get a telebus pass paid for by welfare funds. We think this is the way to go.

Question: What is the bus-driver wage rate?

Answer: Driver wage rate is among the highest in the country—about $4.00 per hour.

B-LINE DIAL-A-BUS SYSTEM IN BATAVIA

Robert P. Aex
Executive Director, Rochester-Genesee Regional Transit Authority
Executive Vice President, Batavia Bus Service, Inc.

Batavia, New York, is a small community located half-way between Rochester and Buffalo. It has a population of about 18,000, a wide main street, and considerable automobile traffic.

On June 3, 1971, newspapers in Rochester, where the Rochester-Genesee Regional Transportation Authority is located, and in Batavia, where the bus system operates, reported that the authority was taking over the bus system. The Batavia papers also carried stories for 2 or 3 days about a new concept, dial-a-bus, that was to replace the old fixed-route system.

The buses in the old system were about 13 years old and had traveled about 650,000 miles each. The seats had been reupholstered many times. During 1969-1971 the vehicles were frequently out of service because of breakdowns. Ridership and revenues were decreasing, and expenses were increasing. The annual operating deficit was about $7,000 even though the vehicles were fully depreciated.

The B-Line, the name given to the new dial-a-bus service, was further announced in a descriptive brochure mailed to every address in the city of Batavia. The brochure described the manner in which the B-Line would operate, the fares, the operating hours, and so forth. In addition, newspaper advertising and posters further described the B-Line and the individual services.

Dial-a-bus service was installed on October 11, 1971, when many community leaders were invited to meet at one of the local shopping centers, view the buses, and ride in them in a parade. The old buses were allowed to operate for 14 days after the start of the new system. Then, on October 22, it was announced that the old loop bus was "going, going, gone" to "bus heaven" after 13 years and 650,000 miles.

SERVICE

Batavia is not much different from most communities. Automobiles fill city streets, and traffic congestion is bad at times. In an urban renewal project, cleared land has had to be used on a ratio of 3 to 1 for automobile parking space and for new buildings. Our goal is to break the almost complete dependence on the automobile.

B-Line service is designed to fully meet the transportation needs of people in the community. It provides transportation from any point within the city to any other on a 20-minute schedule. Door-to-door transportation to and from day-care centers, schools, colleges, and work eliminates the need to drive an automobile or be driven in one. B-Line service also includes the delivery of small packages within the city.

Special services are provided for senior citizens who live in a high-rise apartment project on Main Street. Dial-a-bus picks up passengers at the entrance of the project and takes them downtown or wherever they want to go. Two days a week there is free bus service on a Shoppers Special paid for by a local retailer. A local bank also pays for free bus transportation to banks. The bus drivers help the elderly to get on and off the buses and provide any other assistance needed.

Dial-a-buses serve public housing projects and make it easy for women to go shopping accompanied by their children. The buses also pick up and deliver passengers at the front doors of the several hospitals in Batavia.

Service has been expanded several times since it began on October 11, 1971. When service was extended to LeRoy and Stafford, 2 nearby communities, the size of the bus fleet was increased. We started with three 23-passenger Flxettes and have added a fourth 23-passenger Flxette and a 10-passenger Ford Courier.

We recently announced a Bankers Special, chartered by a local bank on scheduled dates, on which passengers may ride free to do banking in the downtown area. Free bus service in cooperation with the local merchants was also offered for shopping trips downtown between the hours of 10 a.m. and 5 p.m. on Thursday, Friday, and Saturday.

COMMUNICATIONS AND RECORD KEEPING

Bus drivers take all their commands from dispatchers by radio. The dispatcher uses a 6- by 4-ft control board, radio, telephone, and magnets. Our productivity goals are 10 passengers per vehicle per hour for general service and 17 for subscription service.

Communication between the base station and the vehicles has been by radio. A 20-ft antenna on top of a 100-ft tower enables signals to be sent and received throughout the service area. Vehicles are equipped with 2-way mobile units: 1 frequency to receive messages and 1 frequency to send messages back to the base station.

Recently, it was decided to experiment with digital communications. An application has been prepared to be submitted to the Federal Communications Commission for permission to install and use radio telemetry equipment. Initially, a 30-day experiment will be conducted through the use of telemetric equipment at the base station and in 2 vehicles. The results will be evaluated, and a decision will be made to order equipment for the base station and all vehicles on a lease-purchase basis for a 6-month trial. If the trial is undertaken, a second evaluation and a decision will be made regarding the use of this equipment. It is hoped that digital communications will reduce voice messages by at least 50 percent and will permit reduction in dispatching personnel required.

Paperwork is kept at a minimum. Drivers carry a vehicle log on the bus while on dial-a-bus service. An inside office form is used as a reservation list for home-to-work or home-to-school service. A route sheet is used by the driver when he is on subscription service. A small form is used by the telephone operator on which to record requests for service.

A few operating reports are important. One shows the number of hours each vehicle operates each day and the hours on each type of service. The totals are carried out for the day and for the week. A weekly ridership report tells management what is happening in the various categories of service and establishes the level of vehicle productivity for each week.

RIDERSHIP

Ridership increased from 944 in the first week to more than 1,500 at the end of the fifth week and to more than 2,000 at the end of the sixteenth week. The fixed-route system carried about 75,000 riders per year, and the B-Line is expected to carry about 100,000 to 110,000 during its first year.

Productivity for dial-a-bus service has ranged from 7.0 to 12.0 and has averaged 9.0. Productivity for subscription services has ranged from 12.0 to 17.0 and has averaged 15.0.

COSTS AND REVENUES

Vehicle operating costs, exclusive of driver wages, have been computed to be

15 cents per mile to cover maintenance and operation including gas, oil, tires, repairs, insurance, and depreciation and excluding administration and debt service. Driver wages are computed at $3 per hour plus 20 percent for fringe benefits. Total system costs per vehicle-hour have been computed to be $13.54 per hour to cover all costs including administration and debt service. Total system costs per vehicle-mile have been computed to be 62.34 cents per mile to cover all costs, including administration and debt service.

After 7 months of operation, income from all sources for the month of April 1972 covered all of the direct operating expenses and part, but not all, of depreciation. Additional income has been developed from advertising, package delivery, and dial-a-bus charters.

Fares are as follows:

To work and return, 10 trips per week	$4.00
To school and return, 10 trips per week	$3.50
To college	$4.00
11 tickets per trip	$0.36
Dial-a-bus, per trip	$0.60
Day-care service, per trip	$0.25
Charters, per hour	$8.00

PROMOTION AND PUBLICITY

We ran coupon ads in the paper that read, "The B-Line wants to know...." Posters were also used to give details of the different services such as those to work, to school, and to college.

Various promotional gimmicks were developed to increase the awareness of the new service. A very successful promotion was in the form of "I Ride the B-Line" buttons. We also offer free tickets to people who have not ridden the B-Line.

We also prepared a brochure that was mailed to government and industry leaders throughout the area.

We have had national publicity in the syndicated column of James J. Kilpatrick, in Nation's City magazine, and in stories written about other dial-a-bus operations throughout the country.

INFORMAL DISCUSSION

Question: Can you say anything more about your proposed use of digital communication?

Answer: We are now controlling these vehicles by the use of radio, telephone, and a control board. We have under consideration a proposal for digital communication—radio and teleprinting. I hope we do try digital communications, but I cannot indicate at this time what action the board will take.

Question: Do you have union drivers? And, if so, how do you get around having to take the packages on and off buses for your customers?

Answer: We do not have union drivers yet. How do we get the drivers to do this and that? Our approach to both union and nonunion people is that, with bus ridership decreasing all over the country (we are losing 6 to 8 percent of our riders a year in Rochester) if we do not do something pretty soon, there are not going to be any jobs for anybody. We must not only expand but also provide service of a new kind—personalized service to people. Drivers, if there will be any drivers' jobs, will have to fill the needs just like the company will have to.

Question: How much of a deficit do you have, and how do you make it up?

Answer: At the present time, the income from all sources—fare box, advertising, package delivery, and charters—

is meeting all of our direct operating ex-expenses and part, but not all, of depreciation. We believe that we will not be very far into the next fiscal year before we will be able to close the gap.

Question: How do you make up the deficit?

Answer: At the present time, we are covering all of our direct operating expenses, and therefore we have a positive cash flow. The deficit that now exists is confined to depreciation. There is no deficit to be made up; it simply means that, if we cannot close the gap by the time these vehicles have to be replaced, we will have to go somewhere else to get the money for new vehicles. We are hopeful that we will be able to do so. In other words, there is a positive cash flow; $200,000 was borrowed to buy the old bus company and to add new equipment. That money is being paid back with interest, and we expect the income to do that also. At the present time, I think we are well along toward our goal, but I would be misleading you if I told you that we had completely made it.

Question: If this service has rates higher than those of the fixed-route operation it replaced, will you have any problem with residents over the higher rates?

Answer: The previous fixed-route system suffered from a very rapid and steadily decreasing ridership. The owners had no capital to replace the equipment, nor did they have the heart to do it because it was a losing venture. The fare on the old fixed-route system was 25 cents. If you compare the fixed-route and dial-a-bus fares, it is 25 cents versus 60 cents; for work service, it is 25 cents versus 40 cents; and for school service, it is 25 cents versus 35 cents. In 6 months, we have increased the ridership 30 percent over what it was under the old fixed-route system.

Question: How many hours per day are you in service and how many days per week is there service? What is the average time for pickup and delivery?

Answer: We have a parameter of 20 minutes that we try to use—20 minutes from the time a person calls, we try to pick him up, and 20 minutes from the time he gets on the bus, we try to deliver him to his destination. We are averaging about 10 minutes. We operate from 6 a.m. til 6 p.m., Monday through Friday.

Question: Will you explain again how you pay for your capital and interest?

Answer: It is paid for out of income from all sources. If there is anything we are sure of, it is that the fare box alone (at these fares) will not cover the load.

Question: What are you doing about working for lower fares in the inner city?

Answer: When we first examined the Batavia situation, we found that one of the greatest sources of taxicab revenues was the welfare department. We are convinced that the primary consideration is not fares but service. Is it service that somebody needs? And is it service that is dependable and reliable? For the kind of service we are giving in the city of Batavia, it is the judgment of the citizens—not ours—that our service is reasonably priced.

Question: What is the wage rate for the drivers?

Answer: Our drivers are averaging $3.00 an hour plus 20 percent fringe benefits. However, we expect that that will be changed shortly. If not by us, then by somebody else!

MODEL CITIES DIAL-A-RIDE SYSTEM IN COLUMBUS, OHIO

William C. Habig
Executive Director, Mid-Ohio Regional Planning Commission

The model cities transit project, which has been in operation since October 11, 1971, is a part of the Columbus Model Cities Program, which is in its second action year ending June 30, 1972. We serve an area on the near-east side of Columbus that is 2½ square miles in size and has about 37,000 people according to the 1970 Census. Of that total, 85 percent are black. Automobile ownership is very low. There is a high need for mobility, and so it is a natural place to put in a dial-a-ride system to give all residents of the area similar mobility.

Before we started dial-a-ride service, we ran fixed-route service for 7 months from March 1 through September 30, 1971. We had originally proposed dial-a-ride as the transit project for Model Cities, but we were not able to implement it because of institutional problems, which I will not discuss. We started the fixed-route service with 45-passenger GMC coaches. All of the buses were furnished by the Columbus Transit Company (CTC), the regional private operator. In this case, we paid charter rates ($9.50 an hour) for the bus, driver, and supervision. All we had to do was develop the routes, manage the project, keep track of the ridership, and adjust the service. We had originally hoped to begin dial-a-ride on July 1, 1971, but because of contract delays we lost another 3 months, and it was October 11 when we finally started the new service.

The fixed-route service was provided by 6 buses operating on 4 routes for 102 bus-hours per weekday. These buses were painted a special color, and they carried about 600 persons during peak hours of an average weekday. There were some 50 bus stops marked with the logo "Ride On" and bus route numbers so that people could easily travel throughout the neighborhood. This project is an intraneighborhood service. It does not go outside the Model Cities area but does link up with CTC radial routes, 6 of which run east-west through the neighborhood. We designed the fixed-route service to go to many key points within the area. Three senior citizen high-rise buildings in the neighborhood provide our most frequent riders. There are 3 major hospitals, 97 churches (which run us ragged on Sunday), and 5 major supermarkets. There is a well-established route between 1 senior citizen building and this supermarket. A library and a YMCA serve as major recreational facilities in the Model Cities area.

At the outset of the fixed-route system, we found that the 45-passenger bus was not maneuverable on the narrow streets and alleys over which we had to operate. Therefore, we started using a 19-passenger Flxette vehicle not only as a solution to that problem but also as a vehicle that met the requirements of dial-a-ride service.

The dial-a-ride service consists of a basic loop with 21 time checkpoints that our dispatchers and call-takers use to schedule the service. This loop is run both clockwise and counterclockwise. During peak periods, we operate 4 buses, 2 in each direction. The 21 checkpoints are marked on a map, and each tour around the line must pass those points but can deviate from the route anywhere between a pair of them. The checkpoints are marked in the field with the logo and the phone number indicating that this is a dial-a-ride checkpoint and a person may wait for the bus at that location. We encourage people to call, however, so that we can give them an estimated pickup time and keep better track of operations.

CTC bought 3 new air-conditioned Flxette buses at our request, and we have a lease-purchase contract with them. These buses cost about $16,000 apiece, and at the end of the project the city of

Columbus can purchase them. We also purchased a fourth bus (used) to provide additional service. The buses are radio-equipped, and we now use a handset (initially, we used a loudspeaker on the bus, but that proved too difficult because communications were heard by passengers). CTC stores the buses at its main garage.

Any resident in the area can dial the number of the dispatch center and request service. We operate from 6 a. m. to 10 p. m. weekdays, from 8 a. m. to 8 p. m. on Saturday, and from 8 a. m. to 7:30 p. m. on Sunday, a total of 51 bus-hours per weekday and fewer on weekends. At the dispatch center, located in the center of the neighborhood, there are 4 phone lines on a rotary. The level of work during the peak period requires 3 call-takers and 1 dispatcher; as many as 50 calls per hour have been received during this period. We are on a very limited budget and do not have typewriters or any other kind of equipment.

The clockwise or counterclockwise direction of the bus is indicated on a call card. The call-takers record name of the person, number in the party, pickup and drop-off addresses, phone number, date, and time.

The dispatch board has separate maps for the 2 directions, the maps are divided into 4 segments. The cards are posted on a drop-off or a pickup peg in the 4 segments on each map. The call-takers give the cards to the dispatcher, who puts them on the hooks and then, as the buses operate, traces their paths by the 21 checkpoints on the map with magnetic markers. The dispatcher calls a batch of cards to the driver as a bus approaches a particular sector on the map. We rely on both the dispatcher and the driver to schedule a tour. The driver is required to record a series of drop offs or pick-ups on his log sheet. (We debated this because of the additional burden it puts on the driver, but we find that this is the best way we can do it under our circumstances.) The driver records checkpoints at which he received a call, the time, the pickup or drop-off location, and the type of fare paid.

We have had problems with people not being available when the bus arrived. Many people will not be waiting outside the building. One woman came out of the house, put her baby on the bus, and went back into the house for awhile. She left the baby to reserve the bus so that it would not go away. Many similar situations have occurred that really hamper the operation. When service was originally designed, we estimated only about ¼- to ½-minute average wait per pickup; actually, the wait is 1 minute and more in many instances. The driver is instructed to go up to the pickup location, blow his horn once if there is no one outside, wait no more than a minute, and then proceed onward.

The fares were set at 20 cents for adults and 10 cents for children at the request of the Model Cities Agency. We think the fare is far too low and should be 50 cents. However, because Model Cities funds are involved, we follow the agency's request to maintain fares at this level. Because of the low fare, the service is heavily subsidized. The adult fare will be 25 cents in the next year of operation.

The loads on the buses vary—our average load is about 9 passengers for a given tour on a 19-passenger bus. There were constant complaints that the old 45-passenger buses were always empty. The productivity of the buses is about 7.6 paid fares per bus hour. Although there are certain key focal points such as hospitals and supermarkets, there is a many-to-many system in which the buses go from any origin to any destination within the 2.5-square mile neighborhood.

The dial-a-ride system also ties into the main system, which is operated by a private company and is losing riders at the rate of about 17 percent a year. We lost a transit levy in the primary election, so that the outlook for public transit in Columbus is rather dim. Had the levy passed, radios could have been installed in the large buses so that they could be linked up better for transferring. As requested by the Model Cities Agency, anyone using a dial-a-ride bus can purchase a 45-cent ticket and use that to board the large bus without paying any additional fare. So, passengers never pay more than the city fare, and, in effect, we carry them free. Only about 5 percent of our riders transfer, however, because so many routes that they can walk to run through the neighborhood.

One of the conclusions that we have drawn from this project is that the fare is much too low, especially for a system that is to continue beyond the Model Cities Program. It is our feeling that, if we are funded for another year, that year may be the last year of this project. We have, therefore, encouraged the city and the residents to raise the fare substantially and to begin to tailor the service so that it can be continued as a neighborhood service. We have not been able to convince them to do so, and the low-fare service to residents will continue during the next 12 months.

All bus drivers are employed by CTC and are union members. We found that they learned the system very quickly and have assisted us by keeping track of destinations far and above what we expected. Drivers can operate several tours that have regular riders without any guidance at all from the dispatch center. The difficulty, though, is that "extra-board" drivers have to be trained each time they come on the system. Every 4 months drivers rebid all jobs, and we have a real training problem on our hands when that occurs.

The ridership is now averaging 350 per day on a 7-day basis and about 400 per weekday. It grew steadily until February, leveled off, and then began to decline slightly during the spring period when the weather improved. We feel that the kind of service now provided with 4 buses and the budget constraints make it impossible to build any more ridership because our waiting times are too long to do so.

We are now going into the third year of the Model Cities Program in Columbus, and we are requesting $300,000 to carry on the dial-a-ride project and to improve the level of service. We have had many breakdowns that have forced us to operate only 2 buses during some of our peak periods, and that has caused problems in rider confidence.

We will continue to have the same setup with drivers. We are paying $8 per driver-hour to the bus company, including wages, fringes, overhead, and profit. In addition, we are paying the company lease costs, storage, and maintenance. Our operating cost that we are paying out to the bus company is, therefore, more than $12 per bus-hour; a normal charter rate that we paid last year was $9.50. One of the reasons for the high level of subsidy is the high costs that we incur by dealing with a private transit company.

During the next year we plan to do a very expensive evaluation of data. We have the call cards (nearly 400 a day), which we are going to convert so we can more readily process them in the computer. We are getting the first reliable transit origin and destination data for innercity residents in Columbus that have ever existed. We think that the data are going to be quite valuable not only for travel on the dial-a-bus project but for overall travel in the neighborhood.

INFORMAL DISCUSSION

Question: What has been the response to the dial-a-ride?

Answer: The response from the neighborhood in general has been good. In fact, a private firm queried residents, and our Project rated No. 1 of 33 Model Cities projects that included housing, health care, and everything else. The reason for the good response is that the service is very visible to the residents. We have had some problems with breakdowns, and some waiting times are longer than we like; but, in general, I think the residents view this service very positively.

Question: How large is the service area?

Answer: The population is 37,000.

Question: What is your level of service?

Answer: The scheduled headways were running 4 every 25 minutes. Our average waiting time is about 25 minutes, and our average driving time is about 25 minutes. This is based on preliminary data and would have to be verified.

Question: Might a taxicab company operate the service?

Answer: Well, it might. We are doing it the way we are because of the taxi franchise and the bus company franchise. At one time, we tried to use taxicabs because they have more flexibility, but we got into real tough political and legal problems and wound up with this kind of an operation.

MODEL CITIES JITNEY TRANSPORTATION IN BUFFALO

Michael White
Monitor, Buffalo Model Cities Jitney Transportation

The jitney program was first proposed by 3 senior citizens and 1 staff member from the Model Cities Agency. These 4 people became a committee to bring about the Model Cities Jitney Program.

The first proposed jitney program was supposed to provide transportation for everyone in the Model Cities Neighborhood area and to be a paid system.

The next proposal was to provide a free transportation service to any persons living in the neighborhood who were blind, handicapped, elderly, or members of any club, group, or organization. The franchised company offered no major opposition to this proposal, and arrangements were made with an established cab company in the area to operate the new system.

The proposed aims of the jitney program are to decrease the isolation of the elderly, the blind, and the handicapped and to help them get to doctors, hospitals, shopping, recreational activities, and back home again safely. The primary goals are to improve mobility of the elderly in general by offering a free door-to-door personalized service that can be obtained simply by a telephone call. The senior citizens call a day in advance to make arrangements for pickups the next day. At the same time they may also make the return trip arrangement, or that can be made the next day when they are ready to return.

The jitney program started on December 15, 1970, in the Model Cities Neighborhood area. The area has a population of 62,000 of which 7,000 (according to the 1970 Census) are aged 50 and older. Only those aged 59 and older are eligible to use the jitney service.

We began our operation with 4 buses. Three were to be used on a day-to-day basis, and one was to be left in the shop for emergencies. However, we found that we used all 4 buses every day, even though at the time we did not have a noticeable number of people riding, because the area was just too large to cover with 3 buses.

On March 3 we put 3 new buses into service, and our total ridership went up approximately 2,000 people that first month. Our return times went from 30 to 20 minutes to less than 15 minutes on the average. Our riders increased more than 25 percent, and we were able to serve many more group trips. We took 2 of the 3 new buses and used them to pick up return trips, carry long-distance trips, help out when the regular bases fell behind, and help with group trips. The third bus was used for emergencies.

We find that practically everyone wants to ride between the hours of 7 and 11 a.m. Between 11 a.m. and 5 p.m., most of the people who went out in the morning return; and from 5 to 10 p.m. ridership decreases. Although the period from 10 to 12 p.m. is slow, we keep our buses operating mainly because of the contract and also because we have a few people who are returning from work and churches.

We serve any Model Cities Neighborhood area club, group, or organization that makes reservations at least 3 days in advance; we do not serve anyone who is aged 59 or under, not handicapped, or not blind unless that person is in one of the reserving groups. (The exception is that senior citizens may be accompanied by someone to give them help or a small child with whom they are babysitting.) Group trips may be as far as 50 miles away.

Buses	From	To
2	7 a.m.	3 p.m.
2	8 a.m.	4 p.m.
1	9 a.m.	5 p.m.
1	10 a.m.	6 p.m.
1	12 noon	8 p.m.

From 7 a.m. to 3 p.m., all 7 buses are in service, and we have no emergency vehicle. At 3 p.m., 2 drivers get off, and 1 driver starts the second shift. At 4 p.m., the last shift starts with 1 driver. Between 4 and 6 p.m. we have only 4 drivers and after 8 p.m. we have 2 drivers.

DIAL-A-RIDE APPLICATION IN GREAT BRITAIN

Philip R. Oxley
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Following the development and demonstration of demand-responsive public transport systems in North America, a number of authorities in Great Britain expressed interest in the system. British Railways in particular would like to establish whether such a system can be effective as a means of inducing additional rail use. In the London area this means off-peak services only because during peak times the railways in this area are already at or close to absolute capacity. Away from this area the service is viewed by British Railways as a feeder to its main lines, which are under increasing competition from road-based transport as more motorways are opened.

A number of subsidiaries of the National Bus Company have also become interested, particularly for small towns. At present these are usually served by longer distance routes that pass through them, but the patronage available is not sufficient to justify the use of conventional vehicles (40+ seats) on in-town services.

Finally, a number of taxi and hire-car firms are also considering the use of dial-a-ride, particularly since the Maidstone application by a taxi company was approved.

None of the services proposed has yet become operational, and the success or otherwise of demand-responsive transportation still remains problematical in the United Kingdom. However, judging by the response to the publicity that occurred when the first 2 proposals (Maidstone and Abingdon) were approved, there seems little doubt that demand-responsive transportation will spread if the early services are successful.

The following sections summarize the 6 dial-a-bus studies that, to date, have progressed the furthest. Locations are shown in Figure 1.

MAIDSTONE

Operator:	Denis Hire Car Company
Service:	Many-to-two, off peak, Monday to Saturday, 2 vehicles plus 1 standby
Fares:	20 pence flat fare and 10 pence for children 3 to 14
Status:	Application granted by South Eastern Area Traffic Commissioners May 3, 1972; service scheduled to commence August 30, 1972

Figure 1. Dial-a-ride study locations as of May 1972.

The service operates between the residential areas of Loose and Coxheath (population 6,000) on the south side of Maidstone and the center of the town. The 2 drop-off points in the town center are at the western end of the main shopping street and at Maidstone East Railway Station. The two pickup points are at the railway station and a midway point on High Street. The hours of operation are 9 a.m. to 4 p.m. and 5:20 to 11 p.m. Monday to Saturday; there is no Sunday service.

The timing of the dial-a-ride bus arrivals and departures at the railway station is designed to meet all off-peak London trains because one of the looked-for results of the service is the increased use of these off-peak trains. They run on headways of approximately 30 minutes.

Passenger requests for journeys from the service area to the town center may be made by telephone to the control office, which is situated at Maidstone East Railway Station. Passengers must call at least 60 minutes prior to the departure times of the trains they wish to catch, although later requests will be accepted if service permits. For the reverse journey passengers may either make their requests direct to the control office (the bus standing bay is immediately outside the office) or telephone if they wish to be picked up on High Street. A free direct-line phone is available by the High Street pickup point. The vehicles are 15-passenger buses built to normal PSV regulations and fitted with 2-way radios.

ABINGDON

Operator: City of Oxford Motor Services, Ltd. (National Bus Company)
Service: Many-to-two, Tuesday to Sunday, 1 vehicle plus 1 standby
Fares: 8 pence flat fare
Status: Application granted by South Eastern Area Traffic Commissioners April 26, 1972; service starts June 4, 1972

The service operates from the residential areas of Abingdon to the town center on Tuesdays and Sundays between 9 a.m. and 9 p.m. On the other days of the week the bus operates on a fixed-route, fixed-schedule basis with a flat fare of 5 pence between the hours of 9:50 a.m. and 3:30 p.m. For the purposes of the dial-a-ride service, this small country town of approximately 18,000 population has been divided into 3 zones, each of which is serviced in sequence.

