

INCREMENTAL IMPLEMENTATION OF DIAL-A-RIDE SYSTEMS

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Ford Motor Company is currently pursuing a program of company-funded research in urban transportation. This work is being carried on by the Transportation Research and Planning Office that is staffed by a multidisciplinary team of researchers and engineers. The programs cover a wide variety of critical problem areas and place strong emphasis on the proper role of public transportation as well as the use of the personal vehicle (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11). To make certain that these programs are relevant and useful, we work closely with transportation system operators and specific communities.

Typical of this approach is the work on dynamically dispatched public transportation. Dial-a-ride is one of our most active programs. Projects are being carried on in conjunction with several communities that are concerned with the problems of providing high-quality public transportation under today's economic conditions. Our research objective is to determine whether this promising new system can be offered at a price attractive to potential users and at cost levels acceptable to operators.

To accomplish this objective, we found it desirable to launch a program of field experimentation. This program is built on the findings of the dial-a-ride program funded by the U.S. Department of Transportation and draws heavily on work reported by other researchers. In this case, our role is to translate the theory developed for the dynamic dispatching concept into useful practice for the benefit of transportation operators and the public.

MOTIVATION FOR IMPLEMENTATION

There are sound reasons for moving toward implementation of dial-a-ride systems now, without waiting for more exotic hardware developments or additional studies. The most important is market identification and quantification. Public transportation is absolutely necessary for the nondriving segment of the population. Unfortunately, as this user group declines in relative numbers and in political power, service cannot be provided on an economically sound basis. In order to be viable, public transportation must lure a significant number of choice riders.

Sound though the basic research on dial-a-ride has been, the quantification of demand remains one weak area. Review of existing models forced us to conclude that nothing short of extensive field testing would answer these market questions for a new, untried mode. The current state of the art in demand modeling is simply inadequate to furnish highly reliable projections of choice ridership.

Field experimentation for the quantification of demand is not a one-way street. New models being developed by researchers will require field test data for calibration. Our program can, therefore, contribute to development of improved models as well as to the furnishing of absolute demand measures.

A second important reason for addressing implementation at this stage concerns the problems associated with launching new transportation services in today's economic and political environment. Too many sound concepts are lost because they cannot hurdle

the many barriers to implementation. New ideas are risky, politically and economically. Implementation cannot be taken for granted; in fact, it must be fought for every step of the way.

The first and foremost hurdle is finding financial support. Private operators of public transport (those few who remain in the bus industry and the taxi firms) operate on a marginal, day-to-day basis. Short-term costs and revenues occupy their immediate concern; risk capital is nonexistent. Local governments, likewise, feel the pressures of increased demands for all kinds of services. These demands rise faster than revenues. Public responsibility dictates a cautious approach to high-risk ventures in public transportation or elsewhere. We cannot expect local government to underwrite pilot programs alone. Only where adequate public support is generated can they be expected to give any help at all.

State and federal governments have allocated almost all of their public transportation funds for the purchase of entirely conventional equipment. More than 87 percent of the moneys distributed by the Urban Mass Transportation Administration and its predecessors have been used for capital grants. Some help is available through the research and demonstration program, however; and there is a possibility that dial-a-ride projects will be allocated some share of these funds.

Finally, the manufacturers of hardware for transportation systems might be expected to participate in implementation. The obvious channel here is in development of prototype hardware. Development of the necessary dial-a-ride hardware is well within the capabilities of the private sector, providing a market has been defined. For example, the vehicle for dial-a-ride service (Fig. 1) was developed by Ford and is now being marketed because we became convinced that there is a significant potential in this area. Similar developments in digital communications and operating software needed for fully automated dial-a-ride systems can be anticipated from industry. However, the investment of millions of dollars in high-risk implementation projects is too speculative for private enterprise to undertake alone.

This suggests a cautious but deliberate incremental approach to implementation and one that takes advantage of the transportation operator's existing knowledge and investment, any government (local, state, or federal) support that can be obtained, and any private risk capital that can be attracted. This is precisely the Ford approach to dial-a-ride implementation. Surely, massive funding would be preferable and would permit more rapid diffusion, but the lack must not be allowed to deter a true test of this most promising concept.

Financing is not the only problem, however. Facing the implementation issue means dealing with regulatory problems (will dial-a-ride be regulated as a taxi, a bus, both, or neither?) and labor questions (how will present transport workers' unions respond to the new type of service, or how will taxi labor, now paid on commission basis, be renumerated?).



Figure 1. Courier vehicle used in Mansfield and Toronto dial-a-ride tests.

In an extensive survey of experimental and innovative systems, we have found that perhaps the most important single factor in the success or failure of new services is management support and dedication. Management at all levels must be committed to the new concept. There is no substitute for attention to detail and strong emphasis on customer service. An enthusiastic management will show the new service in its best light and can be a major factor in overcoming labor or regulatory problems that may arise.

These implementation problems, however formidable, must be addressed now if

dial-a-ride is to have a chance for success in the relatively bleak field of public transportation. The Transportation Research and Planning Office is convinced of the validity of the dial-a-ride concept. We are now working with communities and operators in a variety of ways toward the goal of implementation. Dial-a-ride is worthy of an honest assessment in terms of its eventual success in the marketplace, but it must first be successful in the legislative and executive chambers of government, in the union hall, and in management offices.

DIAL-A-RIDE SERVICE SPECTRUM

Dial-a-ride covers a large range of potential systems from conventional transit bus operations to taxi service. Figure 2 shows this spectrum by using existing technology as the basis for comparison. The horizontal scale represents dynamic routing; the vertical scale represents dynamic scheduling. Once the constraints of fixed routes and schedules are relaxed, the degree of dynamic response in both of these dimensions is essentially a function of the dial-a-ride algorithm used.

In its most sophisticated state, dial-a-ride offers taxi-like service, the only important differences being shared riding, slightly longer travel times, and lower fares. However, there is a large spectrum of potential dial-a-ride systems that offer substantially less than full taxi service. These are commonly referred to as many-to-one and many-to-few systems. Many-to-one dial-a-ride actually begins where conventional bus service leaves off. Many-to-one indicates a focal point for the service such as a town center, rapid transit station, airport, medical complex, or other major activity center. The many-to-few concept is an expanded system in which between 2 and 10 focal points can be served.

As a first step in Ford's evolutionary program of implementation, a pioneering field experiment in dynamic routing within a fixed schedule has been undertaken in Mansfield, Ohio. This experiment is structured as a many-to-one dial-a-ride system.