The control office is situated in the main shopping precinct in the center of the town, and 1 of the 2 pickup and drop-off points is immediately behind it. The other dial-a-ride stop is on the south side of the shopping area by the bus stops used by longer distance bus services.

Requests for service into the town center are made by telephone to the control office (a phone recorder is used when the office is not manned). In the reverse direction, passengers register their requests with the bus driver who does his own scheduling on the outbound tours.

BRISTOL

Operator: Bristol Omnibus Company, Ltd., under contract to British Railways
Service: Many-to-one, Monday to Friday, 2 to 3 vehicles
Fares: 40 pence provisionally
Status: Application to the Traffic Commissioners' Court to be heard in August 1972

The service centers on Bristol Parkway, a new main line railway station that was opened to traffic on May 1, 1972. Most trains run from South Wales to London, but there are also a small number that run to North West England.

The service is designed to meet all train arrivals and departures to and from London and to serve the northern sector of Bristol. The station itself lies about 1 mile beyond the built-up area and at present has only 1 scheduled (30 minutes) bus service. There are no fixed routes for the dial-a-ride buses, but 2 or 3 specific pickup points may be designated at which the buses always call. Otherwise, use of the service to get to the station is by telephone request made to the station booking office. The ticket clerk doubles as a dial-a-ride dispatcher. In the reverse direction, passengers purchase tickets at the booking office, board the bus, and give their destinations to the driver.

At present, 3 share taxis are being operated under a temporary license by the Bristol Omnibus Company pending the introduction of the buses. A flat fare of 40 pence is charged for this service, but it is possible that this may be reduced when the buses are brought into use.

HARLOW NEW TOWN

Operator:	London Country Bus Services, Ltd.
Service:	Many-to-few, 7 days per week, 17 hours per day, 6 vehicles
Fares:	3 to 12 pence suggested range
Status:	Proposal approved by the Harlow Urban District Council and at present lodged with the Department of the Environment for consideration for a government grant

The Harlow-Kingsmoor service is proposed to operate between the Kingsmoor residential neighborhood (population 5,000), a local shopping center (Staple Tye), and the Harlow Town Center (the High). Dial-a-ride vehicles operate on a fixed route through the neighborhood with deviations from that route in response to requests for doorstep service. In some places of the area where it is not possible to provide actual doorstep service because of the physical layout of the area, collection points for small groups of dwellings have been identified. It is proposed to discontinue the existing scheduled bus that serves Kingsmoor after the first few weeks of dial-a-ride operation. Because of the need still to provide a service that can be used by people who do not have access to a telephone, the dial-a-ride service will operate on fixed headways.

The old Harlow service serves the High, a local shopping center (the Stowe), and the Harlow Mill Railway Station (off-peak times only). Unlike the Kingsmoor proposal, the service is routed in response to requests, and fixed scheduling occurs only during off-peak times when London train arrivals and departures are served at the Mill station.

The control office for both services is situated in the center of Harlow and is in contact with the vehicles via mobile teleprinters with radio communications reserved for emergency use. The question of the use of a computer for backup to the manual dispatch system is currently under consideration.

CHELMSFORD

Operator:	Eastern National Bus Company, Ltd.

Service: Many-to-few, 7 days per week, 17 hours per day, 4 to 5 vehicles
Fares: Not yet determined
Status: Proposal under consideration by the operating company

The service operates between a residential area (Galleywood) on the outskirts of Chelmsford and a number of stops in the center of the town including the main bus station, the railway station, and the principal shopping street. It is a fully demand-responsive service in response to telephoned requests for service. Minor changes are proposed to the regular buses that operate in or close by the service area including turning short the one service that penetrates into the area.

The service area has a population of approximately 6,000 and a very wide range of housing types. Second-phase plans have been proposed for extending the service area to cover an adjoining suburb (Great Baddow) and for providing a local many-to-many service within the 2 areas. Such a service involves the use of as many as 14 vehicles.

HARROGATE

Operator: West Yorkshire Road Car Company, Ltd.
Service: Many-to-one, Monday, Tuesday, Wednesday, a.m., Thursday, Friday, Saturday; 2 to 3 vehicles
Fares: 10 pence for adults (15 cents return) and 5 pence for children 3 to 14; short-ride single fares: 5 pence for adults and 3 pence for children
Status: Proposal approved by Traffic Commissioners' Court July 20, 1972; service starts September 25, 1972

The service, known as "Chauffeur Coach," runs among 5 residential areas and the shopping center of Harrogate. Each residential area has 2 inbound and 2 outbound buses per day; for example, the Knox area service is served by inbound buses leaving the service area at 9:10 a.m. and 2:10 p.m. and by outbound buses leaving the town center at 11:05 a.m. and 4:05 p.m.

The service is designed specifically for the shopper, and within the town center the buses follow a fixed route but will pick up and drop off passengers whereever requested. In the residential service areas, the buses follow a fixed route but will deviate in response to requests for doorstep service. There is no premium fare for the doorstep service. Passengers wishing to be picked up at their doors may telephone their requests to a control office; in the reverse direction, they simply hail the bus and tell the driver where they wish to be dropped off. So that stop time will be minimized in the town center, fares from outbound passengers are taken when they leave the bus and not when they board it.

OTHER PLACES

Further dial-a-ride applications that are still in the study stage include East Kilbride New Town, Basildon New Town, Eastbourne, where the proposal was recently approved by the Borough Council, and London.

INFORMAL DISCUSSION

Question: Telephones are not so universally distributed in the United Kingdom as in the United States. Does the lack of telephones give you any problems?

Answer: It is a problem. The average telephone ownership in the United Kingdom is about 40 percent of the households. Some of the areas we are servicing, of course, are significantly higher than that. In some of the better residential areas it is nearly 100 percent. Because there are no telephones, we are cutting off, in effect, a part of the population, or at least making it difficult for them. One possible way around this is to make provision for people to book well in advance; the other way is, of course, to do what we are doing with the Kingsmoor, and that is to introduce some element of fixed routing and fixed scheduling. Telephone ownership is increasing at the rate of, I think, 6 or 8 percent per year so that one must realistically look at dial-a-ride as a service that, if it is going to succeed, will only succeed in perhaps 5 or 10 years. For the moment, we have to accept that we are, in fact, cutting off some of the people.

Question: Will the systems cover costs out of the fare box?

Answer: I think you will have to ask me that in about 3 months. I really do not know yet. The general principle that is being followed in Abingdon is that service ought to pay for its operating costs out of the fare box, but I think the bus company, in this case, would expect that it would not have to cover its capital costs as well. Whether it will cover its operating costs I do not know. It has operated only 1 day so far, to my knowledge, and it did not cover its operating costs on its first day.

DIAL-A-RIDE DEMONSTRATION IN HADDONFIELD

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The Haddonfield Dial-A-Ride Demonstration Project is sponsored by the New Jersey Department of Transportation under a grant from the Urban Mass Transportation Administration. Total funding for the project is approximately $1.7 million; about 80 percent is provided by the federal government, and 20 percent is provided by the state. Revenues from operations are returned to the project and are used to offset costs.

The transportation department has primary contracts with 3 organizations: Highway Products, Inc., to supply 11 standard vehicles and 1 specially designed vehicle for invalids; Transport of New Jersey to supply drivers and maintenance for all dial-a-ride vehicles; and LEX Computer Systems and DAVE Systems to design, manage, and operate the project. In addition, MITRE Corporation is under contract to UMTA to evaluate the program. This evaluation includes analysis of survey data, analysis of operating and revenue data, and preparation of computer software.

The Haddonfield project is similar to earlier dial-a-ride projects, and, although bigger and more complex, it draws extensively on their experiences. In particular, several of the features of the Haddonfield project reflect the work that has been done by M.I.T., Ford Motor Company, and GO Transit.

Haddonfield, New Jersey, a suburban community, is located about 7 miles east of Philadelphia and has a population of approximately 15,000. The PATCO line (also locally called the Lindenwold Hi-Speed Line) runs through Haddonfield; a station is located in the center of town. The trip from Haddonfield to central Philadelphia takes 15 minutes on the Lindenwold Line.

The initial demonstration area includes the entire municipality of Haddonfield, portions of the boroughs of Cherry Hill, Barrington, and Lawnside. The area is approximately 5½ square miles and has more than 25,000 people. This relatively small initial area was chosen to minimize any start-up problems and yet provide capability for controlled expansion at a later date.

Work started in Haddonfield in August 1971, and service commenced on February 19, 1972, after a 6-month preparation phase. The drivers went out on strike on March 1; so, there were only 10 days of initial operation. The strike occurred during negotiation of a new contract between Transport of New Jersey and the Amalgamated Transit Union (it had nothing to do with the dial-a-ride project). The strike lasted 76 days, and service was resumed on May 15. To date, we have completed approximately 5 weeks of operation.

The principal objective of the Haddonfield Demonstration Project is to determine the public's attitude toward and its acceptability of dial-a-ride service; a second objective is to determine the economic feasibility of manually controlled dial-a-ride systems.

We provide 4 principal types of service: many-to-many, many-to-one, one-to-many, and shuttle. The many-to-many service operates 24 hours a day, 7 days a week, primarily because the Lindenwold Line also operates 24 hours, 7 days a week. The many-to-one service is designed to gather commuters in the morning and deliver them to Line-haul stations or their work places. The one-to-many service is used primarily to deliver passengers from the Haddonfield station to their homes in the evening. The shuttle service was instituted to handle high demands for service between 2 primary locations in the service area, e.g., from the station to the Music Fair. It is not a scheduled shuttle but implemented whenever this type of operation is the most

Figure 1. Dial-a-ride bus.

efficient method of handling the demand.

The buses (Fig. 1) seat 17 people and provide room for 10 standees. The vehicles are air-conditioned and have high-intensity reading lights, perimeter seating, carpeted floors, and sizable storage racks. Their short wheelbases and tight turning radii are valuable features for maneuvering on side streets. One vehicle has been specially constructed for the handicapped (Fig. 2). The vehicle has a manually operated ramp in the rear of the vehicle and can accommodate 3 wheelchair passengers in addition to regular passengers. The vehicles have been filled to capacity several times during the first 5 weeks of service, and public reaction to the vehicles has been favorable.

The dial-a-ride office is staffed by controllers who have 4 principal functions: receive calls, schedule, dispatch, and perform clerical and accounting duties. Each controller is trained in several functions so that the system can be

Figure 2. Bus for passengers in wheelchairs.

Figure 3. Typewriter for preparing trip tickets.

operated by 1 or more persons depending on demand; the maximum required to date has been 3 controllers.

When a request for service is received, a trip ticket is typed in duplicate on a specially constructed electrical typewriter (Fig. 3). Information recorded on the trip ticket includes pickup address, delivery address, telephone number, status and number of persons riding, estimated pickup time, and passenger's name. We take the telephone number so that we can inform passengers of any significant changes in their scheduled pickup times.

One copy of the trip ticket, referred to as the pickup ticket, is placed in a black magnetic holder with a pointer. The other copy, referred to as the delivery ticket, is placed in a white magnetic holder. A code is marked on the pickup ticket to indicate the time that the customer expects to be picked up, and other critical data are indicated, such as whether the invalid vehicle must be used or whether an important appointment must be kept. These magnetic holders are then placed on an enlarged map of the service area (Fig. 4), oriented to show the vector from pickup to delivery point. Colored markers are later placed in the pickup and delivery holders to indicate which vehicle will be used. Each bus has its own color code, and the colored markers trace the route for each bus. As the bus travels along its route, the holders are taken off the board and are given to the dispatcher (Fig. 5), who relays the information to the driver.

The scheduler makes the decision about which vehicle to assign for each passenger on the basis of a number of algorithm and pattern recognition techniques. In essence, he is trying to maximize vehicle utilization while meeting the constraints of each passenger's expectations.

Communications are usually initiated by the drivers when they call in by 2-way

Figure 4. Scheduling map.

Figure 5. Dispatcher's console.

radio at each stop. The driver is then given and records the next stop and the next-but-one stop. Thus, if the driver gets to his next stop but cannot get through on the radio, he can go ahead without delay to his next-but-one stop. At all times, the control center knows which passengers are on each vehicle and the approximate position of each vehicle.

The system provides an exceptional level of security as a result of instant driver communications that can be relayed to police, identified passengers, position of each vehicle known to within a few blocks, locked fare vaults, and door-to-door service. In fact, at night drivers use high-intensity flashlights to illuminate paths to a customer's door if requested.

The drivers have between 20 and 35 years of experience as bus drivers. We were concerned that there would be retraining problems with drivers who had this amount of seniority. But that did not happen; they learned very quickly. They like their work, perform it well, and, in fact, have become our best public relations and sales staff. Numerous letters and phone calls have been received complimenting drivers on their politeness and considerate actions.

There are basically 3 fares: 60-cent cash fare, 50-cent discount ticket sold in books of either 10 or 40 tickets, and 40-cent senior citizen or group and family ticket sold in books of 10 tickets. Group and family tickets may be used by 3 or more persons traveling together to and from the same pickup and delivery points any hour on Saturday, Sunday, and holidays and between 9:30 a.m. and 4:30 p.m. and 7:00 p.m. and 6:30 a.m. on weekdays. Other tickets may be used any day and any hour.

Subscription service is also provided. A customer may call and make arrangements to be picked up each day at a predetermined time and location. A card is made, and each day the request is automatically processed.

Service at the Haddonfield station does not always require a call to the control room. During the hours from 4:15 p.m. to 6:45 p.m., a commuter may simply look at a zoned map on the station wall (Fig. 6), determine the zone in which he lives, board the bus that has his zone marked in its front window, and inform the driver of his destination. The driver makes up a tour from the addresses given him by the passengers that board his vehicle and in this instance does not have to receive instructions from the control center. The dispatcher does, however, often insert many-to-many trips into the driver's tour, especially on his way back to the station.

Recently, one of our buses participated

Figure 6. Service area and zone map at station.

in an interesting contest between public transportation and the private automobile. Two reporters from a Philadelphia newspaper held a contest to see which one would arrive at the office in Philadelphia first, the one using public transportation or the one using a private automobile. We had no knowledge that this race was taking place. Both participants started out at the same time (midafternoon, nonrush hour) from an apartment building in the dial-a-ride service area. As one reporter left in his car, the other placed a call from a public phone for a dial-a-ride bus pickup, waited 11 minutes for the bus, rode to the Haddonfield station, waited 6 minutes for the train, and then rode to Philadelphia. Although the reporter using the car won the race by about 3 minutes, his costs were a dollar more in terms of bridge tolls and parking. In addition, he had to fight traffic, whereas the reporter on public transportation was able to organize his notes for the article en route.

The manual scheduling system that we have devised can be replaced by a computer if the service area is expanded. The typewriter can be replaced by a teletypewriter or cathode ray tube terminal, and minimal retraining of personnel will be required. The dispatcher console now displays information similar to the type of information that will be presented by a cathode ray tube. We expect to have a computer later this year. It will be tested, debugged, and run in parallel with the manual system before being placed on line. After that, the computer will do the controlling and decision-making, and the manual system will serve as a backup system.

During the first 10 days of operation in February, there were a number of significant problems. The first day of fare collection occurred in the middle of the first serious snow storm of the year, and we had a great number of inquiries. Although we were able to adjust to the high demand, the wait times in some cases were as high as 1 hour. (The local taxi company at the same time had wait times significantly longer.) We also had a lot of false calls during the first few days of operation. The youngsters found out how the system worked much faster than the adults did. Teenagers would place a request that sounded like a valid order. Later, control personnel started recognizing voices and the pattern of the calls and called back to verify the trip request. Now the problem is under control, but there are still a few false calls. Radio interference was also a major problem during the initial start-up. The frequency assigned to the project was shared with a trucking company in New York, 80 miles away. The same weather problems were also shared. Though interference was easily tolerated on ordinary days while drivers were being trained, when the snow storm hit the area the trucks from the trucking company had serious problems and used the radio for long periods. This created a critical situation for the dial-a-ride project. During the strike, a frequency change was requested and approved, and the problem is now entirely resolved.

The familiarity of the drivers with this new type of system also created a problem. The bus drivers were used to driving along a standard route. They had to be taught not only dial-a-ride procedures but names of all streets in the service area. The house numbers in the area are not marked on the curbs and, in many instances, are not marked at all. Thus, the drivers had to learn many individual addresses. They were provided with maps that had all the streets identified and all the house numbers in blocks. During the initial start-up, there were some problems with the drivers getting lost, and this resulted in the dispatcher having to guide some of the drivers around by radio. To assist us in picking up and delivering passengers at night, the customers were requested to leave the lights on at their homes so that the pickup address could be identified easily.

Ridership has been increasing steadily. To date, there is no indication that the demand is leveling off. Weekly ridership at the end of the fourth week was 2,436 passengers. Demand has been primarily for many-to-many service. Shoppers and senior citizens have used the service far more than commuters. As a result, the advertising, which was initially aimed at the community as a whole, has now been shifted more toward the commuter. It is anticipated that many commuters will continue to use their automobiles until they are faced with the need to replace them, and then dial-a-ride, by eliminating a major capital outlay, will look much more attractive. This effect, however, will take several years before it develops fully.

INFORMAL DISCUSSION

Question: Do you not offer more service than you have a demand for?

Answer: At this time we are trying to ensure that capacity is ahead of demand. The overall funding for this demonstration—the $1.7 million—assumes no revenues. All revenues are put into a separate account and returned to the government separately. Therefore, even if we did not take in a dollar, we are still fully funded. That is one reason why we can have the service level somewhat ahead of what the demand is. And we hope to keep it that way.

Question: What will happen after the initial demonstration?

Answer: We anticipate that there will be a computer-operated demonstration that will continue beyond this initial phase.

Question: What do you tell someone who asks whether service will continue after the demonstration?

Answer: We evade the question whereever possible. We imply that it is a continuing operation, and we try to imply that as long as possible so as to encourage people to change their modes. We do not lie, however; if we are asked the direct question, "How long are you funded for?" we tell them.

Question: Do you use a zone scheme for routing buses?

Answer: No, we try to route the buses completely without regard for zones except, of course, when we provide one-to-many service in the evenings. Then, of course, the vehicles are assigned temporarily to a zone.

Question: Do you take deferred and periodic requests?

Answer: We take both deferred and periodic requests. The deferred requests are put on a board and are processed a half hour before the actual pickup is needed. The periodic calls are put on a cardex system, and the tours are made up in the morning.

DIAL-A-RIDE DEMONSTRATION IN HADDONFIELD: PLANNING AND INITIAL OPERATION

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The objectives of this paper are to describe some of the results of the household survey conducted in the Haddonfield, New Jersey, area by the MITRE Corporation before the dial-a-ride (DAR) demonstration project started; to indicate how some of these survey results were used in reaching decisions concerning the initial operating parameters; and to give some of the initial operating results of the demonstration.

The survey was conducted in October 1971 in 4 Camden County communities: Haddonfield, Barrington, Lawnside, and part of Cherry Hill township. The communities are located about 7 miles east of Philadelphia and are linked to Philadelphia by a high-speed rail facility, the Lindenwold Line; a station is located in Haddonfield. The surveyed area has a population of about 33,000 people. Interviews were conducted in about 500 of the 10,000 households. Socioeconomic characteristics of the surveyed communities are given in Table 1.

The objectives of the survey were (a) to measure trip characteristics in the initial service area (i.e., where people went on local trips, how many trips were made, and which modes were used); (b) to determine modal split and characteristics, such as travel time and cost (information concerning modal attributes and their ratings was used to develop a model to forecast demand for DAR); (c) to assess reactions to DAR; and (d) to obtain data that could be used to establish initial DAR operating parameters.

SURVEY RESULTS

Trips

The distribution of work locations is as follows:

Location	Percent
Home	6
Within service area	9
Outside service area	
Use Lindenwold Line	13
Do not use Lindenwold Line	72

The following modes are used for work trips:

Mode	Percent
Use Lindenwold Line	
Use automobile to get to station	78
Walk to station	18
Take bus or taxi to station	4
Do not use Lindenwold Line	
Use automobile	85
Walk or take bus or taxi	15

Table 1. Socioeconomic characteristics.

Item	Haddonfield	Cherry Hill	Barrington	Lawnside	All
Population	13,118	8,646	8,422	2,757	32,943
Black population, percent	1.7	0.5	1.3	90.4	9.0
Area, square miles	3.3	2.5	1.6	1.5	8.9
Households	4,345	2,648	2,484	669	10,146
Mean income/1966 IRS return, dollars	10,365	9,819	6,977	5,410	–
Automobiles/household	1.5	1.7	1.4	1.4	1.5
Workers/household	1.1	1.4	1.2	1.3	1.2
Licensed drivers/household	1.9	2.1	1.8	1.9	1.9
Persons/household	3.1	3.6	3.4	4.0	3.2

Of the estimated 47,630 round trips made to work each week, it is estimated that 15,400 can be made completely or partially via DAR. The remainder of these trips are to destinations that cannot be served by DAR or by DAR combined with other public transportation.

For nonwork trips, 92 percent of the trips within the survey area and 97 percent of the trips to Cherry Hill Mall, a large regional shopping center about 3 miles north of downtown Haddonfield, were made via automobile.

For those people who use the Lindenwold Line, distributions of modal attributes for existing work trips were obtained. It was felt that practically all of these trips could be diverted to DAR. Time and cost of work and nonwork trips by automobile and ratings of modal attributes are given in Table 2. Comfort, convenience, and reliability were measured by the use of the semantic differential. Respondents were asked to rate the mode on a scale from 1 (very uncomfortable) to 7 (very comfortable).

Importance Ratings

After attribute values were obtained, respondents were then asked to rate the importance of these attributes. The importance ratings obtained generally agree with the results of other such studies. People in 250 of the households surveyed were asked to rate the importance of these attributes for work trips, and people in the other 250 households were asked to rate the importance of these attributes for nonwork trips. Results are given in Table 3. Both groups rated trip cost as being least important and reliability as being most important.

User Reaction to DAR

About half-way through the interview, respondents were given a description of DAR and asked whether they could use the service. As expected, 75 percent of the people who currently use the Lindenwold Line for work trips stated that they could use DAR for trips to the station. Of those people who were not using the Lindenwold Line, however, only 25 percent thought they could use DAR. Most of these people stated that DAR, either by itself or in combination with another mode could not take them to their work destinations because they were outside of the envisioned service area. (Of those interviewed, 72 percent did not use the Lindenwold Line.)

Based on the current volume of work trips made in the service area and on the reactions to DAR obtained in the survey, it is estimated that about 3,000 round trips a day could be diverted to DAR. This

Table 2. Time, cost, and attribute rating for automobile mode.

Type of Trip	Time (min)	Round-Trip Cost (cents)	Rating: Comfort	Rating: Convenience	Rating: Reliability
Work trips					
To station	7.4	35	6.0	6.3	6.4
Nonwork trips					
Within survey area	9.2	48	6.3	6.2	6.4
To Cherry Hill Mall	17.2	65	6.3	6.1	6.3

Table 3. Mean attribute rating for existing modes.

Attribute	Work Trips	Nonwork Trips
Time	6.1	5.2
Cost	4.8	4.7
Comfort	5.7	5.3
Convenience	6.3	6.2
Reliability	6.6	6.4

is the maximum size of the work-trip market, and it is not expected that this trip volume will be achieved.

About half of the households surveyed indicated that they would make additional trips if DAR were available. The mean number of additional trips per household was 2.0. Information concerning the amount of latent demand that actually is being satisfied by DAR will be obtained in future on-board surveys.

The most frequent reason given (42 percent) by those who thought they could not use DAR was that trip destinations were outside of the proposed service area. Thirty-six percent of those who did think that they would use DAR stated that they were satisfied with their current mode (usually the automobile).

Those respondents who thought that they would use DAR were then asked to indicate a reasonable fare, travel time, and waiting time for various types of trips. The mean for work and nonwork trips is as follows:

Item	Work	Non-work
1-way fare, cents	25	49
Travel time, min	12.5	13.3
Wait time, min		15.0

These values were considered in establishing initial fares and times.

About 10 percent of the people living in the service area are aged 65 and older. For persons in this category, respondents indicated mean fares to be 53 cents for those under age 65 and 41 cents for those over age 65. The randomization test for 2 independent samples revealed that these distributions were significantly different at the 0.05 level. For this reason, the DAR fare for older citizens was set 10 cents lower (40 cents versus 50 cents) than fares for other people.

Respondents were also asked to rank the relative importance of various DAR attributes for work and nonwork trips (Table 4). Fare is ranked quite high for DAR but was ranked as being the least important for existing modes. Thus, there may be some inconsistencies in people's thinking with respect to their attitudes toward the cost of various modes.

Table 4. Mean attribute rankings for DAR.

Attribute	Work Trips	Nonwork Trips
Waiting time	1.7	2.1
Fare	2.8	2.5
Door-to-door service	2.8	2.5
Travel time	3.1	3.4
Comfort of vehicle	4.7	4.4
Attractiveness	5.8	5.8

Initial DAR Attributes

Partially as a result of the household survey, the initial DAR service area was established in all of Haddonfield, that part of Cherry Hill Township that was surveyed, and those parts of Barrington and Lawnside that are north of Interstate 295. Although it is somewhat smaller than the survey area, this initial service area is about 5.4 square miles in size and contains 8,200 households. In addition, several local shopping malls lying at or beyond the perimeter of the service area are also served by DAR. Respondents in the household survey expressed a strong interest in having DAR service to these shopping areas.

Based on survey data, initial DAR fares and times were set as follows:

Item	Amount
Fare, cents	
Cash	60
10-ticket book	50
Persons over 65	40

Item	Amount
Fare, cents	
Children	None
Travel time, min	10 to 15
Wait time, min	10 to 20

INITIAL OPERATING RESULTS

Ridership

Figure 1 shows weekly ridership during the 11-week period since service began on May 15. DAR has served 27,435 passengers during this period.

Figure 2 shows average ridership on weekdays, Saturdays, and Sundays. The average number of weekday riders was 495 during this period; the peak was 580 passengers on June 23. The greatest number of riders was generally carried on Fridays, and the lowest number was carried on Sundays. Saturday ridership exceeded the average for weekdays during the first week of operation and again during the week ending June 11, when it reached a daily peak of 402 passengers. Since that time, Saturday ridership has leveled off somewhat, with a mean of 297 passengers per day. Sunday ridership during the 11-week period has remained relatively constant, increasing from a low of 92 passengers per day during the first week of operation to a mean of 136 passengers per day for the period from June 11 to July 30.

The hourly ridership on a typical weekday is shown in Figure 3. (Data shown in Figures 3 through 9 were obtained on 5 weekdays: June 8 and 16 and July 10, 18, and 26.) Trips between 9 a.m. and 4 p.m. account for 45 percent of the daily total. About 20 percent of daily trips are made between 4 and 7 p.m., and about 7 percent are made between 7 and 9 a.m. The last percentage may be low because

Figure 1. Weekly ridership (May 21 to July 28, 1972).

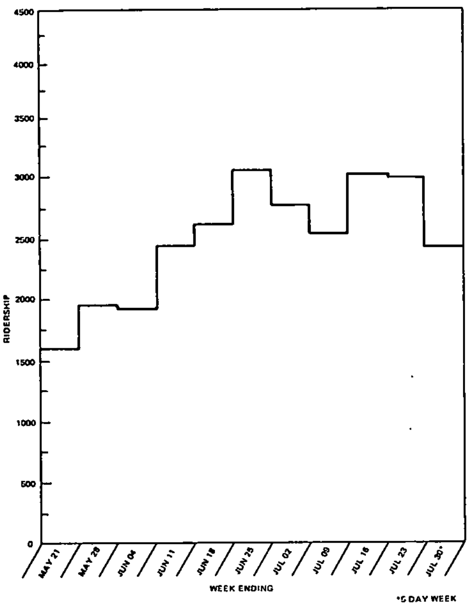


Figure 2. Average ridership on weekdays, Saturdays, and Sundays (May 21 to July 28, 1972).

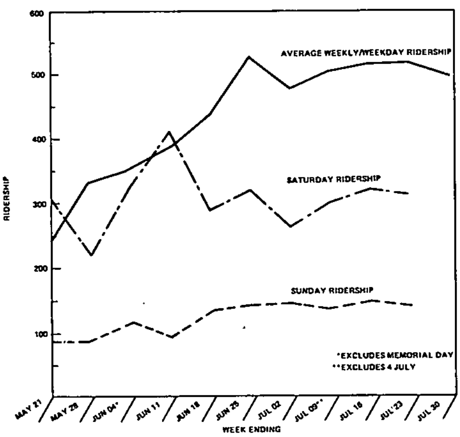
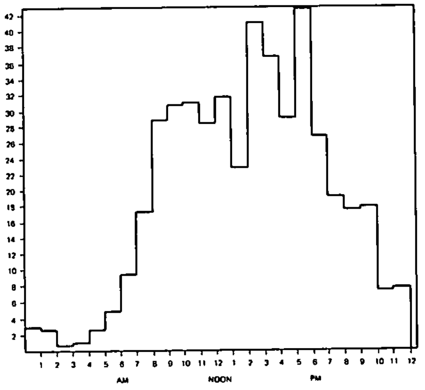


Figure 3. Average number of riders.



many service area residents live within walking distance of the station or because those who travel to the station by automobile have not yet changed their commuting habits.

The average number of riders, standard deviations, and percentage of weekly total from June 19, 1972, through July 30, 1972, (excluding July 4) are given in Table 5.

Vehicle Productivity

Vehicle productivity is defined as the number of requests received per vehicle per hour or day. It depends on the number of requests for service received and the number of vehicles available to service these requests. Vehicle productivity, however, should not be viewed as the only measure of system performance.

For a given demand rate, a large number of vehicles in operation will result in both a relatively low vehicle productivity and a high quality of service because waiting and riding times will be short. As the number of operating vehicles is reduced, productivity will increase, because each vehicle will carry more passengers, and quality of service will decrease, because there will be fewer vehicles to service customer requests.

Average hourly weekday vehicle distribution and average hourly vehicle productivity are shown in Figures 4 and 5. During the first 11 weeks, the number of requests for service was low with respect to the number of vehicles in operation. Consequently, the average productivity was 4.09 passengers per vehicle-hour. One reason for this is the experimental nature of the project. Another is that the hourly vehicle distribution during a 24-hour period was based on the typical hourly transit demand

Table 5. Average ridership and standard deviation by day of week.

Day	Mean	Standard Deviation	Percent of Weekly Total
Monday	446.3	26.26	15.19
Tuesday	491.8	48.23	16.73
Wednesday	525.7	34.78	17.89
Thursday	512.8	36.61	17.45
Friday	528.3	27.65	17.98
Saturday	299.3	21.44	10.18
Sunday	134.7	9.65	4.58
Total	2,938.9		100.00

Figure 4. Average number of vehicles in use.

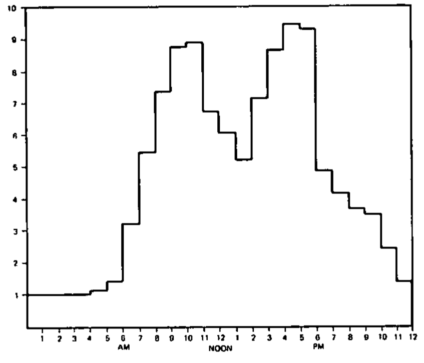
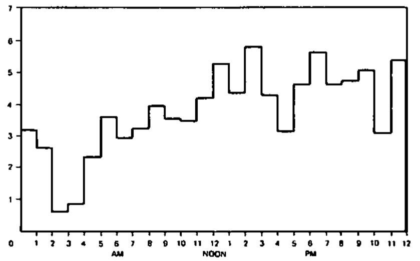


Figure 5. Average vehicle productivity.



distribution, and this has not been the case.

Productivity on a typical weekday between 5 and 11 a.m. reflects the relatively small use being made of dial-a-ride by commuters and the relatively high number of vehicles in service. Productivity between 11 a.m. and 4 p. m. is above average because the vehicle supply dips during this period and ridership continues to rise. Between 4 and 5 p.m. productivity dips sharply but then rises and remains above average from 5 to 10 p.m., reflecting a fairly good fit between vehicle supply and requests for service. A better match between supply and demand in the other hours of the day is expected after the driver rebid in September 1972.

Average hourly ridership, vehicles in service, and vehicle productivity by period of the day for the 5 representative weekdays are given in Table 6. Vehicle productivity is highest in the 2 off-peak periods—9 a.m. to 4 p.m. and 7 to 11 p.m.—reflecting the nonwork trip use that dial-a-ride is receiving in these periods.

Table 6. Average ridership, vehicles in service, and productivity by time period.

Period	Riders	Vehicles in Service	Productivity
7:01 a. m. to 9:00 a. m.	23.00	6.35	3.62
9:01 a. m. to 4:00 p. m.	31.54	7.30	4.32
4:01 p. m. to 7:00 p. m.	32.73	7.83	4.18
7:01 p. m. to 11:00 p. m.	15.40	3.45	4.46
11:01 p. m. to 7:00 a. m.	3.97	1.39	2.86

Quality of Service

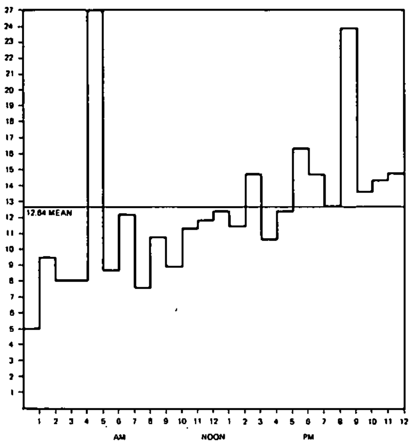
The quality of service greatly influences the number of riders attracted to dial-a-ride. Although quality of service may connote a combination of factors, it is considered here to consist only of time—average wait time, pickup time deviation, and ride time.

Three types of dial-a-ride trips are offered: immediate, deferred, and periodic. An immediate trip is one that the passenger wants to start as soon as possible. A deferred trip is one that the passenger wants to start at some specified time in the future. A periodic trip is one that is made regularly, at the same time, to the same destination, on the same day or days of the week. One telephone call initiates periodic service.

Wait time is the time elapsing from the end of the telephone call requesting service to the time the vehicle arrives to pick up the customer. Of the three types of trips serviced by dial-a-ride, wait time is a measure of quality of service for immediate trips only. Three factors contribute to the average weekday wait time of 12.64 min (Fig. 6). The first is the time required to execute the control room procedures, i.e., assigning the trip to a vehicle, notifying the driver of the location of the pickup, and recording data. The second factor is the time required for the vehicle to travel from its current location to the pickup point. A third factor is a delay by the passenger who is not ready when the vehicle arrives.

Beginning with the early morning hours,

Figure 6. Average wait time.



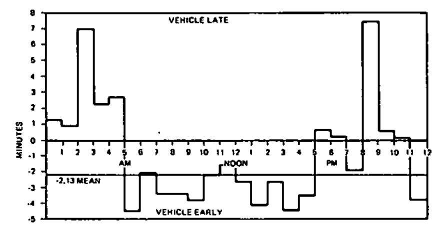
the mean wait time gradually increases as the number of requests for service increases and reaches a maximum of 16.5 min during the 3 to 7 p.m. peak period. The relatively high wait times from 4 to 5 a.m. and 8 to 9 p.m. are not typical because on the days sampled very few trips were made during these periods.

Pickup time deviation is the difference between the pickup time promised to the passenger at the time the trip is requested and the actual pickup time. Unlike wait time, pickup time deviation can be measured for immediate, deferred, and periodic trips.

Figure 7 shows that the mean pickup time deviation is -2.13 min, indicating that on the average vehicles arrive about 2 min earlier than promised. This deviation, which usually falls within a narrow range from -4.5 to + 3.0 min, is desirable because customers are not likely to be satisfied with the service if vehicles arrive excessively early or late.

Of the 4 factors that contribute to the

Figure 7. Average pickup time deviation.

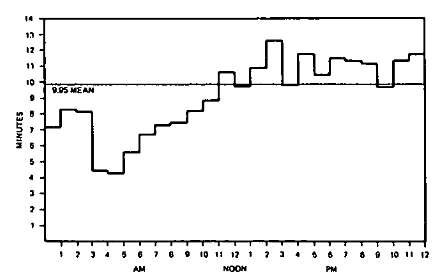


pickup time deviation, 3 are the same as those that contribute to wait time. The fourth is the accuracy with which the control room staff estimates the promised pickup time. This estimation process takes into account the average pickup time deviation of the previous half hour, the number of buses available, and the location of the origin of the current trip.

Ride time is the time the passenger rides on the vehicle from pickup to delivery. The average weekday ride time of 9.95 min (Fig. 8) is close to the average automobile ride time of 9 min and implies that passengers usually travel directly from origin to destination.

As with the mean wait time, the mean ride time increases on an hourly basis until peak ridership is reached during the midday period. At this point, the ride time reaches and remains at a level of

Figure 8. Average ride time.



about 11.5 min. Consequently, between 2 and 7 p.m. when the greatest number of passengers are carried, the typical dial-a-ride trip will take about 24 min (13 min wait time and 11 min ride time).

Table 7 gives average wait and ride times and average pickup time deviations by period of the day for the days sampled. As the day progresses and ridership increases, the average wait and ride times also increase. As vehicle productivity (requests per vehicle per hour) increases, so do the average wait and ride times because each vehicle will have more passengers to pick up and drop off.

The relation between vehicle productivity and unit-ride time is shown in Figure 9. The data show that, as the day progresses and ridership increases, both vehicle productivity and customer wait and ride times also increase.

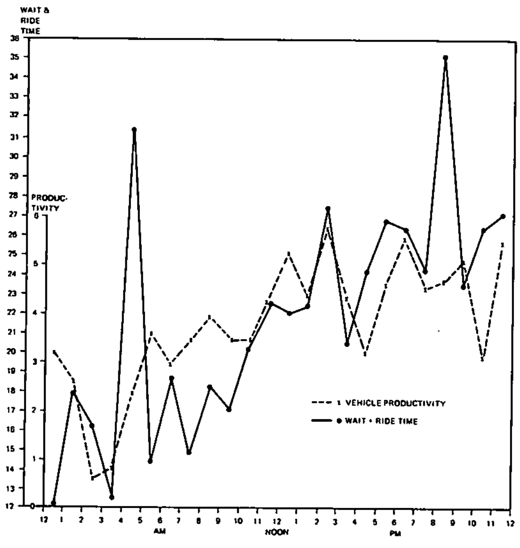
The correlation between the sum of wait and ride times and the vehicle productivity was found to be +0.52. That is sufficiently high to indicate that a statistically significant positive correlation exists between these 2 variables. When one is plotted against the other, it is found that the regression equation describing the relation is

$$\text{Wait time} + \text{ride time} = 12.89 + [2.83 \times \text{vehicle productivity}]$$

Table 7. Average wait and ride times and pickup time deviations by time period.

Period	Wait Time	Ride Time	Pickup Time Deviation
7:01 a.m. to 9:00 a.m.	9.86	7.29	-3.39
9:01 a.m. to 4:00 p.m.	12.98	10.15	-3.07
4:01 p.m. to 7:00 p.m.	14.29	11.36	-1.11
7:01 p.m. to 11:00 p.m.	16.26	10.86	+1.61
11:01 p.m. to 7:00 a.m.	15.76	8.02	-1.75

Figure 9. Average wait and ride times and vehicle productivity.



Thus, if vehicle productivity is 4.0, then average wait and ride times will be 24.21 min. Indeed, when actual vehicle productivities average about 4.0, the actual wait and ride times are about 24 min.

SUMMARY

As of August 1972, dial-a-ride vehicles in the Haddonfield area carried more than 3,000 one-way trips per week and between 500 and 600 per day. This does not represent a steady-state demand level because usage of the system has been steadily increasing since the demonstration project began. The most notable feature of demand for DAR has been the relatively high usage made of the system during the off-peak periods for many-to-many nonwork trips.

The household survey provided a great

deal of information concerning the attitudes toward and preferences of potential DAR users. Through this survey, residents of the service area had a voice in the selection of system operational parameters. The 60-cent cash fare, reduced rates for senior citizens and for those purchasing books of tickets, service to local shopping areas, 15-min average wait time and 10-min average ride time are all based on statements of survey respondents regarding dial-a-ride attributes that they preferred or felt were reasonable. As far as possible, the service has been designed to meet the needs of those whom it serves.

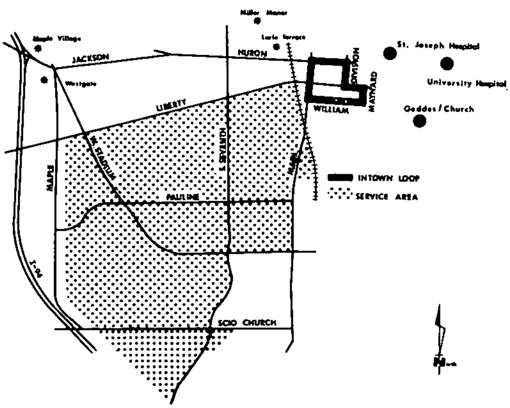
DIAL-A-RIDE PROJECT IN ANN ARBOR: DESCRIPTION AND OPERATION

Thomas Urbanik, II
Dial-A-Ride Project Coordinator, Ann Arbor Department of Traffic Engineering and Transportation

The purpose of the Ann Arbor dial-a-ride project is to test the market response and economic viability of door-to-door, dynamically routed and scheduled public transportation in a Michigan community. The project is sponsored by the Michigan Department of Commerce, Bureau of Transportation, and the Ann Arbor Transportation Authority (AATA). The Transportation Research and Planning Office of the Ford Motor Company is technical consultant.

This report describes the project and gives a summary of the operation from September 20, 1971, to February 29, 1972. The information was assembled by the consultant and project staff.

Figure 1. Service area.



SERVICE

The residential service area (Fig. 1) contains approximately 3,300 households. Within this service area, customers may request doorstep service by telephoning the dispatch center. The primary downtown destination points to be served have been organized into a loop. Passengers may request pickup or delivery at any point along the loop. At the 2 extremes of the loop, key points have been established where there are free direct telephones to the dispatch center. The loop is merely a convenient way to provide a many-to-few mode of operation. Vehicles can enter the loop at any point and, in actuality, rarely complete a trip around it.

In addition, service is provided to the University of Michigan, St. Joseph's Hospital, and University Hospital. At the dispatcher's option, callers are provided point-to-point service within the residential service area.

The service hours are from 6:30 a. m. to 6:00 p. m., Monday through Friday, and from 8:00 a. m. to 6:00 p. m. on Saturday. There are a maximum of 3 vehicles in service; the number is set according to the demand.

The fare structure is 60 cents cash (exact fare) for a 1-way trip. Tickets may also be purchased in strips of 10 for $5. A $15 unlimited-use pass is available for a calendar month. Any number of members of a family may travel between the same 2 points on 1 pass. A special unlimited-use pass that is good only between 9:00 a.m. and 3:00 p.m., Monday through Friday, and all day Saturday is available for $10.

VEHICLES

The entire dial-a-ride fleet consists of existing vehicles from the AATA fleet except for a Ford Courier (10-passenger van with roof conversion to provide a stand-up interior) on loan from Ford's Transportation Planning and Research Office. The other 2 vehicles making up the basic 3-vehicle fleet are 1969 Ford club wagons (school bus package) that were refurbished and repainted for dial-a-ride service. As many as 3 GMC 3301, 28-passenger vehicles have been used as backup vehicles for breakdowns or accidents.

COMMUNICATIONS

The dial-a-ride system shares the existing AATA radio channel and transmitter. All equipment is from existing inventory. The radio frequency is 44,520 MHz (low band) and suffers skip from distant stations during summer months. The telephone communication consists of 3 public lines (group hunt) and 2 direct lines servicing the 2 free telephones previously mentioned. These lines are in addition to 3 existing for the regular AATA service.

CUSTOMER SERVICE

The dispatcher answers all incoming telephone calls and records the following information: time of call, pickup address or point, and delivery address or point. The dispatcher then gives the customer an estimate of the pickup time. For walk-in customers, the driver radios the information given above to the dispatcher so that a complete record is made of each vehicle tour.

At all times, there is only 1 dispatcher on duty. During peak times, the head dispatcher for the line-bus operation answers the phone and places the customer on hold for servicing by the dial-a-ride dispatcher.

DISPATCHING SYSTEM

The central concept in dispatching the Ann Arbor dial-a-ride system is the vehicle tour. The tour beings when the dispatcher radios a driver and gives the driver a sequenced list of pickups in the service area.

During times of heavy demand, the dispatcher may transmit an unordered list.

When he arrives at the downtown loop, the driver calls the dispatcher. (The point of entering the loop is usually determined by the driver unless he is previously instructed by the dispatcher.) The driver circulates on the downtown loop (or executes the hospital and university leg), simultaneously dropping off inbound passengers and picking up outbound passengers according to the list of stops transmitted by the dispatcher. The driver radios the dispatcher when he leaves the loop.

All outbound distributions are performed in sequence so that an outbound subtour is completed at the farthest point in the service area from downtown. No passengers are picked up until all passengers are dropped off. The driver radios the dispatcher after all passengers are dropped off. If there is insufficient demand to dispatch another tour, the driver is instructed to park either in the service area or downtown depending on anticipated demand.

RIDERSHIP

During the 24-week period from Wednesday, September 22, 1971, through Saturday, March 4, 1972, 23,541 passenger trips were provided. Total weekly ridership has exceeded 1,200 trips 5 times during this period; the average for the last 11 weeks was 1,176. Weekday ridership has leveled off at approximately 214 trips per day, and Saturday ridership has declined to 108 trips from a preholiday average of 148. (Standard deviation of week total is 53 trips; standard deviation of mean weekday average is 18 trips.)

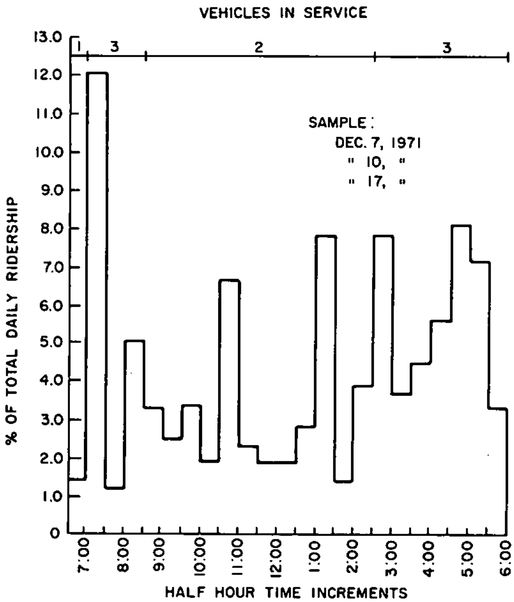
Day of week trends have been established as follows (days do not include Thanksgiving, Christmas, and New Year's Day):

Day	Percent
Monday	17.3
Tuesday	17.8
Wednesday	17.5
Thursday	17.5
Friday	19.0
Saturday	10.9

Figure 2 shows the hourly demand pattern experienced on 3 typical days in December. The times are when service was requested and not when passengers were picked up; therefore, some smoothing of peaks in actual service is experienced. The dominant morning peak reflects travel to work and to Slauson Junior High School. The 10:30 to 11:00 a.m., 1:00 to 1:30 p.m., and 4:30 to 5:00 p.m. peaks result from Slauson School shift changes. Rationale for the assignment of 2 vehicles from 8:30 a.m. to 2:30 p.m. is clear from the data shown in this figure.

Table 1 gives the daily ridership total since the project began. Through December 18, 1971, 822 households have used the dial-a-ride service at least once, accounting for a "penetration" of approximately 25 percent. Throughout that period, new households were trying the service at the rate of approximately 63 per week (11 per day average). Although household use has not been tabulated subsequent to December 18, it is almost certain that by February 29, 1972, more than 1,000 households, or fully one-third of those eligible, have used dial-a-ride service at least once. However, most of these households are infrequent users.

Figure 2. Hourly demand.



TRIP GENERATORS

Approximately 93 percent of all dial-a-ride trips are to or from points on the downtown loop, the hospitals, or the university area. The remaining 7 percent are intraservice area trips such as from one address to another. The relative popularity of the several destination points available to dial-a-ride users is approximately as follows:

Point	Percent
Downtown loop	67
Slauson Junior High School	17
Hospitals	12
East University stops	4

REVENUE

Table 2 gives a summary of revenue and ridership for the 5 pass periods since the beginning of the project. Also given are average pass fare, as derived from pass ridership and pass revenue, and average fare for all users. The pass charge was $10 per month through January; it was increased to $15 per month in February.

Even though the December ridership was lower than that for November, the revenue was higher. This is because more passes were sold, but were used less, and because more rides were paid for with cash. Revenues for January and December were about the same, but January ridership was higher, making a lower average fare. The February revenue was $300 higher than that for January, but the ridership was almost the same.

The revenue increase resulted from the higher pass cost. Although pass sales reached a peak of 92 in January, the pass revenue peaked at $1,110 during February. The increased pass cost appears to have caused some users to switch from pass to ticket or cash fares. The increased pass cost raised the average fare from a low of 40.4 cents during the first pass period to 49.4 cents during February. The increase was due in part to fewer rides per pass. During the first period there were 38.9 rides per pass, but there were only 34.4 during the February pass period.

SERVICE TIMES

Detailed time studies have been conducted on 4 separate occasions; results are given in Table 3. Ridership for the

Table 1. Daily ridership.

Week Beginning	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
9-20	–	–	45	70	90	63	268
9-27	89	92	70	90	107	81	529
10-4	94	109	99	86	105	80	573
10-11	93	129	114	118	147	96	697
10-18	106	130	130	134	134	73	707
10-25	143	113	119	136	165	130	806
11-1	154	191	235	192	208	143	1,123
11-8	199	222	219	207	221	162	1,230
11-15	204	191	173	186	228	163	1,145
11-22	200	193	200	–[a]	147	131	871
11-29	199	205	202	192	238	164	1,200
12-6	213	208	208	199	209	155	1,192
12-13	205	238	201	193	242	118	1,197
12-20	216	185	170	128	97	–[a]	796
12-27	129	128	137	136	91	–[a]	621
1-3	191	195	194	192	201	102	1,075
1-10	198	202	185	214	234	107	1,140
1-17	238	232	207	233	250	89	1,249
1-24	184	214	226	242	234	129	1,229
1-31	226	194	188	220	212	119	1,159
2-7	234	209	237	223	227	95	1,225
2-14	203	229	209	199	209	113	1,162
2-21	174	225	208	228	223	111	1,169
2-28	205	213	207	219	227	107	1,178

[a]Holiday.

study dates was as follows:

Date	Number
10-15 and 10-19	277
12-10	209
2-18	209

Table 2. Monthly revenue and ridership.

Type of Fare	Month	Revenue (dollars)	Riders: Number	Riders: Percent	Avg Fare (cents)
Pass	September-October	480	1,867	52.1	25.7
	November	813	2,664	55.8	30.5
	December	882	2,399	52.2	36.8
	January	920	2,781	56.5	33.1
	February	1,110	2,546	51.5	43.6
	Total	4,205	12,257	53.8	34.3
Cash	September-October	835	1,392	38.9	
	November	1,033	1,722	36.1	
	December	1,098	1,830	39.7	
	January	1,040	1,734	35.3	
	February	1,046	1,744	35.5	
	Total	5,052	8,422	37.0	
Ticket[a]	September-October	131	262	7.3	
	November	154	308	6.5	
	December	148	297	6.4	
	January	162	323	6.6	
	February	268	536	10.9	
	Total	863	1,726	7.6	
Other[b]	September-October		59	1.6	
	November		79	1.6	
	December		76	1.6	
	January		81	1.6	
	February		81	1.6	
	Total		376	1.6	
Total	September-October	1,446	3,580		40.4
	November	2,000	4,773		41.9
	December	2,128	4,602		46.2
	January	2,122	4,919		43.1
	February	2,424	4,907		49.4
	Total	10,120	22,781[c]		44.4

[a]Used by customers. Through observation period, 83 percent of tickets sold were actually redeemed; therefore, revenue from ticket sales was higher than amount shown.
[b]Not accounted for in other fare types. Number was tabulated precisely during first month and that same percentage was used for other months.
[c]Does not agree with total of 23,541 because 4 days (March 1 through 4) are not included.

In general, service, as measured by service times, improved between December 10, 1971, and February 18, 1972. Most notable improvements were the reductions in average times and variances of inbound waiting, inbound riding, and total inbound travel. The inbound service improved to both the downtown loop and the hospital-university area. There has been some deterioration in service times for outbound travel from downtown, but outbound service times from the hospital-university area have improved.

PRODUCTIVITY

The productivity of equipment and labor used in a dial-a-ride system is the most important determinant of cost per ride for a given set of prevailing local conditions. Productivity depends on overall demand levels, demand density (passengers requesting service in a given area), service area density and network, and characteristics of the dispatching system.

Typical system productivity for February ridership levels was as follows:

Item	Amount
Vehicle-hours/day	27.2
Labor-hours/day	
Driver, regular	27.7
Driver, overtime	1.5
Dispatcher	12.0
Total	41.2
Average passenger trips served	214
Passengers per vehicle-hour	7.85
Passengers per driver-hour	7.40
Passengers per dispatcher-hour	17.8
Passengers per labor-hour	5.20

During the period from 4:30 to 6:00 p. m. on high demand days, average productivity often reaches 10 to 11 per hour. Although the question of ultimate system capacity remains unanswered, there is no doubt that a potential for growth exists during many of the midday hours. The problem is one of maintaining service times. During busy hours, stops are closer together, and consequently a given vehicle may serve more calls per hour than during periods of slack demand. Productivity could be increased during slack hours only by forcing longer waiting and riding times for the users during that period. Therefore, an increase in off-peak demand appears to be a highly desirable goal to build productivity levels.

The degree of ride sharing achieved in the Ann Arbor dial-a-ride system has resulted in an average of 5.25 passengers/vehicle-tour. A detailed analysis of tour times has allowed the development of a simple linear relation for tour times, which is statistically significant (R^2 = 0.805 for inbound tours and 0.710 for outbound tours) at the 1 percent confidence level and is accurate within ±12 min in more than two-thirds of the cases studied.

$$T = 25.36 \text{ min} + (3.17 \text{ min} \times N_I) + (2.15 \text{ min} \times N_O)$$

where

T = tour,
N_I = number of inbound stops, and
N_O = number of outbound stops.

The tour times calculated by this equation will be valid for the present demand density. However, the objective of increasing demand and thus reducing distance between stops will force a recalibration of the coefficients.

SURVEY OF CUSTOMER REACTION

Two separate surveys have been conducted to measure customer reaction to dial-a-ride service. The first was a 3-

Table 3. Time study results.

Direction	Date	Observations	Wait Time Minutes	Wait Time S. D.	Ride Time Minutes	Ride Time S. D.	Total Minutes	Total S. D.
To downtown	10-15 and 10-19	80	8.0	6.2	11.2	4.0	19.2	6.8
	12-10	51	11.5	8.3	14.9	5.1	26.4	8.7
	2-18	45	9.9	7.9	11.7	4.0	21.5	8.4
From downtown[a]	10-15 and 10-19	101	5.0	6.1	11.7	4.3	16.7	7.2
	12-10	45	10.1	10.2	13.0	4.9	23.1	12.2
	2-18	42	11.8	8.3	15.2	8.4	27.1	10.8
To hospital-university	10-15 and 10-19[b]							
	12-10	14	16.1	10.0	18.4	8.1	34.5	9.1
	2-18	23	9.1	7.4	15.0	4.6	24.1	8.5
From hospital-university[a]	10-15 and 10-19[b]							
	12-10	8	9.8	7.2	21.1	9.8	30.9	9.4
	2-18	15	10.1	9.8	17.0	6.7	27.1	11.9

Note: Service times are not weighted by multiple calls for the same trip. Each datum is an observation of waiting, riding, and total travel time for a specific pickup and delivery address, independent of multiple riders; i.e., service times for 2 persons traveling together are recorded once, not twice.

[a]October waiting times are not properly shown because direct phones were not in and many persons did not call ahead. "Walk-ons" and "hail stops" were recorded as 0 wait times.
[b]Service not operating.

day on-board survey in which 298 valid returns were obtained. The second was a telephone survey of households who used dial-a-ride service only once or twice during the first 3 months to determine what improvement might induce these occasional users to use the service more frequently. In addition to these surveys, others have been conducted by Berla and are reported in the next paper in this Special Report.

General information obtained in the surveys is given in Table 4. Because of the great concern over irregular riders, all surveys contained questions designed to urge service area residents to "sound off" about dial-a-ride service. In general, it has been rather difficult to elicit any negative remarks about the service. People who have never used the service or who have stopped using it were asked, What aspect of dial-a-ride service has not been attractive or satisfactory to you? Users were asked, What improvement in dial-a-ride service would encourage you to use it more frequently? The number of respondents and their responses are are given in Tables 5 and 6.

The responses indicate that waiting time is the most critical variable from a user's point of view. A greater variety of available destinations seems to be the

Table 4. Characteristics of users and their travel.

Item	Percent
Trip purpose	
Work	35
Shop or personal business	33
School	23
Other	9
Former mode	
Automobile	50
Walk	19
City bus	13
Induced travel[a]	5
Other	13
Ride once a week or less	55
Ride one-way only	50
Automobiles/household	
None	8
One	47
Two or more	45
Licensed drivers	56
Men	69
Women	31
Age	
Under 18	39
25 to 34	21
Over 65	1

[a]Trips that were not made before and would not have been made had dial-a-ride service not been available.

Table 5. Number of survey respondents.

Survey	Respondents: Number	Percent: Users	Percent: Nonusers	To Service Questions: Number	To Service Questions: Percent
On-board	298	100		255	86
Telephone	102	52	48	36	35
Home interview					
Users	204			111	55
Nonusers	463			99	21

Table 6. Percentage of respondents and responses regarding service improvement.

Response	On-Board Survey	Telephone Survey	Home Interview Survey: Users	Home Interview Survey: Nonusers
Shorter wait times; more accurate wait-time prediction	38.0	19.5	0	0
More available destinations	22.2	25.0	62.2	49.5
Lower fare; ability to make change	23.2	11.1	18.0	12.1
Shorter ride time	10.9	11.1	0	0
Extended service hours	0	8.3	9.9	11.1
More inconvenient than automobile	0	11.1	9.0	14.1
Other	5.7	13.9	0.9	13.2

single improvement that would induce nonusers to try dial-a-ride or to encourage occasional users to travel more frequently. Lower fares are simply not a realistic option at this point (from an Ann Arbor Transportation Authority policy point of view). Experience with extended service hours on Friday evening has shown that ridership response is not adequate to cover costs, at present budget levels.

Table 7 gives the results of a telephone survey that was conducted to determine why persons who tried dial-a-ride only once or twice did not ride again. This survey showed that only 3.9 percent of the respondents had had a bad service experience; conversely, more than half of them used dial-a-ride again, and 8.8 percent have become regular users. The problem identified by this survey is that most families view dial-a-ride as a backup or secondary mode of transportation that is used only when the automobile is not available. No evidence indicates that poor service is responsible for the relative infrequent use most families make of dial-a-ride. This type of attitude toward public transportation is impossible to address at the operating level and must be approached as a long-range policy and educational issue by the Ann Arbor Transportation Authority.

Table 7. Responses regarding user's experience with service.

Response	Respondents (percent)
Totally dissatisfied and will not use again	3.9
Neutral or supportive but automobile satisfies travel needs and cannot perceive of any possible future need for service	18.6
Only moderately dissatisfied or supportive and might use again under extreme circumstances, i. e., if automobile is disabled	15.7
Dissatisfied with service but use on irregular basis	0.0
Satisfied with service and use on irregular basis	52.0
Satisfied and use regularly	8.8
No response	1.0

As part of the research conducted by Berla, 886 citizens in the city's fourth ward (which is included in the dial-a-ride service area) were asked to express their attitudes toward public transport. The following responses were made to the question, Do you agree or disagree that Ann Arbor really does not need a public transit system?

Response	Percent
Disagree strongly	75
Disagree somewhat	13
Disagree somewhat and agree somewhat	5
Agree somewhat	2
Agree strongly	3
Do not know or no answer	1

They were then asked how transit service could best be improved in Ann Arbor and responded as follows:

Response	Percent
Improve bus lines	8
City-wide dial-a-ride only	25
Combined dial-a-ride and line service	61
No bus service	1
Other, such as rapid transit	3
Do not know	2

There appears to be substantial support for public transport in general and for dial-a-ride in particular. The Ann Arbor Transportation Authority can be encouraged by this result and should develop policies that will turn this general support into ridership on the system.

DIAL-A-RIDE PROJECT IN ANN ARBOR: PUBLIC RESPONSE

Michael J. Berla
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Ann Arbor, like most other U. S. cities, is almost totally dependent on private automobiles for the movement of people. Those who have access to automobiles have certain obvious advantages: They can go wherever and whenever they want to; they can choose those who occupy their vehicles; and many of the costs of their driving are heavily subsidized by members of the nondriving public.

Conversely, there are strong disadvantages when a transportation system is so heavily dependent on the automobile as its only type of vehicle. For individuals, it is relatively expensive in terms of total cost per passenger trip, and it is inefficient in terms of the number of hours per day, week, or year that the automobile is actually operated. For a community, it is wasteful of scarce urban land necessary for streets and parking facilities, it generates more air pollution per trip than other modes, and it excludes or seriously disadvantages those who are unable to operate or afford private vehicles.

Any effort to provide a more diverse transportation system in Ann Arbor implies that serious efforts will have to be made to shift a significant proportion of those trips now being made by private automobile to other modes, primarily public transit. To state this necessity, however, is a long way from beginning to bring about such a change. The change that is envisioned in the discussion that follows will be extremely difficult to accomplish precisely because, for so many individuals and households, the present, single-mode system seems to be working so well. However, the Transportation Authority believes that Ann Arbor has much to gain from the effort.

A transportation system may be characterized as a method for moving people and goods. The 2 major components are the technological system that effects the movement and the human beings who use it.

During the past decade, there has been much research on transit technology in the areas of systems, hardware, and cost-effectiveness relations. In economic terms, the supply side of the transportation equation has been intensively studied.

Much less attention has been paid to the demand side of the equation: who uses a given system? How much? What are the factors that encourage and discourage the use of alternative modes? One reason, it seems to me, for a de-emphasis of the demand side of the transportation equation has been the difficulty in analyzing the demand factors as precisely as the supply factors have been analyzed. For example, although it may be relatively easy to develop cost analyses for various alternative transportation modes, it is much more difficult in analyses of consumer behavior to quantify the components of demand.

In simplest terms, the supply cost of a unit of transportation includes annualized capital costs plus operating costs per unit moved. As long as we are willing, as we have been traditionally, to ignore the many externalities associated with transportation enterprises, we are able to calculate relatively simply the supply prices for various transportation alternatives.

Unfortunately, the same has not been true in the analysis of demand for transportation. We have simply made the assumption that some set of preferences somehow related perceived cash cost, travel time, convenience, reliability, and comfort in some way to produce individual demand functions for each consumer. These demand functions can somehow be aggregated to produce a single demand curve for a given transit service. When that curve is intersected with the relevant supply curve, an equilibrium price and quantity are produced.

But what, in fact, are the components of the demand function for transportation? Take cash cost as one example. According to Lansing and Hendricks (1), whose work was based on data gathered in 1963 and 1965 in an extensive national survey, fewer than 1 out of 3 drivers has ever calculated what it costs to make the journey to work by automobile; even fewer agree on those costs. Yet economic theory is based on the assumption that consumers are knowledgeable about the costs of options they face and that they tend, at least in the aggregate, to make rational decisions among them.

Again, even if consumers were aware of the cash costs of various transportation choices, how would they trade these costs against noncash factors such as travel time, convenience, comfort, and privacy? We really do not have the beginning of a set of comprehensive data regarding these crucial questions—let alone a theory that would relate these data if they existed.

In Ann Arbor, when it became clear that there would be an experimental demand-responsive transit system implemented in a portion of the city, we decided that, in addition to the usual work on cost factors, we would place some emphasis on studying the demand for such a system. We began by conducting a mail survey in the political subdivision of the city in which the experiment was to be conducted. Because there had been little publicity regarding dial-a-ride prior to the completion of the survey, we felt that the responses would provide a reasonable set of "before-experiment" data, which could later be compared with "after-experiment" data.

Some 6,300 four-page questionnaires were consequently mailed to an address list generated from the city clerk's computerized registered voter file. Comparison with a list of households that had been created by a census of the proposed dial-a-ride service neighborhood revealed that approximately 90 percent of all households in the neighborhood were discovered by a computer canvass of the registered voter file.

A second survey was conducted during a 1-month period, beginning during the thirteenth week after the system went into operation. The sample for this survey consisted of 40 percent of all households in the original dial-a-ride service neighborhood—approximately 840, of which 675 were actually interviewed.

Finally, a third major source of data about consumers consisted of the dispatch records kept. Ideally, every single passenger trip made on dial-a-ride is assigned to a specific household. The other end of the trip is also recorded as well as the number of persons in the household making the trip and the method of payment (cash, ticket, or flash pass).

One problem that developed in data from dispatch records, was the inability of the system to distinguish particular apartment numbers within a multiple unit street address. For this reason, trip data assigned to 96 households at multiple-family addresses have been deleted from the following data. The balance of this paper, then, consists of a discussion of several of the items collected from each of the remaining 579 single-family households located in the original dial-a-ride service neighborhood. Particular attention will be given to significant differences between using and nonusing households and to differences among various levels of use among user households. What we are attempting to do is to isolate those factors most strongly associated with and, therefore, best predictive of levels of household use during the first 13 weeks of the experimental project.

One aspect of the experiment that was under control of the researchers had to do with the paid advertising for the new system. Given an unrealistically low item for marketing in the project budget, the Transportation Authority decided that paid advertising for the service should be limited to direct mail inasmuch as all other forms of advertising would go in large proportion to households not in the service area. (As originally constituted, the service neighborhood comprised less than 7 percent of all households in the city of Ann Arbor; this represented an even smaller fraction of the circulation delivered by local printing or broadcasting media.)

The direct-mail format consisted of a series of 8 two-page or four-page newsletters mailed to 80 percent of the households in the service area during the course of the 15-week period beginning about 2 weeks before service was initiated. The 20 percent of households that did not receive the newsletters consisted of half of the total 40 percent sample that was surveyed in December and January. For the marketing impact experiment, the 20 percent constituted the control group, whereas the 80 percent that did receive the newsletters were the treatment group, 25 percent of whom were drawn into the survey sample.

As with trip data, we also found that treatment data (i.e., information as to whether the household had received the newsletters) were unrealiable for multifamily units. This resulted from the fact that in apartment units the typical method of distributing bulk mail is to leave a pile of the pieces in some central place near the apartment mailboxes rather than to distribute one piece to each mail box. In many apartment complexes, some households were supposed to receive the marketing treatment and some were not. In fact, however, this distinction was not made by the U.S. Postal Service; consequently, households that were part of multiple-unit complexes were all assigned missing data codes to indicate their status on the newsletter mailing list.

We are then left with 579 single-family units out of a total of 2,066 units in service area A for which we have both survey data and reliable trip and marketing data. Of these 579 units, 410 or 71 percent never used the dial-a-ride service during the monitoring period, and 169 or 29 percent used the service at least once.

Table 1 gives relevant variables, where available, for the 675 survey households, the 306 single-family units that received newsletters, and the 273 single-family units that were not mailed newsletters.

First, consider simply the following distribution of the 579 households by number of trips made during the study period.

Use	Percent
Did not use	71
Did use	29
1 trip	7
2-3 trips	7
4-8 trips	7
9 or more trips	7

The maximum number of trips by a single household was 140. The maximum number of trips generated by any family in the entire dial-a-ride service area during the 13 weeks under consideration was 345, or about 4½ percent of all trips made by the almost 2,100 households in the neighborhood.

From data collected in almost 600 home interviews, what can we say about differences in households, given differences

Table 1. Variables for survey households.

Variable	Households All	Received Newsletters	Did Not Receive Newsletters
Percentage using system 1 or more times in first 13 weeks	—[a]	30.0	28.4
Use during first 13 weeks			
Mean	—[a]	2.76	3.68
Standard deviation	—[a]	9.57	16.23
Mean number in household	3.14	3.5	3.45
Median income class	$15,000 to 20,000	$15,000 to 20,000	$15,000 to 20,000
Median education of male head of household	Bachelor's degree	Bachelor's degree	Bachelor's degree
Mean number of automobiles	1.72	1.76	1.83
Mean number of licensed drivers	2.07	2.10	2.18
Mean number of full- or part-time employees	1.37	1.36	1.44

[a]Data not available.

in use of the service? First of all, we know that use or nonuse of the service was related to the following items that were collected in the survey data: the respondent's attitude toward the interrelation between the automobile and the city environment; the number of teenagers in the household; the ratio of number of persons over age 5 in the household to number of automobiles registered to household members; and educational attainments of male and female heads of households.

Perhaps the most interesting item in this list is that dealing with attitudes toward the automobile and the city's environment. Thirteen items were constructed to attempt to probe this relation. Factor analysis was then performed on the scores on these items, and from them 6 items were selected that seemed to capture most of the information they contained. Respondents were asked to evaluate whether they agreed or disagreed, along a 5-point scale that was provided, with the following 6 statements:

1. There are too many private automobiles in Ann Arbor today.
2. More people in Ann Arbor should get out and walk or ride bicycles instead of driving their cars.
3. Ann Arbor would be better off if part of the central business district were closed to private automobiles.
4. Many familes in Ann Arbor would be better off if they could spend less of their incomes on owning and operating private automobiles.
5. Ann Arbor's future is seriously threatened by the growth of private automobile ownership.
6. My family would be willing to replace some of our trips by private automobile with trips by public transit.

The scores on these 6 items were summed and averaged. The more a respondent agreed with these statements, the more likely was it that the household was one of those using dial-a-ride. We are now in the process of analyzing these data to produce an algorithm for predicting the probability that a given household will use this kind of service.

Within the smaller group of 169 households who used the system one or more times and on whom we have reliable use and survey data, there is a rather interesting distribution of the variable "number of trips." The distribution is negative exponential for the values between 1 and about 30 trips. Beyond this limit, because of the existence of extreme cases, the distribution becomes curvilinear even when expressed in logarithms.

We have broken the set of user families into the 156 households that used the system between 1 and 29 times, the straight-line exponential portion of the curve, and the 13 households that used the system more than 29 times during the 13 weeks under study. (Incidentally, these 13 households, representing only about 7 percent of all user households in the sample, generated collectively almost exactly half of all trips recorded by this sample.)

Once we have identified a user family, another set of variables appears to explain the actual number of trips that any given household will actually make, given that it will make 1 or more trips. Here the strongest variables on which we collected data are ratio of number of persons in the household to number of automobiles; length of time the family had lived at its present address; number of residents in the household; household income; number of full-time employees; educational attainment of the heads of household; and number of licensed drivers in the household. Interestingly, the set does not include the index of attitude toward the automobile and the environment.

It should be possible to develop a prediction formula, based on regression analysis, for this subset of the sample. How we will handle the extreme 8 percent of cases that have, in this particular sample, accounted for approximately half of the total trips is not yet clear. Perhaps the best first approximation will be simply to use a multiplier on the number of trips predicted out of the straight-line portion of the sample.

In any case, it is hoped that predictions generated from this kind of household survey analysis can do a far more accurate job in the future of setting the range of potential ridership than traditional aggregated modal-split and origin-destination models have done in the past. As a result of using these aggregated models, the weekly ridership per household predicted in our application for state demonstration grant funds was 6 times what the actual figure turned out to be after the system stabilized and allowances were made for changes in the scope of the service area from what had initially been projected.

One other aspect of our survey seems worthwhile of attention at this time. We asked all respondents whether, if the localized dial-a-ride system could be expanded to a city-wide service that would cost the taxpayers about $5 per person or about $500,000 per year, they would vote for or against such a tax. Of 883 respondents, 64 percent answered "Yes", 23 percent answered "No", and 13 percent answered "Don't know." Support was about as high among those households who had used the system one or more times as among those who had not.

We were interested in predictors of this variable measuring political support for funding such a system. Table 2 gives a 2-dimensional comparison of households: those in the service area and not in the service area and those sent the newsletter and not sent the newsletter. Initially, we predicted that the effects of these 2 variables on level of support for a city-wide system supported by a half-million dollars in taxes would be both positive and additive. That is, we hypothesized that people in the service area would, on the average, exhibit more support for the service than those not in the service area; and we hypothesized that, in either case, people who received the 8 newsletters—would be more favorable to to a tax-supported city-wide system, regardless of where they lived, than those not so treated.

Table 2. Support for dial-a-ride subsidy by service and marketing treatment.

		Service		No Service		All	
Marketing Treatment	Response	Number	Percent	Number	Percent	Number	Percent
No newsletter	Yes	185	61	39	68	224	62
	No	77	25	12	21	89	25
	Don't know	43	14	6	11	49	13
	Total	305	100	57	100	362	100
Newsletter	Yes	179	67	39	66	218	67
	No	54	20	12	20	66	20
	Don't know	36	13	8	14	44	13
	Total	269	100	59	100	328	100
All	Yes	364	63	78	67	442	64
	No	131	23	24	21	155	23
	Don't know	79	14	14	12	93	13
	Total	574	100	116	100	690	100

We found that, however, 63 percent of the households receiving service and 67 percent of those not receiving service supported the imposition of a tax to provide city-wide dial-a-ride service. The data also showed that 62 percent of households that did not receive the newsletter and 67 percent of those that did supported the tax. Again, the difference is marginal.

These variables proved to be interactive rather than additive. That is, the setting on one variable predicted a different rate of change, and indeed of direction of change, on the other variable. Whereas, in the service neighborhood, support for the city-wide system subsidy went up, as predicted, with application of the newsletter marketing, it went down, under the marketing treatment, in those households that were not in the dial-a-ride service area. The differences are relatively small, so that a good deal of caution must be exercised both in accepting and in interpreting these results.

What preliminary conclusions can be drawn from Ann Arbor's dial-a-ride experiments to date? First of all, and perhaps most important, it is extremely difficult to wean any large number of individuals away from deeply entrenched travel behavior patterns, particularly when travel modes are strongly reinforced by existing institutional arrangements. The American city is currently based on the premise that most people will make intraurban trips by privately owned and operated motor vehicles. And a person's automobile is widely recognized as a symbol of his wealth and status. Further, because most of the cost of automobile ownership and operation is not related to the number of miles the vehicle is driven, being heavily dominated by the fixed costs of depreciation, insurance, and licensing, the marginal cost of any given trip by private automobile is relatively low.

The ability to bring about significant trip diversion, then, is heavily dependent on the rate of automobile ownership in a community. In Ann Arbor, that rate is about 1.75 per household, or 7 cars for every 4 households. As long as there is any significant proportion of desired trips that can only be made by private automobile, most affluent families will choose to own enough automobiles to be able to make those trips. Yet, because of the low marginal cost of any trip, once fixed costs of ownership have been met, many of the trips that could have been made by public transit are more cheaply and conveniently made by private vehicle.

Yet, Ann Arbor seems to be in the process of reevaluating its transportation preferences and habits. Evidence of this is still scattered, but it is sufficient to encourage the Transportation Authority in its efforts to expand the percentage of trips made on public transit vehicles. Last year, for the first time in recent memory, a road improvement bond issue was voted down by about a 2 to 1 majority. Most of the opposition came from groups and individuals who said that the city needed to rethink its transportation patterns and should explicitly attempt to divert trips from private to public transportation.

In March, 1972, the question of supporting a city-wide dial-a-ride system at a cost to the taxpayer of approximately $5 per person, or $500,000 per year, was included in a survey of voter attitudes in a sample drawn from the entire city. Here again, the favorable response won majority support, 56 to 35 percent, with 8 percent undecided.

Finally, during the past 2 years that the city budget has been under consideration, the dial-a-ride project has had additional money voted for it, i. e., more than that in the recommended budget of the city administrator. These decisions came during an era when the city's fiscal condition has been more precarious than at any other time in the past 2 decades. These and other scattered pieces of evidence indicate, at least to members of the Transportation Authority, that the public and its elected representatives are rethinking basic transportation issues in Ann Arbor.

Within a few months, the authority will propose to city government and the voters a specific policy that calls for major efforts to increase the scope of public transit in the city. That increase will come in the form of a city-wide system of neighborhood dial-a-ride feeders offering coordinated transfers to an express trunk-line system for interneighborhood transportation and to major trip generators such as the university, hospitals, shopping centers, and the downtown central business district.

Thus, we project a reversal of the downward trend in public transit that has characterized urban life in the United States since World War II. That reversal is apparently under way in Ann Arbor and in other cities throughout the country and indeed throughout North America. That dial-a-ride has a major place in the planning for this reversal now seems assured.

REFERENCE

1. Lansing, J. B., and Hendricks, G. Automobile Ownership and Residential Density. Institute for Social Research, Ann Arbor, Mich., 1967, Ch. 4.

DIAL-A-RIDE PROJECT IN ANN ARBOR: LEGALITY

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Prior to the commencement of dial-a-ride service in Ann Arbor in September 1971, rather clear indications existed that the local taxicab industry regarded the program with fear and suspicion and and would give serious consideration to instituting litigation to prevent the program from coming into being. In an effort to cooperate with the taxicab industry and to alleviate its fears, the Ann Arbor Transportation Authority specifically designed the dial-a-ride program so that taxicab companies could bid to become the operators of the system. No bids were received, however, and the authority proceeded with plans to operate the system itself. To no one's great surprise, a lawsuit denominated Kon et al. v. City of Ann Arbor et al. (Washtenaw County Circuit Court, No. 5967) was commenced by Ann Arbor's 2 major taxicab companies just a few days prior to the scheduled commencement of service. The principal relief requested in the suit was an injunction against the operation of the dial-a-ride system.

The taxicab companies contended that the establishment of dial-a-ride would be unlawful for several reasons.

1. Dial-a-ride vehicles were really taxicabs and were, therefore, required to obtain licenses under the Ann Arbor taxicab ordinance;
2. The granting of licenses to existing taxicabs by the city constituted an implied agreement by the city that it would not engage in a competing business or, in the alternative, that if it did engage in such a business it would do so on terms identical to the terms under which the taxicab industry operates; and
3. Ford Motor Company (which was sued as a co-defendant) was being greatly enriched by the program without giving adequate consideration in return, and the public was thereby defrauded.

The city responded to the complaint of the taxicab companies by filing a motion for summary judgment, in which the Ford Motor Company joined. In its motion, the city answered the principal contentions of the plaintiffs as follows:

(1) The alleged necessity for compliance with the Taxicab Ordinance. The Ann Arbor Taxicab Ordinance (City Code, Chapter 85) defines "Taxicab" as follows:

> 7:151(1) "Taxicab" shall mean and include any motor vehicle operated solely or mainly within the public streets and quasi-public places of this City, accepting passengers for transportation for hire on call or demand, between such points as may be directed by the passenger or passengers. The term taxicab shall not include vehicles furnishing mass transportation service, such as motor buses which operate over fixed routes or on a fixed schedule or between definite termini; buses employed solely for transporting school children; chartered buses; or motor vehicles used solely for funerals, weddings, christenings, and similar events.

Plaintiffs assert that the dial-a-ride system, if established at all, must be established in conformity with the Taxicab Ordinance, but it is clear from the very definition of taxicab that the ordinance is inapplicable to dial-a-ride.

First, the ordinance states that taxicabs will operate "between such points as may be directed by the passenger or passengers." The dial-a-ride vehicles, however, are not subject to the specific directions of the passengers. As described in the dial-a-ride work program, the vehicles will pick up passengers at their homes but will be permitted to drop these passengers off only along a loop surrounding part of the central business district. As the work program makes explicit, "No stops will be made on streets off the loop."

Second, the ordinance specifically exempts the following from the definition of taxicab: "vehicles furnishing mass transportation service, such as motor buses which operate over fixed routes." The dial-a-ride vehicles will be operated under the auspices of the Ann Arbor Transportation Authority, a body corporate duly organized under P.A. 55 of 1963 [M.S.A. Section 5.3475(1) et seq.] for the specific purpose of operating a mass transportation system. Each vehicle will provide transportation for 12 persons at one time, and no passenger will have the power—as he would in a taxicab—to limit the number of passengers to be transported. Moreover, as previously indicated, the dial-a-ride vehicles operate at least in part along a fixed route, namely, the central business district loop.

Hence, because the dial-a-ride vehicles are not to be subject to the specific directions of their passengers, because they will furnish mass transportation service, and because they will operate over fixed routes, these vehicles are simply not taxicabs under Chapter 85 of the City Code and, therefore, need not conform to the provisions of that chapter.

(2) The alleged unfair competition, breach of contract, and "deprivation" of property without due process. The individual plaintiffs are municipal taxicab licensees, and they claim that this status gives them standing to prevent the city from instituting the dial-a-ride system. A remarkably similar contention was advanced by the operators of private streetcar systems which had been municipally franchised when the city of San Francisco proposed to construct a municipal system; the battle progressed through the federal courts and up to the U.S. Supreme Court, and at all levels the power of the municipality to create its own transportation system was upheld [United Railroads v. San Francisco, 239 F. 987 (N.D. Calif. 1917); affirmed, 249 U.S. 517 (1918) (Holmes, J., for a unanimous Court)].

Before the U.S. District Court, the operators of the private streetcar systems argued—much as plaintiffs do here—that the creation of a municipal system would breach contractual obligations created by their franchises and would deprive them of property without due process of law. The court rejected this argument quoting with approval from the decision of the U.S. Supreme Court in Knoxville Water Co. v. Knoxville (200 U.S. 22):

> A municipal corporation, when exerting its functions for the general good, is not to be shorn of its powers by mere implication. If by contract or otherwise it may, in particular circumstances, restrict the exercise of its public powers, the intention to do so must be manifested in words so clear as not to admit of two different or inconsistent meanings.

In the instant case, plaintiffs do not contend—nor could they truly—that the city of Ann Arbor in granting taxicab licenses explicitly agreed not to enter the taxicab business. A fortiori, plaintiffs cannot successfully contend that the city agreed not to commence a dial-a-ride system, which, by definition, is not even a taxicab system. Plaintiffs state only that their licenses are implied contracts, and, under the clear-cut decisions of the U.S. Supreme Court, the exercise of the municipal police power in the public interest cannot be relinquished by mere implication.

Thus far, plaintiffs' contentions have been treated purely as matters of law and have been shown to be untenable. It might be added, however, that plaintiffs' arguments are also factually unsupportable. The dial-a-ride system, in its initial phases, will serve only 2,100 of Ann Arbor's 31,000 households and only between 6:30 a.m. and 6:00 p.m. on Mondays through Thursdays and between 6:30 a.m. and 11:00 p.m. on Fridays and Saturdays, and is thus clearly incapable of competing—let alone competing unfairly—with the taxicab industry, which serves the entire community 24 hours a day. Thus, even if the creation of a municipal transportation system gave plaintiffs a legal foundation for their claim—which it does not—their "damages" in this case would be entirely too speculative to justify equitable relief.

(3) The alleged illegality of cooperating with Ford Motor Company. Plaintiffs argue that, because Ford Motor Company stands to benefit from its agreement to cooperate regarding the development of the dial-a-ride system, commencement of the system is illegal. The short answer to this contention is that, if benefit to a private party invalidated a government contract, a government could almost never enter into contracts—a patently absurd conclusion.

Plaintiffs appear also to advance the related argument that the consideration received from Ford is "woefully inadequate" and that the agreement is therefore invalid. This argument, particularly in light of the facts of the situation, is entirely without merit. It is first to be noted, as a matter of law, that a municipal contract is presumed to be valid (1). Moreover, the adequacy of consideration is not generally a matter of judicial concern (1). In this case, it is the considered judgment of the members of the Ann Arbor Transportation Authority that the arrangement with Ford Motor Company is more than fair to the city and its residents and very much in the public interest.

While it is true that Ford may obtain data which will be useful to it in developing dial-a-ride systems in other localities, the information to be obtained from the Ann Arbor experiment will be public information, usable not only by Ford but by all other interested parties. Furthermore, Ann Arbor is under no obligation whatever to obtain future vehicles from Ford if the system proves successful. Ford, in exchange for this information, is devoting numerous hours of expert manpower to developing a system which is expected to be of great long-term benefit to the citizens of Ann Arbor in meeting their transportation needs; additionally, Ford will, at no cost, lend a vehicle to the Transportation Authority for use in the initial phases of the program. Even if the court is inclined to consider the question of adequacy of consideration, there can be no doubt that the citizens of Ann Arbor are being treated fairly in the instant situation.

Summary: What was true in the case of the San Francisco streetcars in 1917 is even more true in today's crowded urban environment: The municipality must be permitted to further the public interest by improving the system of public transportation. Particularly in a case like the present one, where the proposed improvement is experimental in nature and covers only a small part of the city, the speculative fears of the taxicab industry provide no basis for equitable relief.

The city further contended that the taxicab industry was precluded by the legal doctrine of estoppel from obtaining injunctive relief. The city argued that, at the urging of the taxicab industry, the city had gone out of its way to make it possible for the taxicab industry to become the operator of the dial-a-ride system and that it would therefore be inequitable for the taxicab industry to be permitted to keep the system from coming into being.

Following a hearing, Washtenaw County Circuit Judge Ross W. Campbell granted the city's motion for summary judgment, thereby dismissing the lawsuit. A copy of the judge's opinion is included in the Appendix.

Subsequent to the issuance of the Circuit Court order, the plaintiffs filed an appeal with the Michigan Court of Appeals. The matter was argued in April 1972. The arguments of the taxicab companies on appeal were essentially the same as those made at the trial level, with a slight shift in emphasis. Rather than complaining principally of a purported violation of an implied agreement not to compete, the companies contended they were being denied equal protection of the laws because they were governed by standards different from those applied to dial-a-ride concerning such matters as rates and licensing. The city, in its brief, answered this contention as follows:

While appellants phrase their constitutional arguments both in terms of due process and equal protection, it appears that these arguments are based on a single premise, namely, that similarly situated activities are being treated in an unlawfully dissimilar manner. As appellees have demonstrated in the preceding portion of this brief, it is simply not the case that dial-a-ride and taxicabs are similar activities; moreover, appellants' suggestion that taxicab rates are somehow forced upon them by a malevolent city government is simply untrue. Hence, appellants' premise is false, and their argument is without support. However, it is worth going on to point out that even if dial-a-ride and taxicabs were virtually identical in their operations and even if the city did force the taxicab industry to charge particular rates, appellants' constitutional claims would be invalid, for the following reason: Dial-a-ride is an activity of a governmental agency, performed in the interest of public health, safety, and welfare, and this fact would make it constitutionally permissible to govern dial-a-ride by standards different from those applied to the taxicab industry.

In Springfield Gas and Electric Co. v. City of Springfield [257 U.S. 66 (1921)], the U.S. Supreme Court considered, and unanimously rejected, the claim that it constituted a denial of equal protection of the laws for a state to require private utilities to be regulated by a utilities commission while allowing a municipality to set the rates for a utility owned by it. Mr. Justice Holmes explained the Court's conclusion in the following way (257 U.S. 70):

The private corporation, whatever its public duties, is organized for private ends, and may be presumed to intend to make whatever profit the business will allow. The municipal corporation is allowed to go into the business only on the theory that thereby the public welfare will be subserved. So far as gain is an object, it is a gain to a public body, and must be used for public ends. Those who manage to work cannot lawfully make private profit their aim, as the plaintiff's directors not only may but must.

Appellants cite an A.L.R. annotation and a handful of cases which purportedly demonstrate that it makes no difference that dial-a-ride is a governmental project and that dial-a-ride and taxicabs must follow the same procedures. These authorities, however, are utterly irrelevant. All that these authorities indicate is that, if a government provides a service, it cannot unreasonably discriminate among users of the service. For example, the Ann Arbor Transportation Authority could not discriminate unreasonably among dial-a-ride riders. The authorities in no way suggest that there is anything unlawful about a governmental agency engaging in an activity which competes with a private activity, even if rate structures are different and even if such competition is detrimental to the private activity.

Indeed, the propriety of governmental agencies engaging in activities potentially competitive with private business has been upheld by the highest courts on both the state and federal level, and the poverty of appellants' position is best indicated by the fact that appellants have consistently ignored these controlling decisions throughout these proceedings [Springfield Gas and Electric Co. v. City of Springfield, supra; United Railroads v. San Francisco, 249 U.S. 517 (1918); Detroit v. Wayne Circuit Judges, 339 Mich. 62 (1954); Andrews v. City of South Haven, 187 Mich. 294 (1915)].

To summarize, it is not true that dial-a-ride is the same sort of transportation system as the taxicab industry, nor is it true that any governmental agency forces the taxicab industry to charge rates higher than those of dial-a-ride; however, even if either or both of these allegations were true, appellants would have failed to state any valid constitutional claim.

On June 2, 1972, the Court of Appeals rendered a unanimous decision upholding the Circuit Court and affirming the legality of Ann Arbor's dial-a-ride system. A copy of this decision is also given in the Appendix. The taxicab companies have elected not to appeal the decision of the Court of Appeals to the Michigan Supreme Court. Hence, it would appear that the legal basis for Ann Arbor's dial-a-ride system has been firmly established.

Reference

1. McQuillin. Municipal Corporations, 3rd Ed. Sections 29.96 and 29.02.

Appendix

TRANSCRIPT OF OPINION OF WASHTENAW COUNTY CIRCUIT JUDGE ROSS W. CAMPBELL

THE COURT: Gentlemen, I apologize for being much longer than I had anticipated, but in deference to the amount of work which counsel have put into the case, the numerous serious questions presented and their complexity required more time to decide the matter than I had anticipated, and I wanted to be able in rendering my decision to make the opinion as detailed as the complexity and number of issues required.

First of all, I would like to comment that this, indeed, is a most unfortunate situation. The public through its duly elected officials and government is trying to develop and improve less expensive systems of transportation for the people of the community, and the changes they are attempting to introduce, at least experimentally, necessarily compete with and threaten the livelihood of those who are established in providing additional service. The situation is somewhat reminiscent of the dislocation that we know accompanied the advent of the industrial revolution many years ago, a process which is still in evolution. But this case is not so much a conflict between the municipal and private enterprises as a matter of mutation and experimental change in the form of public transportation service, as I see it.

Let us assume for a moment, without deciding, that dial-a-ride is a taxi service under Chapter 85, Section 7.151(12), of the Ann Arbor City Code, and that, if operated by a private person or a corporation, it would fall within Chapter 85, Section 7.161, of the code, which requires a certificate of public convenience.

The Court does not interpret Chapter 85, Section 7.161, of the code as applying to the city itself. It would be patently useless and circular to require a city to obtain from itself a certificate of public convenience and necessity before it could operate a taxicab service itself. The provision of the code was obviously intended to apply only to persons other than the city itself. So, I find first that provision of the city code does not apply to the city itself should it undertake to operate a taxi service.

Second, viewing the complaint in the manner most favorable to the plaintiffs, I find that there is no estoppel operating against the defendants.

Third, there is no allegation that an individual passenger in the vehicles which the transportation authority would be operating would have the power, as they would in a taxicab, to limit the number of passengers who could be in those vehicles, again viewing the complaint in the manner most favorable to the plaintiffs; that is, there is no allegation that the passengers or any one passenger could hire the entire vehicle with one fare and deprive other persons or other members of the public from occupying empty seats in it.

There is further no allegation in the complaint that the vehicle could be hired to take any particular route that the passenger wishes; instead it must follow a fixed route. Now these are not the only indicia, but it would be difficult to conceive of a taxi, at least within our traditional concept of a taxicab, in which a passenger did not have those two rights.

Now even if these vehicles are otherwise classed as taxicabs or even if they are ordinary taxi vehicles which the city should choose to utilize for this purpose (I do not understand that they do but assuming for the purpose of this argument or this opinion that the city were to utilize ordinary types of vehicles like those used as taxicabs), I would find that they are vehicles which are within the words of the ordinance furnishing mass transportation service, and the furnishing of mass transportation service is not dependent upon the configuration, the geometry, size, number of seats, or the color of the vehicle which is used for that purpose. As such, I find that these vehicles are expressly exempted from the definition of taxicab under Chapter 85, Section 7.151(12), of the Ann Arbor City Code. My third finding, then, is that these vehicles are not taxicabs within the definition of this section of the code.

Now, there is no question but that the dial-a-ride system will compete with the plaintiffs, but does it constitute unfair competition, within the technical definition of that phrase, as grounding an action under the law? To do so, there must be traditionally a passing off or pawning off the goods or services of one person as those of another. It is not every competition, no matter how hard it may be on the person who is not used to that competition, which falls within the legal definition of unfair.

There is no allegation here of any passing off or pawning off of the services provided by the proposed transportation authority as those of any of the plaintiffs, individual or corporate; and, accordingly, my fourth finding is that there is no unfair competition within the legal definition of such a phrase as capable of grounding a cause of action.

Do the city licenses issued to plaintiffs constitute a contract which prevents the city from going into the taxi business itself? If so, such a contract exists only by implication. I would quote from United Railroads of San Francisco v. City and County of San Francisco (249 U. S. 517, 993) as follows:

> In the construction of legislative enactments and of ordinances and of contractual relationships which directly concern the public, the doctrine which controls is as announced in Knoxville Water Co. v. Knoxville, 200 U.S. 22; 26 Sup.C. 224, 50 L.Ed. 353: "A municipal corporation, when exerting functions for the general good, is not to be shorn of its powers by mere implication. If by contract or otherwise it may, in particular circumstances, restrict the exercise of its public powers, the intention to do so must be manifested by words so clear as not to admit of two different or inconsistent meanings."
>
> This general rule is but another form of stating a principle that statutory grants by way of franchise or property, in which the government or public has an interest, are to be constructed strictly in favor of the public, and whatever is not unequivocally granted is withheld. Nothing passes by implication.

I find nothing in the law making such a franchise as was granted to the plaintiffs in this case an exclusive one pro tonto, and under these circumstances I must accept the reasonable interpretation of the language used in the ordinance under consideration here as not showing any deliberate purpose to make a surrender of the city's rights, nor as a conferring of such an exclusive right to the plaintiffs as against the city as would enable them to ground this action, even on the theory of a covenant or contract by the city not to compete.

I would point also to the appellate court opinion growing out of the case which I just cited (United Railroads v. San Francisco, 249 U. S. 517, 520) that a covenant by a city not to grant to any other person or corporation a privilege similar to that granted to the covenantee does not restrict the city from itself exercising similar power.

Mr. Crippen has well made his point here that the city originally put this system contract out for bids and might very well have contracted with a private agency for this purpose. But that is not the question before us here, and we will not address ourselves to that. What we have here is a case where a municipal authority itself will be operating the transportation system. Accordingly, the fifth finding of the Court is that the franchise issued by the city to the plaintiffs does not constitute a contract by the city not to compete.

The plaintiffs complain of deprivation of property without due process. The kind of damage which constitutes deprivation of property without due process and grounding of an action on that basis is damage which results from conduct, like taking or appropriation, that would be tortious in and of itself, unless in proceedings in eminent domain or under some other law authorizing it on the condition that damages be paid. In this connection I would again cite the United Railroads case, at page 521: "Mere competition alone does not ground such a right or claim for damages. Mere competition alone is not such a tortious taking as to ground such an action." Accordingly, my sixth finding is that there is no violation of the constitutional provision forbidding the taking of property without due process, viewing the allegations of the complaint in their most favorable light.

The complaint further alleges that the Ford Motor Company is giving the city a free vehicle and technical services in exchange for the city permitting the Ford Motor Company to do certain things. The decision as to the adequacy of consideration is in the first instance one for the duly elected representatives of the city to determine. Their decision and the terms of the contract in this case do not appear to the Court to be so inadequate as to be evidence of fraud or to shock the conscience of the Court. My seventh finding is that I do not find the consideration inadequate nor any evidence whatsoever of fraud from the face of the complaint.

For the same reasons that I have hereinbefore stated, my eighth finding is that I find no denial of equal protection to the plaintiffs. Ninth, I do not find that the actions of the city constitute an unreasonable, arbitrary, or capricious exercise of police power.

For the reasons stated, the motion for summary judgment is granted. Court is adjourned.

OPINION OF THE COURT OF APPEALS

Plaintiffs appeal from the trial court's grant of summary judgment [GCR 1963, 117.2(1)] in favor of defendants. We affirm.

Plaintiffs are licensed by defendant city under its ordinance to operate taxicabs in the city. Under authority of the mass transportation authorities act [MCLA 124.351 et seq.; MSA 5.3475(1) et seq.], defendant city has instituted and operates an experimental transportation system known as "dial-a-ride." Plaintiffs' action sought to restrain defendants, individually or collectively, from establishing and operating dial-a-ride.

On appeal, plaintiffs contend that dial-a-ride is subject to the city's taxicab ordinance; that plaintiffs are denied due process of law and equal protection of the law through the operation of dial-a-ride as proposed by defendants.

Chapter 85, Section 7.161, of the city's taxicab ordinance reads: "No person shall operate any taxicab in the city of Ann Arbor without first having obtained a certificate of public convenience and necessity from the board authorizing such operation." The language of the ordinance precludes its application to defendant city [United Railroads of San Francisco, 249 U.S. 517; 39 Supreme Court 361 (63 L.Ed. 739, 1919)].

The basic premise from which plaintiffs advance their due process and equal protection arguments is rights they assume they have as licensees. We find that basic premise to be false. Defendant city has reasonable control of its streets (Const. 1963, Article 7, Section 29). Plaintiffs have no right to use the streets without the consent of the city [Melconian v. City of Grand Rapids, 318 Mich. 397 (1922)]. The licenses plaintiffs rely on are nothing more than a privilege to do what is prohibited without such licenses [C. F. Smith Co. v. Fitzgerald, 270 Mich. 659 (1935)].

In establishing and operating dial-a-ride, defendant city is doing what the mass transportation authorities act, supra, authorizes.

Affirmed but without costs.

Quinn, Brennan, and Targonski, JJ.

DEMAND-RESPONSIVE TRANSPORTATION AS SEEN BY THE TRANSIT WORKER

John M. Elliott
President, Amalgamated Transit Union

Few challenges are more important to transit workers and their union representatives than to find ways and means of revitalizing public transportation in urban areas. A strong public transit system is essential to the economic and social health of cities. In addition, it represents to the transit worker his only chance for a secure job, earnings adequate to provide a decent standard of living, and the protection of a reasonable pension when his working years are over. Accordingly, for some years the Amalgamated Transit Union has eagerly searched for a remedy or remedies giving promise of rejuvenating public transportation as an economically viable institution.

We know that the real cause of the transit industry's ever-worsening economic position has not truly been the skyrocketing of labor costs in an inflationary era, although certainly those costs must be expected to climb more rapidly in a labor-intensive industry such as transit. The real economic difficulty, however, lies elsewhere: in the declining productivity of a fixed-route transit system that carries an ever-decreasing number of passengers for every mile or hour of service operated as fares increase and service deteriorates.

We have been frustrated, especially in the last several years, by what we consider the failure of government and transit-industry management to respond dynamically and effectively to the challenge presented by this problem of declining productivity. For many years, millions of dollars of taxpayers' money have been spent in building freeways and in providing downtown parking facilities, both of which encourage urban sprawl, dispersed trip origins and destinations, and more and more reliance on the automobile in direct competition with our industry. The automobile, in turn, not only competes with public transportation but causes the traffic jams that stall our public transit vehicles. Meanwhile, federal transit-aid funds have been kept to a small fraction of the federal highway-aid funds, and even those transit funds appropriated have been misused for capital improvements that offer little or no near-term benefit to the riders of bare-bones transit systems.

On a number of public occasions, the Amalgamated Transit Union has gone on record in support of a dramatic restructuring of our industry, based on better service to the public and equitable cost sharing by all those who benefit from transit. We have urged that public transportation be operated on a completely fare-free basis, with the costs prepaid primarily by the local taxpayer. This new form of universal public transportation that is supplied by and for the entire community served by the system at absolutely no user charge to the passenger is, we believe, the single best hope of providing every urban citizen an efficient, convenient, and attractive alternative to the private automobile.

On the other hand, we are firm in our conviction that revitalization of our industry must also include improved service through innovations such as express bus lanes and, perhaps even more important, demand-responsive doorstep service that will make public transportation available to everyone in the entire community served by the transit system.

Thus, the ATU has looked with favor on dial-a-bus as an attractive improvement, offering jobs and economic progress to our membership and increased ridership and productivity to the transit system. For several years in public statements, we have urged that dial-a-bus be given a much higher priority in the federal transit-aid programs, which have focused, we feel, far too much on capital-intensive remedies, such as highly automated-rail and fixed-guideway systems designed primarily for service to and from the downtown areas. We suggested then that the demand-activated concept of dail-a-bus holds more promise of attaining a total system of reliable low-cost public transportation to the entire community. We feel that the dial-a-bus concept offers to the transit industry a real opportunity to open new markets in the lower density areas and wherever trip origins and destinations are too widely dispersed to permit service by conventional line-haul transit.

Frankly, in the years since 1968 when the new-systems studies of the U.S. Department of Housing and Urban Development recommended dial-a-bus for special study and demonstration because of its near-term potential and limited development costs, practically nothing has been accomplished to advance this concept in an operational setting. In June 1970, the Urban Mass Transportation Administration wrote to us stating that dial-a-bus would be given "a proper demonstration" because it was regarded as "one of the few near-term new system solutions for public transportation problems, particularly in lower density residential areas." Unfortunately, UMTA decided to demonstrate this demand-responsive service by using manual dispatch of vehicles, although only a reliable computer-dispatch capability, with its memory bank, could guarantee optimal performance of the dial-a-bus system in terms of speed, reliability, convenience, and cost. In August 1970, we wrote an open letter to the U.S. Department of Transportation inquiring why it should take so long and be so difficult to make use of dial-a-bus techniques, systems, and equipment that had already been developed and laboratory tested and needed only to be demonstrated in a proper operating project to determine whether they would improve public transit service.

Two years later the first only federal dial-a-ride demonstration project—a manually dispatched service with a fleet of 12 vehicles—finally was launched at Haddonfield, New Jersey. This service is provided by drivers and maintenance personnel belonging to our union and employed by Transport of New Jersey. The demonstration service was held up by an unrelated labor dispute and resumed following a long and difficult strike for a new working agreement. The operating results available to date, which tend to show considerable ridership in the off-peak and weekend hours, must be regarded as preliminary and probably affected at least to some degree by the labor dispute. Under the best of circumstances, as we have pointed out to the department, there can be no possible relevancy of the manual test to the ultimate success or failure of a computer operation.

We predict that if there is no change in the present attitudes of the Congress and the executive branch of the federal government, this still promising new-system concept called dial-a-bus will be sunk without trace, in apparent deference to those who believe in mass expenditures for new capital equipment, automated rapid transit systems, people movers, and the like. The proponents of the so-called "capital-intensive" approach would have us believe that, because as much as 80 percent of all transit operating costs at present are labor costs, the only way to solve the industry's economic problem is to eliminate labor. As recently as April 12, 1972, UMTA stated to the House Appropriations Committee that any additional investigation into dial-a-ride technology in fiscal 1973

...depends on what we learn from Haddonfield and from approximately 10 other non-federally supported projects similar to Haddonfield that are in operation. If we conclude that dial-a-ride's economic characteristics are such that virtually no communities in the Nation are willing to support it, then there will be no additional technological development. If, however, we conclude that there are a substantial number of communities willing to support dial-a-ride, then we plan to (1) test our first generation computerized control system in Haddonfield, using the existing manual control system as backup; (2) commence extension of the first generation computer system into a second generation system, one that does not rely upon manual control for backup; and (3) search for a new site to conduct a second dial-a-ride demonstration.

It seems to us that UMTA proposes to reject computerized dial-a-bus from any future federal funding on the basis of a manually dispatched operation and, even worse, because the experiment proved "uneconomic" in terms of its inability to support itself from the fare box.

Such outmoded and inequitable concepts of fare-box financing have long proved unworkable as applied to conventional public transit. Secretary of Transportation Volpe, himself, expressly rejected them, stating that the fare box should not be expected to cover all the costs of providing essential transportation services. Why should dial-a-bus be differently treated? To the extent that dial-a-bus simply provides new service in currently unserved areas, replaces fixed-route service, or functions as a collector-feeder system between line-haul services and lower density residential areas, it seems to us no different from traditional forms of public transportation that have, in many cases, received the financial support of the community at large. Of course, to the extent that dial-a-bus is used to provide a true premium or luxury type of service on a convenience basis, the individual user may reasonably be expected to pay his full way without support by public funds.

We have had such limited experience with dial-a-bus in an operational setting that it is difficult as yet to appraise the nature and extent of its impact on collective bargaining in the industry or on the needs and desires of our membership. We believe, however, that demand-responsive services should improve the convenience, reliability, and speed of transit and thus generate a greatly increased patronage base. The increased ridership, inspired by this more responsive service structure, should enable the transit system to function more productively, measured in terms of the number of passengers carried per vehicle-hour and mile operated, and thereby to reduce the overall cost per ride.

Moreover, there is every reason to believe that dial-a-bus transit might, for the first time, enable the industry to tap substantial ridership from the off-peak market, which, typically, has far lower demand densities and dispersed origins and destinations. Coventional line-haul transit serves 5 to 10 times more people during the peak hours than during the average midday period. Penetration of the off-peak market should offer the industry substantial labor and other cost economies and provide increased revenues as well. Dial-a-bus should help stabilize the number of jobs in the industry, reduce the need for split-shift schedules, and otherwise provide a means of achieving higher labor productivity without eliminating jobs.

We fully expect 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. In any event, we are convinced that demand-responsive transit will provide the transit worker with better job security and the potential for greater earnings. Demand-responsive transit is, therefore, an attractive opportunity to the worker, can help stem the industry's economic decline, and can, at the same time, provide new job opportunities, better wages, and more adequate pensions, health and welfare, and other benefits and conditions of employment. In other words, we see no reason why demand-responsive techniques should present any special collective bargaining problems for our members or for the industry.

Under no circumstances, however, should the city transit worker who provides dial-a-bus service, as distinguished from regular line-haul service, be asked to accept lower wages or more restrictive working conditions in order that dial-a-bus can be made to pay its way or that lower fares can be charged. We have always taken the position that it is not an answer to the industry's economic problems to reduce wages and labor costs to the lowest possible level consistent with the need for an adequate supply of manpower. The suggestion that demand-responsive 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 operations whose true costs neither the employer nor the community as a whole is prepared to pay.

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. At this early point in our experience with dial-a-bus, we would urge that demand-responsive operations be integrated into the regular service with only such minimum revision of normal compensation, seniority, and working conditions as is clearly essential and agreeable to both parties. As in any collective bargaining situation, we would expect management to propose to do this work under terms most favorable to itself, while the worker, as usual, will be more impartial and sacrifice at least some portion of his interests to the greater benefit of the community! Presumably it is on that basis, rather than self-interest, that has led our membership in Haddonfield and Rochester to agree to certain restrictions on their normal picking rights, based on seniority, as they apply to dial-a-bus assignments and the right to bump into and out of this special work.

Perhaps we should close this presentation by stating that transit labor can only be counted on to look with favor on demand-responsive transit as long as the policies and programs for its implementation are sound and as long as adequate levels of employee protection are provided to those who may be adversely affected by such innovation. Under such conditions, the worker's response to the introduction of dial-a-bus systems should, in general, be friendly.

As a final caveat, we might add that in our judgment the transit industry has been very slow to revise its fixed-route structures and to take advantage of demand-responsive concepts. A continuing failure in this regard may well lead to the unnecessary introduction of competitive systems pledged to more dedicated service to the economic and social life of the community. We feel strongly that this should not happen, and we urge transit management to make a greater commitment to the earliest possible introduction of these demand-responsive services in the interests of better public transportation to the community as a whole.

INFORMAL DISCUSSION

Question: During the course of your formal comments you made a reference to the split shift. Will you elaborate on that? If I understood correctly, you indicated that there might have been a move to eliminate the split shift in working conditions, and it seemed to me that you concurred in that. Is that correct?

Answer: You put the emphasis in the wrong place. We saw that this was an opportunity that would bring about the elimination of the split shift. By using demand-responsive techniques, we could fill in the gap where we now have unproductive and unpaid manpower for periods of 2 to 5 hours in midday. I meant that we could fill in that gap with the demand-responsive needs.

Question: Do you foresee conflicts between labor and management on dial-a-bus?

Answer: I see no conflict. The conflict—if there is one—usually appears because of the demands of management and the demands of the public to get on with the job. The bus driver very much prefers to give courteous, safe, and complete service but finds it difficult in face of constant demands such as "Come on, make this traffic light" or "You're going to be half minute late, and a half minute late means you're going to have 25 percent of the people to carry, and that will delay everybody." It is not that we do not desire to give the service but the management has not given us the time to give effective service.

Question: A problem that we have encountered during the Haddonfield demonstration is that every time drivers choose their shifts we wind up with many new drivers who require training. Can we not get a permanent set of drivers assigned to the service? What is the position of the Amalgamated Union?

Answer: Well, as long as you envision dial-a-bus as a short-term solution, I think that will continue to be a problem. I think that, if there is any value to dial-a-bus, it is not only that it has the impact of being an immediate, short-term value but that it will be there in the long haul. On that basis then, it serves your purposes as operators of a transit system to train as many people as you possibly can—just as you have done and just as the industry did when it trained streetcar men to be bus drivers or gasoline mechanics to be diesel mechanics or bus drivers to be charter or sightseeing guides. We do this because we want as many people in the labor pool as possible. The lesson that you should not rely on too few people to staff an operation has been demonstrated during this conference. Two people are now absent because they were the key people in their local situations. You do not want to have to depend on a small group of people in your dial-a-bus system.

Question: But has anything been resolved on this issue at the national level?

Answer: I tried to maybe go around the back door to tell you that this probably is not so big a problem as you think. But if you think it is, then it has to be resolved at the local bargaining table. This union is formed of fairly autonomous local unions. We give leadership, but not direction.

FORD MOTOR COMPANY'S ROLE IN DIAL-A-RIDE DEVELOPMENT: 1972 AND BEYOND

Karl W. Guenther
Dial-a-Ride Program Manager, Ford Motor Company

Ford Motor Company recently announced its entry into the transportation systems business. The first product of this new venture is ACT, a driverless, computer-controlled vehicle that operates on lightweight low-cost aerial guideways. ACT is designed to transport people and goods within congested activity centers, to connect these activity centers, and to provide access from low-density suburban areas to central locations.

We realize that one type of system cannot provide for all transportation needs, however. In his announcement of the company's entry into the transportation systems business, Henry Ford, II, stated: "Ford is constantly looking for new ways to improve personal mobility and to transport goods. Improved mobility and better urban planning in the cities of today and tomorrow will require not one new system but a whole new family of flexible, convenient, and efficient transportation systems. We are working on other new systems that will be complementary to ACT." One such complementary system is dial-a-ride.

Dial-a-ride provides transportation in smaller communities and low-density suburban areas; in contrast, ACT serves high-density areas. Designed to serve relatively low-volume, diffused trip-making patterns, dial-a-ride offers the traveler doorstep pickup in response to a telephone request. He is taken where he wants to go, when he wants to go.

Dial-a-ride has been carried from the concept stage into practical applications. Several operating dial-a-ride systems have demonstrated conclusively that there is a better way of moving people in these low-density situations than with conventionally operated buses.

Ford's dial-a-ride program dates back to 1969; however, research on demand-responsive systems dates back to the early 1960's. We can now confidently predict 20 operating systems in North America by the first quarter of 1973 (Fig. 1).

Our own research and experience with operating systems (Table 1) has led to the following conclusions:

1. The operation of dial-a-ride public transportation service is totally feasible from a technical point of view;
2. The patronage of the public will be at a substantially higher level for this new kind of service than for the conventional fixed-route, fixed-schedule service; and
3. There is a significant diversion of travel to dial-a-ride from the private automobile.

The credibility for these 3 statements is found in the detailed descriptions of operating systems presented in other papers in this report. It is now generally accepted that dial-a-ride is a technical success and that market response is favorable. However, these conclusions fail to address the all important cost-revenue questions. Is Dial-A-Ride an economic success?

Figure 1. Existing and projected number of dial-a-ride installations.

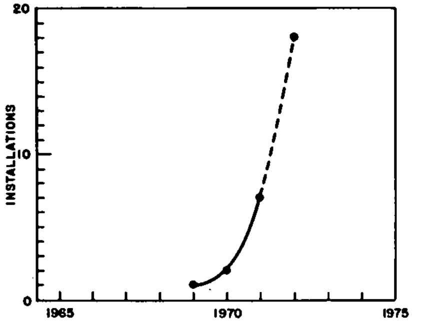


Table 1. Dial-a-ride systems in operation.

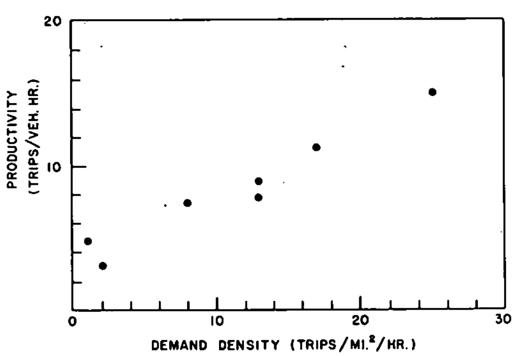
Location	Service Area Square Miles	Service Area Population	Riders per Weekday[a]	Trips per Vehicle-Hour	Trips per Labor-Hour[b]	Trip Cost ($)	Avg Fare ($)	Funding Agency	Funding Percent
Ann Arbor	1.36	10,000	214	7.7	5.4	1.35	0.50	Local	37
								State	63
Bay Ridges	1.34	13,700	463	11.3	7.6	0.60	0.25	Province	100
Batavia	4.75	17,300	455	6.7	6.6	0.61	0.50	Local	100
Columbia	6.00	17,300	54	4.4	3.0	N.A.	0.50	Local	100
Columbus	2.50	55,000	485	9.5	6.3	N.A.	0.20	Federal[c]	100
Haddonfield	6.50	16,000	333	2.6	1.8	N.A.	0.50	State	20
								Federal[d]	80
Regina	2.75	18,000	1,200	15.0	11.5	0.54	0.32	Local	100

Note: Data given represent a snapshot of 7 operating systems for the winter of 1972 and cannot be interpreted as an accurate representation of any system today. Most of the systems represented have since changed, ridership has increased, service has been expanded, and in some cases productivity has improved.

[a]Winter 1972. [b]Includes dispatcher. [c]Department of Housing and Urban Development. [d]Department of Transportation.

To answer, we must first look at system productivity, which is the key to dial-a-ride economics. Figure 2 shows how actual productivity in the field, as experienced in the winter operating season of 1972, relates to demand density. Because dial-a-ride costs (largely labor) are most accurately accounted on an hourly basis, the number of passenger-trips served per vehicle-hour is a direct and very meaningful method of comparing systems. In this case, the actual experience coincides very closely with the predictions made in the M.I.T. research work of 1968-69. This relation tells us very simply that dial-a-ride is more efficient if the distance traveled between stops is decreased, that is, if more people request service in a given geographic area. Therefore, to operate at maximum efficiency, dial-a-ride must generate a relatively high demand—more than 10 trips/square mile/hour. Only the 2 Canadian systems have regularly achieved this productivity, although Batavia, Ann Arbor, and Columbus have all done so on occasion.

Figure 2. Dial-a-ride operating experience.



The problem here is not a technical but rather a marketing issue: how to generate more demand from a given area. Most existing dial-a-ride systems do have the capacity to produce productivities in excess of the averages shown. We thus observe that, although almost every operating dial-a-ride system has demonstrated a greater ability to attract passengers than conventional bus service, in some cases the demand has not been high enough to produce really efficient operation.

The second element of economic viability of dial-a-ride is actual costs, which are made up primarily (60 to 75 percent) of driver and dispatcher labor. The actual cost per ride is obtained by dividing total hourly system cost by total hourly productivity. Because hourly labor rates vary so greatly among communities, no generalizations on cost are possible. We do find differences among systems in their use of dispatching labor, however.

So that dispatching and overhead costs can be kept in line, low-cost manual dispatching techniques have been developed. Some manual dispatching systems for small projects are "overdesigned" at the expense of operating efficiency. There is no need for 2 dispatchers when 1 will do. Elaborate visual dispatching aids (colored maps, lights, and markers) are impressive to visitors, but they can actually get in the dispatcher's way. The responsibilities of the dispatcher and his interactions with the driver deserve careful study and, when properly defined, can make the dispatching operation much more efficient. This is one area where a qualified professional with experience can be of great value in designing a new system.

Data given in Table 1 do not show that even one small-scale dial-a-ride operation is covering all of its costs. (Batavia is coming close and with added revenue sources does hope to break even.) Dial-a-ride is a very important service improvement and is highly attractive to the public, but it is not a short-term cost cutter at the present scale of operations. The actual level of subsidy required in a given community depends on local labor rate, fare structure, and demand for the service. An important observation here is that many communities have elected to provide dial-a-ride service at public expenses, and many are considering expansion of services on the basis of results obtained so far. The matter of public funds for support of public transport should remain a local issue for each community to address in its own way.

We also must reflect on fare structures (it may be desirable to price dial-a-ride service to more closely cover costs) but this again is a local decision.

Our principal findings from pursuing dial-a-ride research, then, are listed below.

1. The concept is becoming readily acceptable to transit operators, and more small-scale systems go on line every day. The "missionary work" has been accomplished; dial-a-ride has credibility and is becoming an important part of the transportation scene.
2. The operation of door-to-door, dynamically dispatched public transportation is totally feasible from a technical point of view.
3. The public is responding favorably to this type of service, from a standpoint of patronage, willingness to pay (directly and indirectly), and diversion to public transport from automobiles.
4. At the present scale of small systems and at present fare levels, dial-a-ride cannot be operated on a break-even basis, i.e., fares cover all costs. This, however, has not discouraged many communities from planning expanded systems.

As a correlative area of research, we at Ford have used dial-a-ride as a test case for learning about the process of innovation in public transport. We have found in this research that

1. Inertia and resistance to innovation are greater than we originally envisioned;
2. A sponsor, an operator, and technical support are required to implement a system successfully;
3. One can identify those character-

istics of a community that produce a favorable climate for innovation;

4. Design and implementation of dial-a-ride system can be a "do-it-yourself" project, providing proper tools are available (such as Ford's computerized system design models) and proper attention is given to all elements of the design; and

5. Each dial-a-ride system must be custom-designed to meet specific local political and social needs.

We have identified and are pursuing several promising areas for ongoing research.

1. Economies of scale in larger systems. We can conclude that spreading dispatching costs and overhead over more vehicles will produce some benefits, but, more important, will larger systems induce higher demand densities?

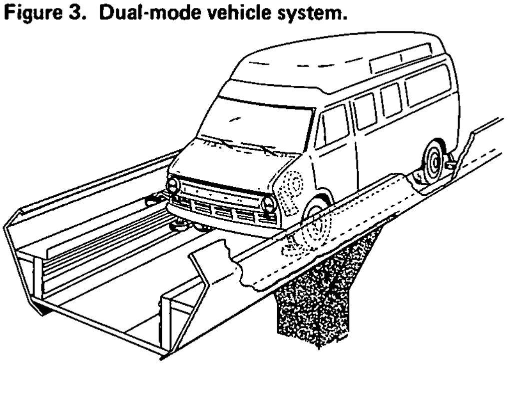
2. Automated dispatching. Our own studies to date have indicated possible application in the automation of information flow as opposed to actual decision-making.

3. Digital communications. A pilot test is scheduled for the fall of 1972.

4. Dual-mode dial-a-ride (Fig. 3). In this system, the guideway and controls for the Ford ACT system provide the flexibility to use dual-mode vehicles, including dial-a-ride buses, that are operated on conventional surface streets and highways but are specially equipped to enter the guideway where they are automatically controlled, register a destination, merge into the main guideway, and then leave the guideway to operate on surface streets. Intuitively, the dual-mode concept is very appealing. One can imagine, for example, a future system where no transfer is necessary either to get on a line-haul mode or to get from the transit station to the final destination. Whether dual-mode systems can really work better than properly interfaced single-mode systems is a question that our future research will attempt to answer.

5. Although it is the largest single component of total freight costs, urban goods movement has received very little study. There may be substantial spin-off from some of our dial-a-ride research into the field of local truck distribution systems, and we expect to launch a substantial research effort in this field.

Figure 3. Dual-mode vehicle system.



An obvious area of Ford concern has been vehicle development. We all acknowledge that currently available small buses have design compromises that make them less than perfect for dial-a-ride application. The present low-volume market does not justify our tooling to produce a special vehicle, nor does the potential future market appear to warrant extensive research and development expenditures. Therefore, we expect to continue working with specialty manufacturers, basing small buses on standard product lines. We are making a Ford Econoline bus conversion, which is explicitly engineered and manufactured to meet transit system needs, available to the industry in the fall of 1972. This conversion embodies strength and safety features that have not been available in small buses.

Ford will continue to actively promote the dial-a-ride concept as part of an overall commitment to better public transportation in urban areas. The present program calls for spreading design-implementation knowledge throughout the transportation community, making a stronger, safer vehicle available, and continuing research in larger, more sophisticated systems.

INFORMAL DISCUSSION

Question: Are there other sources of revenue for dial-a-ride besides the fare box?

Answer: Yes. Some of these sources are being developed in Batavia.

Question: How important is public attitude in general in convincing politicians to spend public money for a dial-a-ride system?

Answer: Sociological researchers tell us that, if a community is oriented in a public-spirited way toward one thing, it will tend to be oriented that way toward all things. If a community supports day-care centers, it will probably also support public transportation. There is a coalition in Ann Arbor right now between what I call the bicycle freaks and the transit freaks. They have motivated a large bloc of the community to stop additional road improvements in this current budget year. This is a fantastic development. It suggests how important public attitude is and that the people in the community must want something before politicians cause it to happen. If the people are indifferent, forget it.

USER PREFERENCES FOR DIAL-A-BUS

Richard L. Gustafson
Research Economist, General Motors Research Laboratories
Francis P. D. Navin
Vice President, R. H. Pratt Associates

This paper discusses the results of a survey of user preferences for the dial-a-bus transportation system in Columbia, Maryland. The analytical techniques used in the Columbia survey are based on those in surveys conducted in the cities of Warren and Center Line, Michigan (1, 5, 6).

The present research study sought to achieve 2 objectives:

1. To determine user preferences for dial-a-bus in an area where an actual system existed, and
2. To evaluate similarities and differences between the results of the surveys in Warren and in Columbia.

Two attitudinal surveys conducted in different cities can provide further insights into the transportation system characteristics that users regard as important. A survey conducted in one city is difficult to generalize to other areas. Preconceived notions of transportation and prejudices often force the analyst to reserve judgment of preferences to the case study city. The attitudinal surveys in Warren and in Columbia afford an opportunity to compare the preferences of 2 different populations in dissimilar environments.

Warren has primarily blue-collar workers; most residents have only a high school education. The household incomes are concentrated in the $10,000 to $15,000 range. The amount of public transportation available is limited; and most important, a dial-a-ride system was a completely new concept to these people. The system was explained thoroughly during the home interview, but the respondents were forced to rely on their imagination or their own perception of public transportation.

Columbia has a more diversified population than Warren. There is a greater proportion of people earning more than $15,000 in Columbia and about the same proportion in the lower income brackets. The respondents have a higher educational level. The population is more dense but much smaller; Columbia has a population of 10,000 as opposed to 200,000 in Warren. The residents of Columbia have seen a dial-a-bus system in operation.

The dial-a-ride service was truly a demand-responsive transportation system providing many-to-many service for the Columbia residents (1). The fare was $0.25 or 10 tickets for $2.25. To request service, the resident called the dispatcher, who checked the location of the vehicles and then assigned the caller to one of the vehicles if the estimated pickup time was agreeable. The dispatcher also took calls to reserve service in advance.

SURVEY DESIGN

The methods of paired comparison and semantic scaling were selected as the measurement devices for the home interview. The method of paired comparison was used to establish a scale of preferences for various system characteristics. The semantic-scaling technique was used to evaluate design alternatives for a number of system characteristics. A more detailed discussion of the techniques and the questionnaire design is given in another report (4).

The paired-comparison questionnaire originally had 32 system characteristics. For the Columbia survey the number was reduced to the following 15:

1. Arriving at your destination when you planned to,
2. Making a trip without changing vehicles,
3. Spending a shorter time waiting

to be picked up,

4. Paying a lower fare,
5. Spending less time walking to a pickup point,
6. Spending a shorter time traveling in the vehicle,
7. Being able to take a direct route, with fewer turns and detours,
8. Having small variation in travel time from one day to the next,
9. Being assured of getting a seat,
10. Calling for service without being delayed,
11. Having more protection from the weather at public pickup points,
12. Being able to select the time when you will be picked up,
13. Having a convenient method of paying your fare,
14. Having freedom to turn, tilt, or make other adjustments to the seat, and
15. Having a greater chance of being able to arrange ahead of time to meet and sit with someone you know.

The semantic-scaling questionnaire evaluated the desirability of design alternatives for the 15 characteristics. Those characteristics that were common to both Warren and Columbia surveys had exactly the same wording and accompanying illustrations in both surveys. The same statistical operations were performed on both sets of data.

In the paired-comparison questionnaire, not all of the paired choices were included in the survey. Three subsets of characteristics were established: levels of service characteristics, convenience factors, and vehicle design characteristics. Lower fare, assurance of a seat, and shorter travel time were paired with all of the characteristics. This allowed the development of a general scale from the relation of the 15 characteristics to the selected 3.

In the original surveys in Warren, no questions assessed the respondent's previous experience with public transportation systems. An additional page was added to the Columbia survey asking the respondent whether he used dial-a-bus frequently, occasionally, or not at all.

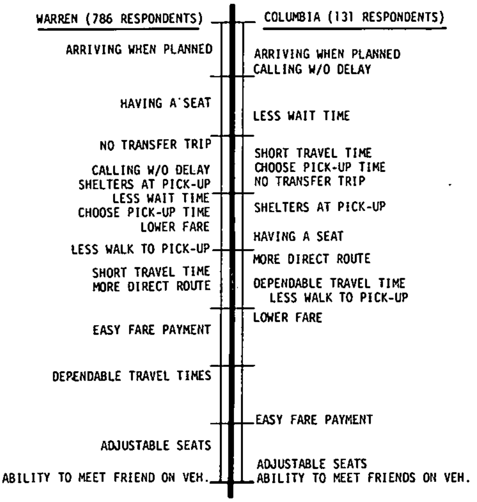
DATA COLLECTION

A home interview survey was conducted for 2 populations: (a) all residents of Columbia and (b) users of dial-a-bus. The general population survey sample was selected as follows: From the alphabetic list of residents for each village, a name in the first 10 names was randomly selected and then every tenth name thereafter was selected. The address was located on a map and assigned to a sample survey area. The users of dial-a-bus were selected from the records of 1 week's calls to the dispatcher. One of the first 10 names was randomly selected and then each tenth name thereafter. This list was merged with the general population list, and the names were randomly assigned to 1 of 6 interviewers. Interviews were conducted during the day and evening. Two call-backs were made before the name was removed from the list. All members of the household over the age of 14 were interviewed. The paired-comparison survey yielded 131 respondents, and the semantic-scale survey had 100 respondents.

ANALYSIS OF WARREN AND COLUMBIA RESULTS

The preferences derived from the paired-comparison surveys in Warren and in Columbia are shown in Figure 1. Only the 15 system characteristics common to both surveys are indicated on the scale. The results from the 2 surveys are quite similar in that dependability is most

Figure 1. Responses to paired-comparison questionnaires in Warren and Columbia.



important to both populations. Characteristics relating to time and cost are in a cluster below the most preferred characteristics. Then, well below these characteristics are those concerned with convenience and vehicle design.

The Warren respondents have only a traditional transit system as a frame of reference, and that is probably reflected by the high preferences for having a seat and a no-transfer trip. The Columbia residents did not rank those characteristics so high because dial-a-bus does not have transfers or very many standing passengers.

The Columbia residents have indicated through their preferences some of the shortcomings of dial-a-bus, particularly those experienced when the service was initiated. The dispatcher was averaging 2 minutes on the phone per request because he had to supply system information. A separate number was provided for system information but was seldom used. Therefore, many potential users were unable to contact the dispatcher. Consequently, calling without delay had a higher preference ranking from the Columbia residents. The service was well received, and often vehicles were unable to serve the demands, and wait times were as high as 60 minutes. The overload also caused increases in the travel time.

Table 1. Means of semantic scales for Warren and Columbia respondents.

Characteristic	Warren (813)	Columbia (100)
Importance of fare	5.7	4.8
Importance of travel time	5.5	5.2
Assurance of a seat	5.2	4.7
Waiting time at pickup	5.9	5.7
Pickup location		
Place of call	6.1	6.4
Nearest corner	5.5	5.1
Neighborhood	4.9	4.2
Nearest major street	4.1	4.3
Facilities at pickup location		
None	4.0	4.2
Curbside phone	4.6	5.0
Enclosed shelter	5.5	5.7
Overhead shelter	5.4	5.7
Waiting time, min		
5	6.1	6.4
10	5.8	6.1
15	4.9	5.0
20	3.8	3.9
Early arrival, min		
5	6.1	6.4
10	6.1	6.2
20	4.2	4.0
30	2.7	2.6
Interior design		
Standard	5.1	5.6
Grouped seats	3.0	3.8
Deluxe	5.2	5.4
One-way fare, dollars		
0.40	5.7	4.1
0.50	5.7	3.3
0.60	4.5	2.2
0.80	2.9	1.6
0.90	3.0	1.4
1.00	1.7	1.4
Fare collection		
20-trip ticket	4.2	4.3
Credit card	3.3	2.9
Monthly pass	3.7	4.0
Tokens	4.1	4.3
Exact fare only	4.2	4.6
Cash with change made	5.3	5.9

This problem is indicated by the preferences for shorter travel time and dependable travel time.

The fare for dial-a-bus was $0.25, and the fare for the fixed-route system in Warren was $0.35. The Warren residents would most likely believe that any new system would cost even more. Because of the existing fare levels, one would hypothesize that the relative preference for lower fare would be lower in Columbia than in Warren, which is the case.

Table 1 gives the means of semantic scales for both the Warren and the Columbia surveys. The means of the desirability of system alternatives closely paralled each other. The fare importance is lower, which is consistent with the paired-comparison results. The desirability of pickup at the place of call is higher for Columbia, and the desirability decreases more rapidly as the pickup gets farther away from the respondent's place of call.

Figure 2 shows the respondent's sensitivity to changes in the amount of waiting time. The curves for both Warren and Columbia are horizontal up to a 10-minute wait, at which point the user's satisfaction diminishes more rapidly as the waiting time increases. The early-arrival sensitivity demonstrates the same 10-minute threshold (Fig. 3). Not only is the threshold similar for both waiting for the bus and arriving early (another form of waiting), but the rate of change of acceptability up to 20 minutes is approximately the same.

The shape of the fare-sensitivity curves shown in Figure 4 is similar for both populations. Also the "knee" of the curve occurs at $0.65 and $0.75, and this may represent an upper limit of fares for those potential patrons with a choice of transportation modes. The different levels of satisfaction can be

Figure 2. Waiting-time sensitivity of Warren and Columbia respondents.

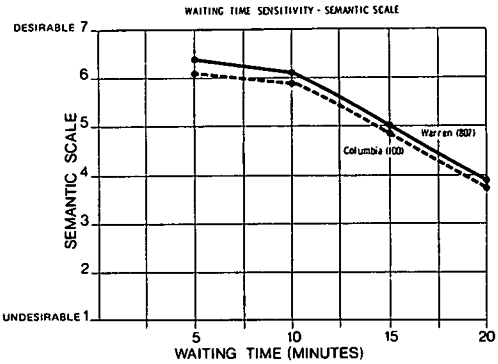
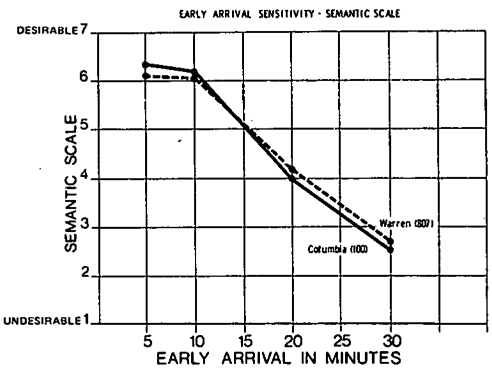


Figure 3. Early-arrival sensitivity of Warren and Columbia respondents.



attributed to the existing public transportation fares. A $0.40 fare is consistent with existing public transit fares in Warren, but it represents a 60 percent increase in Columbia.

ANALYSIS OF SUBGROUPS IN COLUMBIA

The paired-comparison results strat-

Figure 4. Fare sensitivity of Warren and Columbia respondents.

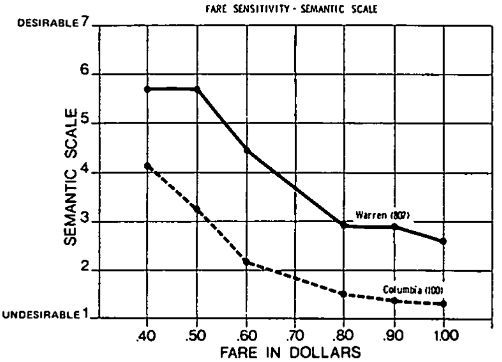
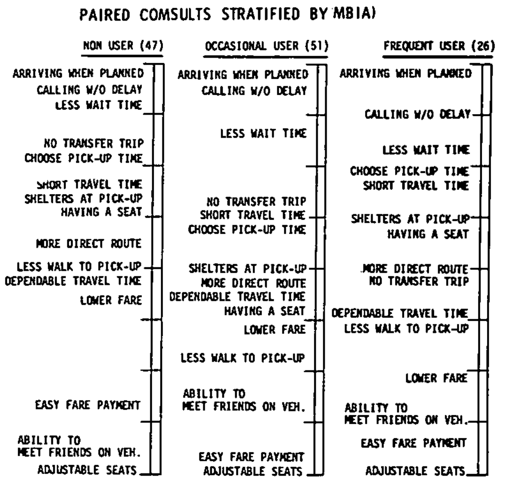


Figure 5. Responses to paired-comparison questionnaires in Columbia by user group.



ified by nonusers, occasional users, and frequent users of dial-a-bus are shown in Figure 5. The groups indicate similar ordering of preferences for most of the characteristics. The frequent users indicate a more even distribution of characteristics throughout the scale, and those seldom using the system have a tendency to group the characteristics. The nonusers indicate high preferences for system characteristics that have been a problem with the dial-a-bus service.

Calling without delay and less wait time are just below arriving when planned on the preference scale for nonusers. Calling without delay is rated the same by both occasional users and nonusers, but less waiting time is rated lower by the nonusers. Less waiting time is rated the same by frequent and occasional users, and calling without delay is rated higher by the frequent user. Sensitivity to waiting time distinguishes nonusers from users, and a preference for the calling-without-delay characteristic distinguishes the frequent user from the other two user groups. Two other characteristics decrease in preference from nonuser to frequent user: no-transfer trip and lower fare.

Users of dial-a-bus are more willing to accept the inconveniences that accompany a public transportation system. Most of the characteristics receive a lower preference rating by the users than by the nonusers except for those characteristics related to the advantages of dial-a-bus over a conventional bus system. To the frequent user, choosing pickup time and arriving when planned are important characteristics that are currently being satisfied by dial-a-bus.

Table 2 gives the means of semantic scales by frequent users, occasional users, and nonusers in Columbia. The importance of fare is consistent with the paired-comparison results. The "knee" of the curve for the seldom and occasional user is approximately $0.65. The frequent user indicates a high mean desirability for the 20-trip ticket, which is already being used and is apparently popular with the frequent user. The

Table 2. Means of semantic scales for Columbia respondents by user group.

Characteristic	Non-user (29)	Occasional User (47)	Frequent User (23)
Importance of fare	4.6	5.2	4.0
Importance of travel time	5.1	5.0	5.5
Assurance of a seat	4.4	4.8	4.6
Waiting time at pickup	5.8	5.6	5.9
Pickup location			
Place of call	6.3	6.5	6.4
Nearest corner	5.8	5.6	5.1
Neighborhood	4.9	3.8	4.0
Nearest major street	5.1	4.2	4.0
Facilities at pickup location			
None	4.1	4.5	4.0
Curbside phone	4.7	5.2	5.1
Enclosed shelter	5.5	5.8	6.0
Overhead shelter	6.0	6.0	5.3
Waiting time, min			
5	6.3	6.8	6.4
10	6.3	6.2	6.3
15	4.8	5.1	5.7
20	3.5	3.8	4.9
Early arrival, min			
5	6.3	6.5	6.4
10	6.1	6.4	6.0
20	4.2	4.1	3.8
30	2.5	2.9	2.1
Interior design			
Standard	5.6	5.5	6.1
Grouped seats	3.8	3.9	3.8
Deluxe	5.7	5.6	5.0
One-way fare, dollars			
0.40	4.0	4.3	3.8
0.50	3.3	3.5	3.3
0.60	1.8	2.3	2.3
0.80	1.5	1.6	1.9
0.90	1.3	1.3	1.6
1.00	1.3	1.3	1.6
Fare collection			
20-trip ticket	4.1	4.3	5.1
Credit card	3.3	2.6	3.2
Monthly pass	3.9	4.0	4.4
Tokens	4.0	4.7	4.4
Exact fare only	4.6	4.7	4.6
Cash with change made	5.6	6.3	5.9

sensitivity of the respondents to various fare levels (Fig. 6) is consistent with the preferences from the paired-comparison questionnaire. A 2-factor mixed-design analysis of variance was performed on the semantic-scale data to determine whether the 3 groups are significantly different (3). The F-value for the group effect is 0.55, which indicates the means of the groups are not significantly different. The interaction of the fare level and the groups (slope of the curves) has an F-value of 1.33, which is not significant at the 5 percent level of confidence. From the data available, one is unable to reject the null hypothesis that there is no difference in the preferences of the 3 groups.

The semantic-scale values on waiting times are shown in Figure 7. Satisfaction

Figure 6. Fare sensitivity of Columbia respondents by user group.

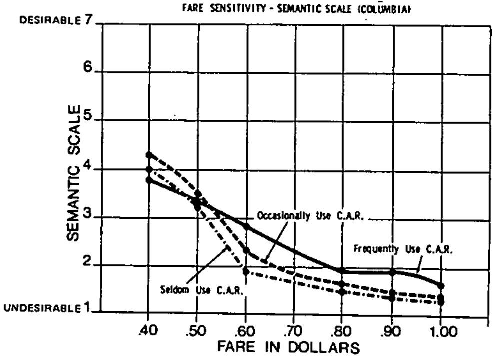
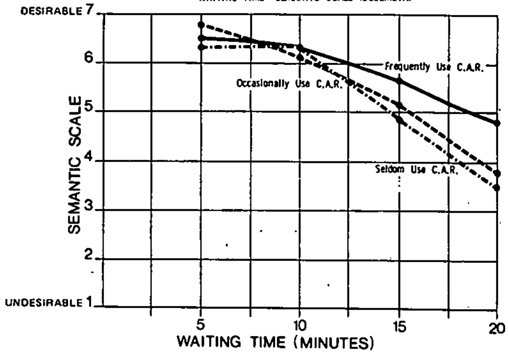


Figure 7. Waiting-time sensitivity of Columbia respondents by user group.



diminishes more rapidly for the nonusers than for the occasional and the frequent users. The 2-factor mixed-design analysis of variance was performed on the 3 groups to determine whether differences are significant. The F-value for the group differences is 0.39 (not significant at the 5 percent confidence level), which indicates that the mean values over all the waiting times are not significantly different for the 3 groups. The interaction of the waiting time satisfaction and the groups (slope of the curve) has an F-value of 2.74, which for 6 and 288 degrees of freedom is significant at the 5 percent level of confidence. The null hypothesis that there are no differences in the interaction of the user groups and waiting time satisfactions can be rejected. The nonusers are more sensitive to changes in waiting times than the users.

The paired-comparison preference scales for the households with 1 or 0 automobiles available and the households with 2 or more automobiles available are shown in Figure 8. The respondents with 2 or more automobiles available have higher preferences for certain advantages provided by the automobile: arriving when planned, no-transfer trip, and short travel time. Those respondents also indicate a higher preference for calling the system without delay and, understandably, are more sensitive to the inconveniences of public transportation.

The fare sensitivity and the waiting time sensitivity are shown in Figures 9 and 10. Both graphs demonstrate results similar to those shown in Figure 1. The households with more automobiles available can substitute the automobile for the public transit alternative more easily. If the system causes inconvenience (transfers, long waits, or long travel time), the 2-automobile household is less apt to be a continuous user of the system. The 1- or 0-automobile households often have no alternative transportation, so they are willing to endure some of the inconveniences incurred in using public transportation.

Figure 8. Responses to paired-comparison questionnaires in Columbia by automobile-ownership group.

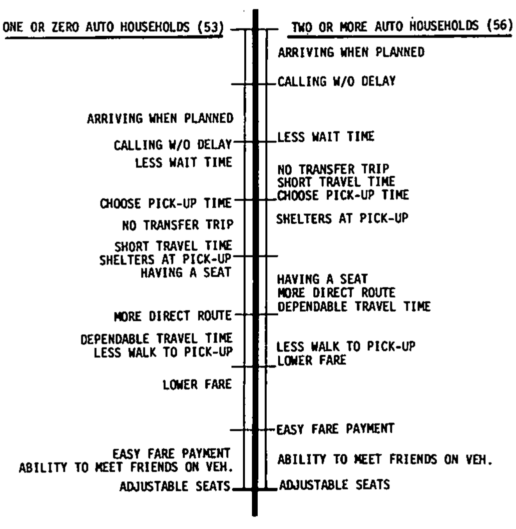
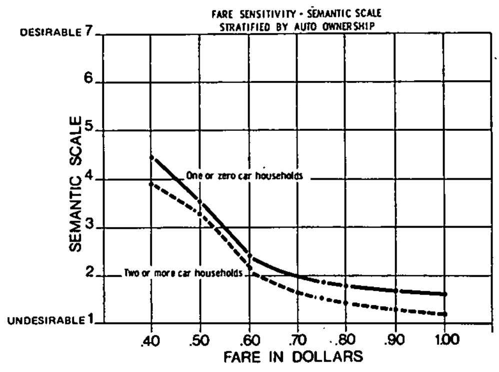


Figure 9. Fare sensitivity of Columbia respondents by automobile-ownership group.



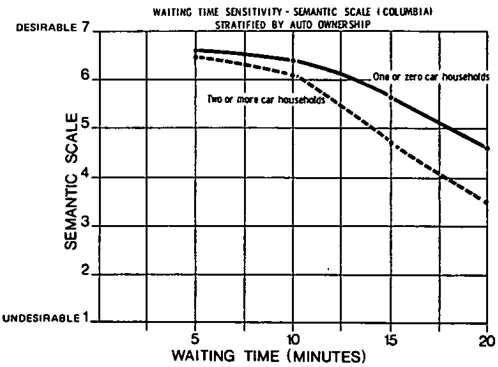


Figure 10. Waiting-time sensitivity of Columbia respondents by automobile-ownership group.

CONCLUSIONS

The Columbia survey provided some valuable information concerning user preferences for the dial-a-bus system. Specifically, it validated a previous survey conducted in Warren, Michigan, and it provided more detailed information on the preferences of the users of the system.

Columbia respondents closely paralleled their predecessors in Warren. The differences in the results are mostly related to the particular problems that dial-a-bus encountered in the implementation process. These characteristics received higher preferences in the Columbia survey because the respondent had been inconvenienced by that characteristic of the system. The similarities of the results are surprising given the differences in the 2 populations. Applying results from one community to a completely different community has been a problem. The results of this study should increase confidence in the case-study approach.

The differences indicated by users and nonusers are related to the inconvenience of using the dial-a-bus system. Phoning the system and the longer waits were more important to the nonuser than to the user. No transfer and fare have some effect in differentiating users and nonusers.

This study provides important information to the designers of dial-a-bus systems. Some reservations were expressed in previous studies concerning the applicability of surveys. The same technique was applied to 2 different areas with similar results. It, thus, represents an important step toward obtaining relevant information concerning the design of demand-responsive systems.

ACKNOWLEDGMENTS

The study is a joint effort by the staff of the Transportation Research Department of the General Motors Research Laboratories and Francis P. D. Navin. The authors wish to acknowledge the contribution of Robert Bartolo and the Columbia Association who started and operated the dial-a-bus system and allowed the surveys to be undertaken. The University of Minnesota provided the funds necessary to undertake the surveys in Columbia.

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INFORMAL DISCUSSION

Question: Who supported the surveys you described?

Answer: The Warren survey was supported solely by General Motors, and the Columbia survey was supported by the University of Minnesota.

Question: Did the responses of the Warren survey nonusers correlate with those of the Columbia survey?

Answer: That is a subject for future research. We have not had a chance to analyze those data, but we certainly intend to.

COMPUTERS, TAXIS, AND GRASS ROOTS TRANSPORTATION

Robert C. Cherry
President, Royal Cab Company of Davenport, Iowa

Royal Cab is a 40-year-old company. When we purchased the company in 1967, we had 6 cabs running and 11 available. The idea of people sharing a ride in our taxicabs started when we began operating the company, and so we have never had a problem about sharing a ride in a taxicab. Our problems have been some that I believe those in demand-responsive transit will be facing shortly.

When we bought the cab company, we wanted to serve the public and meet the demand for transportation. In our city of 125,000 people, there is 1 bus company, which is subsidized by the city, and 1 taxicab company.

As you know, if one has the attitude that something can't be done, it won't be done. When we bought our company, nothing could be done. I was told by the drivers, "You put more than 8 cabs on the road, and we'll quit you. If they want cabs, they'll wait." I was told that this was not a taxicab town, and, to tell you the truth, I very nearly believed them.

On the first day in business, I got there at 4 o'clock in the morning, exuberant about our new company. We had 3 time orders (a time order is an order that is on the books); we missed 2 of them because we did not get the cab there on time. We were really bad, and, consequently, nobody cared about Royal Cab, and nobody cared about public transportation. Fortunately, all transportation in our area was poor.

I was told that people would not ride cabs when the weather is warm, so when warm weather came we cut back even farther. I thought that these people sure had more knowledge about transportation than I had. I said that I would go along and listen to them, but after a period of time I would be able to show them statistics that would prove them to be wrong. They said, "Great! Go ahead!"

In July 1967, 5 or 6 months later, I told them that in no way were we responding to the public's need. "We're in a rut. Nobody's creative, and nobody's caring about the public. It's the public be damned, and I would like to change our image. I would like to start being responsive to what a person wants when he calls for public transportation." We then started using the Checker Cab, which looks like a 1927 box. It is a 7-passenger vehicle that had easy access and complemented our shared rides. We started to keep records on the number of "water haul" passengers (that is a passenger who is not there when the cab arrives). It was amazing how many we had.

At this point I started to look for a good dispatcher. We now have 3 dispatchers, who have a very nerve-racking job and an unbelievable capability to remember where a vehicle is. They are a rare, rare breed, and I knew we would have trouble finding any more like them. I knew, too, that, if our company was going to grow and if we were going to be responsive to the public's transportation needs, our dispatching program had to be implemented. I had no idea how.

Each of our dispatchers has a different personality and moods. When he comes to work after a lovely chat with his wife and a good breakfast then everything goes well. If he comes from an unpleasant situation, then all hell cuts loose, and, as a result, our service breaks down. I felt that there had to be continuity: the cab must arrive on time, every time; the driver working the cab must be treated the same every time; a new driver must get the trip, and time must be taken to "talk him through" to an out-of-the way street. We had to have this kind of continuity, and I think it is also going to play a large part in the success of the demand-responsive transportation program.

I felt that we also had to deploy vehicles better and earlier. I have heard many questions about how long after a call is made does it take the bus to arrive, or how long after a person gets on a dial-a-ride bus does it take to get to his destination. We have had this problem for years, and it has been solved by the ingenuity of the dispatcher who can route a cab driver through a maze of 29.5 square miles of roads so that he does not go more than 4 blocks out of his way as he moves through and picks up various passengers going in the same direction. If the passenger is going to work and cannot be late, the vehicle has to go sometimes with fewer passengers and in a more direct route. Our time from stopping in front of a house until the passenger gets out is much longer than the time reported for dial-a-buses. We feel very fortunate to get a person out in 1½ minutes.

I also felt that, if we could deploy our vehicles rather than "home" them (bring all of our vehicles to the downtown area), we could increase our efficiency. Today, after the last passenger is delivered, the driver stands by and gets further instructions to go on. This greatly increases gross revenue per mile and also makes the response time to the customer shorter.

We needed to grow with some kind of profit program, and that required that we look at the structure under which we worked. We had a taxicab driver on a commission rate taking all of his orders from a dispatcher on an hourly rate. Ninety-nine percent of all of our trips are radio dispatched; we have no cruising and pickup situations. So, if the dispatcher did not like the way the driver parted his hair, if he mumbled a little bit over the radio, or if the driver did not hear the dispatcher right away because of a bus or truck going by, the dispatcher might get mad and the driver might not make so much money. And these things happened! We thought there must be some way to eliminate this kind of dictatorship over the drivers who are out there in the cabs trying to make a living. We wondered whether a computer could dispatch taxicabs.

I contacted the computer company, and, when its representative arrived, he looked at me (my office is just the size of a good latrine) and thought, "There must be a sale here for a typewriter and the company has sent over a systems engineer." I said, "Come on in and sit down." There was the most startled look on this man's face as though he were thinking, "Good God, what can you possibly want from me?" I said, "Do you think you can dispatch taxicabs with a computer?" "Oh yes! What's your problem?"

Well, we had problems for him that he never knew existed. And all of a sudden he went from a very quick "I can handle it" to "Hold on a minute, we had better have some meetings." We had meetings and more meetings and discovered that this dinky little cab company that had 21 cabs had this big computer company completely mystified.

I have a friend who is an industrial psychologist. I asked him to come over and observe our dispatchers. After he had watched them work, his remarks were, "They're machines! They don't make that kind anymore, and don't look for their replacements." The computer company representative also observed the dispatching. His reaction was, "This can't be true! It is abnormal." I said, "It may be abnormal, but that's what happens day in and day out."

A man that comes off a shift of dispatching taxicabs, whether it be 10 or 21, is like a zombie. He really is talking to himself. He has to settle down before he can discuss problems with his shift. A dispatcher is under tremendous strain that becomes greater as business increases. There comes a point when he can no longer handle it. What we wanted the computer people to do (if they could and my money did not run out) was to combine the best of our manual operation, the best of the zone operation, the best of the manual dispatching, and the best of meter control.

Interpretation is very difficult as changes are made. I have always found it to be extremely difficult and continue to find it so. First of all, I am a little younger than most of my drivers, and they know transportation much better than I do. It is very difficult for them to realize that we went from 6 cabs to 21 cabs and are now heading for 40 and that they are making more money than they made when we had 6 cabs. Then if we throw a computer operation in on top of that, they will fight it because they do not understand what is happening.

We did an in-depth study with our drivers. An in-depth study with a taxicab driver is beautiful. Before doing so, you have to learn points 1, 2, and 3 and learn them well, for if you skip point 2 and go to 3, he will bring you right back to it. No matter what is being discussed, he wants to know what it does to him and his pocketbook and why. He may also be afraid of losing the dispatcher because many times he may blame his doing a poor job on the dispatcher and he does not want that excuse taken away. We, therefore, had to have a good rap session with all the people who are running and directing our organization so that they would realize that the computer is not a replacement for them but an implementing tool that will take a tremendous load off of them. The computer does its job steadily day in and day out, and the performance rate of the driver can then be evaluated. He can be shown in black and white that his gross revenue per mile is down. He will not be able to say, "The dispatcher ran me in circles all day long." So with the computer, we get continuity, we get good deployment of our vehicles, and we are starting to get a management program together that attracts other people.

We had a very difficult time convincing the computer people that we required a fairly large computer. The type of equipment we started with requires 17 overlays. We do not have instantaneous response. The wait period is too long, and we realize we are going to have to go to a larger computer. We have alienated a lot of people in our break-in time. You can't imagine what a lady says to you when she calls and you very politely explain that she is being dispatched by a computer. She is very much aware that her cab has not arrived and does not want any jazz about a computer. We have made a lot of mistakes, but we have not backed off from the program because we know it is the best program for public transportation. We handle people; we handle packages; we handle anything that is involved in transportation. The difference between a taxicab in Davenport, Iowa, and a bus is the spelling.

We keep our gross revenue per mile up because we do not allow a cab to cruise. A taxicab driver sits until there is another trip for him or the dispatcher deploys him to another position. Now, the computer has to be the dispatcher and be able to relocate cabs.

I would like to say something about complications of routing with the computer. If the street runs diagonally, a dispatcher is aware of it and does not try to circumvent a driver around a lake or something to pick up a trip just because he is in the area. Most of our 940 streets are grid streets, but others go off at an angle. We have been able to program them all into the computer by calling the angle streets exception streets.

Let's take a look at what really happens. The order is typed into the computer, including information such as origin, destination, number of people, and special messages such as wheel chair or package. The computer searches a file for a taxicab closest to this pickup point, that is either going or can go in that direction. The profitability criterion then determines which of several cars heading in that general direction will gather more revenue per mile by taking this trip, and that cab gets the trip. The computer has a load factor built into it, and so we never overload a cab.

I would like to close by saying that we felt compelled to try to put together a computer program that other cab companies operating 15 to 150 cabs on a 24-hour basis could use and also afford. We are open 7 days a week, 24 hours a day. We need to have continuity so that the man who closes his tavern at 2 o'clock in the morning gets the same response, the same ride, and the same time delay, if there is any, as the man who closes his shop at 4 o'clock in the afternoon. You have to have a people awareness and a supply and demand awareness to make this work.

I really believe this is grass roots transportation. It is not the airlines. It is not the trains. It is grass roots transportation. The problems can be solved and the demand can be handled with the right management.

INFORMAL DISCUSSION

Question: What percentage of your overall cost is allocated to dispatching?

Answer: We hope it is 5 cents per trip cost for computer use.

Question: Do your drivers get any pay for waiting at stations, or do they just get paid for trips?

Answer: Yes, he gets paid for waiting at stations. We charge 10 cents a minute after a 3-minute wait. We also charge 25 cents for more than 3 packages of groceries. To make sure the driver carries those bags, we allow him to keep the quarter. We share waiting time with him because it is taking our time, but anything that is received for manual labor is his.

Question: Do you have figures on computer benefits versus costs?

Answer: Yes, I have some gross revenue figures. In 1967, we were getting 18 cents gross revenue per mile. That is a loser any way you look at it. We brought that up to 32 cents with manual dispatching, and our last computer figures were 44 cents.

Question: What is your average trip cost?

Answer: As a zone company, it is approximately $1.18. We hope to lower that by increasing fares, and only in the taxi industry can you do this. We have sat around so long and done nothing that a price increase can look like a price decrease if handled properly. In the computer, we went from a base zone of 75 cents to a zone anywhere in the city of 50 cents. Yet, our gross revenue per mile picked up. So, needless to say, the people were happy. They were riding cheaper. The ones that were paying more were the ones that went a long way.

Question: How many cabs can the dispatcher handle?

Answer: I think the number of taxicabs the dispatcher handles can be quite large, but the number of trips per hour bogs him down. We find that, if there are more than 110 trips an hour, he is lost because he cannot double trips.

Question: How many trips can a computer handle?
Answer: It depends on the size of the computer. In simulation, we have run as high as 200 trips an hour.

Question: Do you have a good backup system?
Answer: Yes, it is called manual. We have a large map that is incremented out, and we feel we could manage if we should have that breakdown.

USE OF DATA PROCESSING IN TAXICAB CONTROL

John Davidson
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The operation of demand-response vehicles (in this paper conventional, radio-equipped taxicabs) may be likened to the operation of a tramp steamer. The tramp steamer moves from port to port—not having a fixed route or schedule, not knowing whether its next trip will be long or short, and not knowing whether its next revenue trip will originate at the termination of its present revenue trip or whether it must deadhead from the planned termination point to the origination point of its next revenue trip.

So it is with a taxicab operation, and therein lies the problem of utilization of manpower and vehicles. This is especially true of an operation in which a master-servant relation is maintained between employees and managers and in which employee benefits, taxes, and the like must be paid by the "master." If such operations are to continue to exist, the dual problem of manpower and vehicle utilization must be solved in order to offer reasonable service to patrons and to secure this profitable utilization.

This problem does not exist for those taxicab operations that are conducted by the individual entrepreneuer, such as the independent New York cabbie who cruises or secures loads at fixed pickup points, or for those companies that lease vehicles equipped for taxicab use but do not maintain a service organization.

However, those operators of demand-response vehicles, be they taxicabs, jitneys, dial-a-ride, or group-loaded vehicles, that offer transportation service, which includes receiving telephone request for service at a specific address, find this problem of matching vehicles and customers to be one of the most vexing.

In the taxicab industry this system—called dispatching—varies by company. It depends on the size of the fleet being dispatched, the size of the service area, the population density, the presence of one or more "walk-up" traffic generating points (such as an airport, bus station, or major hotel), and the topography of the service area.

I am closely connected with taxicab operations that vary in size from 10 to 700 units, in service area size from 6 to 480 square miles, in population density from 1,000 to 25,000 people per square mile, in topography from seashore to desert to inhabited canyons, and economically depressed areas to "millionaires' row".

The statement relative to dispatching difficulties is verified by experience. Small fleets and service areas where there are no major walk-up traffic points require a system that depends on cooperation between the controller and the vehicle driver, and this cooperation is forthcoming because the vehicle driver must depend on the controller for 98 percent of his business. Operations that encompass larger geographic areas, have customers with varying economic situations, serve many 'walk-up' points, and receive more than 10,000 requests in a 24-hour period, require an entirely different system. The taxicab driver tries to "do the whole thing" on his own, and there is difficulty in handling the volume of requests and in matching the requests with available taxicabs when they are also sought after at walk-up points.

There is, however, a consistent thread running through all of these divergent operations. That thread is a recognition that the systems used, even though they are continuously updated and improved, are still deficient in achieving the desired goals of improved service and efficiency.

It is suggested that the following steps are necessary to bring about the needed improvements. It is believed that they are both technically and economically feasible:

1. Data processing equipment (defined as a conventional computer system with conventional cathode ray tube on tape input and output) must be used for (a) receipt, assignment, and retention of orders for service; (b) receipt, assignment, and retention of units available for service; and (c) matching of orders and available units.

2. Digital communications equipment must be used for (a) transmission of messages from mobile units to base, giving vehicle identification and status without driver input, and location by driver input; and (b) transmission of messages from base to mobile units.

3. Automatic vehicle monitoring equipment must be used to relieve driver of the responsibility of vehicle location input.

Our company has moved into step 1 and is conducting discussions with appropriate parties relative to steps 2 and 3.

The area selected for trial use of the data processing equipment is the Los Angeles metropolitan area. It encompasses the service area of the Los Angeles Yellow Cab as defined by its franchise from the City of Los Angeles and from the City of El Segundo; taxicab operations were also permitted in the cities of Beverly Hills, Burbank, and certain specified areas in Los Angeles County. The land area involved is approximately 480 square miles, and the population is more than 2,500,000.

During the preliminary planning, various concepts and system designs were considered. The final configuration was a service area divided into a number of districts or grids (the term grid was used although the areas are not all equal in size or population density). Grid parameters were that grids must not include areas in more than one political entity, have a vehicular travel time in normal traffic conditions that varies from 5 minutes in central city core to 8 minutes in less densely populated areas, have no cross topographical barriers such as range of hills or freeway, and have no more than 1 major walk-up traffic generating point in each grid.

All streets in a grid are defined by beginning and ending street numbers in that particular grid. Wilshire Boulevard, for example, is in 11 grids. Major intersections, hotels, stores, and points of interest are all listed in each grid. More than 22,000 street, intersection, or specific points are listed in the address file, each coded to the grid to which it is assigned.

Automatic call distribution system equipment is used to assist in the internal handling of the requests for service. As orders are received from patrons, they are punched by conventional keyboard, verified by instant readout, and entered into central processing core. The central processor assigns the appropriate grid number to the order and stacks the orders by grid number and by time of receipt. Call-backs from patrons who have not received service within the quoted time receive priority in the order stacks.

As available taxicabs call in on radio channels that are dedicated to vehicle location, the cab identification and location are also entered into the central processing core by means of the conventional keyboard. The appropriate grid number is assigned to the available taxicab, and then stacks are made in order of receipt.

The central unit then processes the 2 stacks—requests for service and available cabs—and displays on the screen the address at which service is desired and the identification number of the first available taxicab in that grid. If a unit is not available in the grid of the order, the central processing unit searches adjoining grids for the first available unit and displays its number.

When the taxicab driver has acknowledged the call and the order, a copy is printed of the order information including order-taker number, time of receipt, service time quoted, dispatcher number, vehicle number, time of dispatch, and whether the unit dispatched was found in the grid in which the order was located, in another grid, or was located by voice search by the dispatcher.

The program has not yet performed perfectly because the volume of vehicle-to-base communications cannot be handled in the limited amount of air time. The program has been modified so that less reliance is placed on vehicle location input and the orders are displayed on the screen with their identifying grid numbers.

The progress to date has shown that with the volume handled—peaks of more than 600 orders per hour that require more than 2,400 radio contacts per hour—digital communications equipment is needed between vehicle and base to handle vehicle identification, status, and location.

The test area has 4 clear pairs of radio frequencies in the 150 MHz ban assigned for taxicab use, but these were not adequate to handle the flow of vehicle input and dispatch output.

Steps 2 and 3 that will insure the proper flow of information from vehicle and proper identification and location are still in the future. Digital communications equipment for transmission of messages from base to mobile units has the lower priority of the 2 factors in step 2.

The utilization of data processing equipment in the disptach of demand-response vehicles is technically and economically feasible. The utilization of digital communications between vehicle and base is needed when order volume exceeds the limits that can be handled on existing radio frequencies. The use of automatic vehicle monitoring equipment will complete the system for service (patron to company to vehicle to patron). The use of digital communications between base and vehicle will further enhance the use of radio frequencies but is not of vital importance.

GENERAL PURPOSE COMPUTER DISPATCHING SYSTEM

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Is a computer necessary and desirable for a dial-a-bus operation? We would like to submit that, in certain instances, it is. It can certainly provide more effective routing in 2 respects. First, higher vehicle productivity can be achieved through computer decision-making than through manual decision-making. Hence, higher dispatching cost or higher control center costs can be justified on the basis of a reduced overall transportation cost because of the very high percentage cost that is reflected in the driver and vehicle components of the system (about 70 percent of total costs). Second, the computer provides a very consistent, effective dispatching service, the quality of which does not correspond to the good days and bad days a dispatcher may have, as Cherry observed. Gustafson pointed out the importance to patrons of on-time arrival at their destination and the variability of waiting time before obtaining service. With a computer system, one can maintain much more effective controls over these very sensitive service quality parameters.

Computers can possibly reduce the overall cost of the control function because personnel costs will be reduced. This can be effected in 2 ways: The first is by introducing digital communication and thus reducing the need for dispatchers, and the second is by allowing people to bypass the telephone operator and actually input their request for service. Costs can ultimately be reduced.

Underlying all of this is the fact that computer systems have higher capacities than manual systems. When systems grow to 30 vehicles or more, manual decisions will become increasingly difficult.

There are other features that can be implemented through computer dispatching. These include automatic billing so that people do not have to pay when they get on the vehicle; use of standard trips so that personnel costs are reduced; and more than 1 quality of service so that people can choose according to the price they are willing to pay.

The first and foremost computer requirement is reliability. This can be achieved in a number of ways. In initial systems, reliability is ensured through some sort of manual backup mode. Looking farther ahead, we can expect duplication of certain elements in the computer system and perhaps completely duplexed systems to provide the level of reliability required. This, of course, has implications for the economics of the dispatching system.

Other requirements for computer-based systems include address-to-coordinate translation so that one can type in street addresses but have the algorithm operate on coordinates or perhaps zones and coordinates; error-handling capability because initially operators and dispatchers interfacing with the computer will create errors, and typing errors will always be made; capability to handle unusual events because people will want to cancel their trips, vehicles will break down, and people will not show up after they have requested service; graphic-display capability to enable a supervisor to maintain control of the system and influence the quality of transportation service being provided; and capability to receive standing requests, i. e., requests for service at the same time every day from the same origin to the same destination, and advance requests, i.e., requests for service several hours after the call is made. Less necessary but nonetheless desirable features are automatic billing, standard trips, and digital communications.

When implementation options are considered, it is useful to define systems in terms of machine size. Selection of a particular machine is largely dependent on time and development costs, which will vary with computer type. For example, the decision may be between using an existing operating system or developing from scratch a real-time operating system. This is a very significant decision and one that will affect the amount of time needed to get a completely operational system that provides transportation service. Another important decision is that of the programming language to be used. Will the software be written in a high-level language, such as FORTRAN or PL1, or will machine language be used? The machine language will provide a much more effective and efficient computer system but when implemented will be harder to modify (and consequently less adaptable to a third party not familiar with that machine) and will probably take more time to develop.

Operating costs are clearly a very important point in deciding what computer system should be implemented.

Adaptability is one of the most important considerations in computer system choice and design. It is desirable to have a computer system that can adapt to handling an increasing number of vehicles as the demand increases within the service area or as the service area is expanded. Limited core storage and computing time are significant restraints. If it should happen in the future that dial-a-ride requires a certain computer or software feature, then adaptability of this kind is also required.

An important step in the phasing of dial-a-ride experiments is operating with a manual system. This phase provides a significant market test for the dial-a-ride concept and can be important in decisions on the role the federal government should play.

In the next phase, the dispatching system would be operated by a medium-sized computer programmed in a high-level language such as FORTRAN or PLI. The reason for using a high-level language is that it can be easily developed. Ability to build a computerized dial-a-ride system quickly is important. Flexibility is also important. Ability to expand and to modify is necessary so that errors in the initial system design can be corrected. The medium-sized computer is governed primarily by the requirement of the high-level language, which tends to presuppose such a computer. That such computers are easily available is also an important consideration.

In terms of the information to be gathered at this stage, one should first determine the feasibility of computer dispatching. Until recently, there has been significant doubt in the minds of many people that computer dispatching can really work. Beyond this, field testing of assignment algorithms must be performed. Are proposed decisions rules effective in an operational environment? A third area of information is the utility and the necessity of features included in the dial-a-ride system.

Computer dispatching with a minicomputer system would have the feature of low capital and operating costs and thus be more economical. Because its development is based on experience gained in testing of the medium-sized, high-level language system described above, it could be quickly installed and operated without the operator knowing much the machine language in which it was programmed.

A further stage in the development of computer dispatching systems is the provision of more powerful systems with features such as standard trips and digital communication interfaces to reduce personnel costs and the overall dispatching costs.

The system developed at M.I.T. is

programmed in a high-level language and fits in the medium-scale computer category. It evolved from the research into assignment algorithms and the simulation model constructed to test various dispatching policies and economic feasibility. This formed the basis for a very simple unsophisticated, real-time dispatching system that was itself the basis for the final medium-scale FORTRAN product. The programs can operate on any IBM 360 or 370 computer with more than 220K bytes. It is programmed in FORTRAN, operates under the disk operating system; can be operated either in dedicated or in multiprogrammed mode (e.g., dedicated on a 360/30 or partitioned on a 360/50); and has provisions for teletypes, 1050's, 2741's, and an advanced remote display station for graphical input and output. We feel that this system can handle 20 to 30 vehicles. To use this system, one must first code the street network so that the address-to-coordinate translation scheme can work effectively. The travel-time prediction formula used by the algorithm must be calibrated, and the algorithm must be tested and modified as a function of the characteristics of the particular area being served.

The key questions for the future are, How much will a computer improve service provided by a transportation system? and How much will it increase productivity? These questions are now largely unanswered. Looking at the overall costs of dial-a-ride, we see that perhaps 70 percent of the costs relate to the drivers and vehicles and that the remaining 30 percent relate to control and dispatching. If productivity of the transportation service can be increased by, say, 25 percent as a result of using computer dispatching, then it would be reasonable to increase control costs by as much as 55 percent because of the greater weight vehicle costs play in the total cost of the system. So, it is conceivable that a 7-person manual-dispatching system could be converted to a computer system with no personnel reduction if productivity could be increased by 25 percent or more. This is the big unknown: Can we achieve increases of 25 percent?

There are 2 ways to find the answer to this question. The first is through studies of systems such as that of Royal Cab in Davenport, Iowa. The indications given in Davidson's paper are encouraging in this respect. However, those increases were achieved under dynamic management when the company was growing rapidly, and it is difficult to isolate the part played by the computer. Nonetheless, it provides an important data point. The second way is through the Haddonfield Project. When computerized dispatching is under way in that project, we will have a basis for comparing manual and computer dispatching.

ISSUES AND POLICY QUESTIONS CONFRONTING PUBLIC TRANSPORTATION

Elbert C. Mackey
Deputy Director, Michigan Office of Economic Expansion

Mr. Mackey was the speaker at the conference banquet. Although his remarks are not specifically oriented toward demand-responsive transportation, they are included as part of the conference proceedings.

The Michigan Bureau of Transportation was created in 1970 and was given the authority to finance projects in 4 general phases of a public transportation improvement program: Economic and Technical Feasibility; Research and Technology Development; Engineering and Design for New Systems; and Demonstration of Improved or Expanded Public Transportation Services, Facilities, and Equipment.

In general, the purpose of the bureau's programs is to enable the demonstration and the feasibility of expanded and improved public transportation service. Some of the specific projects that are funded by the state and directly related to this objective are as follows:

1. Purchase and operation of electric and propane-powered buses;
2. Study and evaluation of new technology systems;
3. Operation of special buses for the aged and for intercity residents to employment opportunities;
4. Site-specific feasibility study of new technology systems for urban core mobility, large university campus access and mobility, and activity center circulation and connections;
5. Feasibility and planning studies of rapid transit in southeast Michigan; and
6. Study and evaluation of dial-a-ride in Ann Arbor.

With passage of pending legislation, our role will be considerably more involved with the operational aspects of local transit operations. This legislation basically involves creation of a new department of transportation and highways and a 2-cent increase in the state gasoline tax. Of that, 0.5 cent is to be used for an urban transportation discretionary fund, which would receive about $22 million per year for public transportation and related purposes. Half of this amount is to be distributed to local governments or authorities for operational assistance on a population and vehicle-mile of service basis. The remaining funds are to be allocated to specific projects; primary emphasis will be on capital assistance.

I would now like to present what I feel are some of the major issues and policy questions that now face not only the public transportation industry but society as well.

Public transportation has not been responsive to the mobility needs of most urban residents. We have not had innovation in operating practices and in the development of transportation concepts. Departure from existing means of serving mobility needs has been and still is often viewed as a threat and not as a means of offering more competitive transportation service.

I do not wish to dwell at length on the history of urban transportation. However, my point on the issue of conservatism or lack of innovation in public transportation can be brought into focus by a brief examination of the situation that prevailed in the railway and streetcar operations and that also exists in the systems now being proposed for many metropolitan areas.

Prior to the early 1900's, companies operating streetcar and rapid transit systems were prosperous and frequently represented monopolies that served almost all urban passenger travel. In many instances, ridership increased at a faster rate than population until about the end of World War I.

Most operators were not aware of the impending competition. Some even anticipated that ridership would continue to increase as long as population increased. Technological obsolescence was simply not anticipated until it was too late. One must appreciate not only that the competition was keen but also that the industry was not subsidized as its rapidly developing competition was. The situation was a difficult one to respond to.

A significant factor contributing to this situation was that the industry failed to put aside research and development funds. We need only look at the investment private industry makes each year for research and development to know how important this element is to survival. Of the total invested by private industry last year, excluding residential construction, 15 percent, or \$15 billion, was for research and development. The Urban Mass Transportation Administration's research and development fund in 1972 was only about \$53 million, and that was probably the total for this multibillion-dollar industry.

Many of the conditions that existed in the early 1900's exist today. The ability to respond and serve transportation needs in an ever-changing competitive market has not developed. I maintain that the development of this ability is one of the important issues confronting the public transportation industry today.

A great deal of attention is now being given to the development of high-capacity line-haul systems to solve the transportation problems in large metropolitan areas. In my opinion, these systems fail in many respects to respond to the real travel demand. A brief look at the distribution of population, the characteristics of travel patterns, and the characteristics of these line-haul systems raises some serious questions about their applicability.

Increasingly, urban land use and travel patterns reflect the dominance of the automobile. This trend is so obvious that I would not mention it except that it has special significance. The travel desires related to work, shopping, personal business, recreation, and so forth are becoming increasingly decentralized. Residential sprawl is widespread. As a consequence, radial travel desires (the kind best served by line-haul operations) are becoming significantly less important. Of the demand that does exist, a large portion is peak-hour oriented. Consequently, it is difficult to find travel demand that can be efficiently and effectively served by high-capacity line-haul systems. As a result of lower densities, trip lengths have also increased. As a consequence, those without access to automobiles have and will continue to have difficulty getting to their destinations either by walking or by public transportation. With these trends so readily apparent, it seems rather strange that most methods proposed to solve the urban transportation problem are all too often improvements to, or replication of, existing bus, subway, and commuter rail facilities.

Most public transportation proposals in major metropolitan areas focus the majority of funds on rail facilities linking high-income suburbs or airports with downtown centers and on new equipment. Wohl (1) points out that the subway or rail rapid transit systems now being built and proposed are more related to the late nineteenth and early twentieth century suburban commuter railroads than to intercity subway systems of the same period.

Wohl points out that the lines for these systems usually range far into the suburbs and concentrate most of the stations within the suburbs. Stations are spaced far apart and thus provide poor linkages between the station and the traveler's origin or destination. Travelers must, therefore, use a feeder bus or private automobile to get to and from the station. To illustrate the inconsistency between the technology applied or proposed and the demands of the travel market, he made the following observations on station spacing:

City	Miles Apart
Los Angeles	1⅓
Washington, D. C.	1⅕
San Francisco	2
Chicago	⅔
Boston	⅓
New York	⅓

Wohl also observed that the newly built or proposed system lines are long. San Francisco's lines will all exceed 20 miles. Those for Washington, D. C., will average about 12 miles but some will approach 20 miles. By contrast, Boston's longest line is about 15 miles, Chicago's is 16 miles, and New York City's is 15 miles. The rigidity of these systems (the requirement of high densities) also appears contrary to or inconsistent with today's life styles.

In light of Wohl's comments, I would like to review the proposed Woodward corridor rapid rail line in Detroit, which has been developed under planning studies funded by federal, state, and local agencies.

The specific proposal is to build a 27-mile, $600 million rail rapid transit line from downtown Detroit to the city of Pontiac. The line is to have 23 stations with a 1.2-mile average spacing. Of the line's 27 miles, 18 are located in suburban communities and 9 are in the city of Detroit. There are 11 stations in the suburbs, and 12 within the central city, 4 of which are in the CBD. Clearly, an attempt has been made to respond to the need for balance between commuter and local service needs.

The ridership projections for the line are of particular significance, especially when they are related to the incremental construction cost (Table 1). The percentage of riders on the suburban portion of the line (beyond the Detroit city limits to Pontiac) and on the central city portion of the line (from the city limits to downtown), by access mode is given in Table 2. These data were compared in a detailed analysis that the Bureau of Transportation made of the rapid transit proposal for Detroit. It seems apparent from this analysis and recent state-of-the-art developments that a second look may be appropriate at the type of transit technology proposed for the Woodward corridor.

This limited functional capability of a rail rapid system to serve suburban ac-

Table 1. Ridership and costs.

9-Mile Increment	Ridership (percent)	Cost: Million Dollars	Cost: Percent
First	83	315	52.5
Next	15	185	30.8
Last	2	100	16.7
Total	100	600	100.0

Table 2. Access mode.

Mode	Suburb	Central City
Automobile	55	9
Feeder bus	27	54
Walking	18	37

cess as well as central city mobility was dramatically questioned during recent consideration of the Governor's transportation bill. Members of the black caucus were opposed to the steel rail system because it did not meet the needs of their constituents.

I think an appropriate question regarding the application of this technology is, Where are these facilities located in relation to workers or others having the greatest potential need? Clearly, the nature of the travel market and the need have not been examined closely in the development of these systems. It is readily apparent that, if we are to overcome the shortcomings of the steel rail systems, innovative efforts must be made to develop systems that satisfy both suburban and central city transit needs. I do not mean to imply that we are against rapid transit systems. Our concern is with the appropriate application of technology to the problems that exist.

The question of the applicability of the rail rapid transit systems raises a general question of what the public transportation market consists of and how we can respond to that market with a competitive service at an acceptable cost.

Identifying potential markets and defining benefits and costs of an applicable public transportation technology are not easy tasks. Many people are prone to say that there is little need for public transportation services based on patronage trends and public transportation's share of the market. I do not believe that the demand for this service has ever been adequately assessed. A tremendous need exists for low-cost transportation throughout this country.

Our automotive evolution during the past few decades has given many Americans unprecedented mobility. However, for those who lack access to the automobile, a severe mobility handicap exists. Of equal significance is the fact that many individuals are unable to use the automobile because it is at the wage earner's place of work or because they are not licensed to drive.

The issue, however, is how to define this market in terms precise enough for an evaluation to be made of the costs of accessibility restrictions. This issue is a complex one because market demand and cost are also related to transportation system design. We are now well along in the development of new systems that have the potential of improving mobility at a lower cost. However, we have not yet really examined the mobility disparities and need differences among various classes of society, let alone placed a cost figure on them. We know very little about the effect alternative transportation strategies might have, for example, on the opportunity and cost of housing or public services such as water and sewerage distribution systems and land for recreation. We do know, however, from our various tax bills that the present policies being pursued at the local level are expensive. We need to be more concerned about optimizing our capital investments. It does little good to pour money into one area if, at the same time, policies or programs exist that will defeat our objective.

In many instances, I doubt whether present cost figures are representative of true costs. We frequently assume that because we have special funds for certain purposes total project costs are covered. This is not always the case. An example in point is the Lodge Expressway in Detroit. Our analysis of anticipated revenues raised by this facility indicates that it will only pay for about a fourth of its cost.

There are indications that the cost of governmental services will increase in the face of tremendous competition for resources. Therefore, the need is crucial to define more precisely the mobility disparities among segments of society, the cost of these disparities, and the benefits and costs of alternative transportation strategies.

This issue is also directly related to another important issue, and that is, What kind of an urban environment do we really want? At the present time, we do not have local, regional, or state growth policies that reflect strategies that have been carefully thought out and analyzed as to benefits and costs. We appear to be content with an increment of haphazard sprawl each year. I think we need to examine these policies and explore what role public transportation has in developing the kind of urban environment we want.

I would like to say something about the demand-responsive transportation project in Ann Arbor. We feel strongly about the need for supporting the Ann Arbor project. It has potential for solving a problem in one area as well as for providing needed research regarding people's attitudes and travel needs that cannot be gained from traditional research methods that lack the operational element. Certainly, developing, managing, and operating a demand-responsive project require a substantial degree of innovation.

The people in Ann Arbor deserve considerable credit for undertaking this project. Inevitably, there are higher risks involved in the introduction of new service concepts. This type of service entails a whole new set of operating circumstances, and it may have the potential to go a considerable way toward achieving the desirable service characteristics provided by the automobile.

Speed, flexibility, and accessibility attributes of the automobile are the most difficult to duplicate in new system operations. The extensive street network and the design of the automobile provide the basis for both flexibility and accessibility. One must also be aware of the comfort and convenience of the automobile. Many homes do not have the comfortable seats, air conditioning, stereo, and privacy that the automobile has. Yet, the amount of time spent in the home—at least for most areas and for most age groups—is incomparable to that spent in the automobile.

A question frequently asked about demand-responsive service is, Does it cost more or less than line-haul service? Although I believe the question of cost is an important one, it needs to be considered in proper context. Certainly, concern for the market served is an important consideration. In Ann Arbor, we are serving a substantially different market by the demand-responsive system than by the line-haul system, and we want to broaden that market. A valid comparison of costs must also consider alternative objectives. If, for example, reductions in air pollution, in downtown traffic congestion, and in parking costs are objectives, then these must also be evaluated in terms of the system's ability to achieve them.

We can learn much more from demand-responsive service projects than what the operating limitations are. These projects provide the means of obtaining valuable data concerning user attitudes, travel preferences, and trip generation rates. Such research information is essential to the development of competitive transportation systems.

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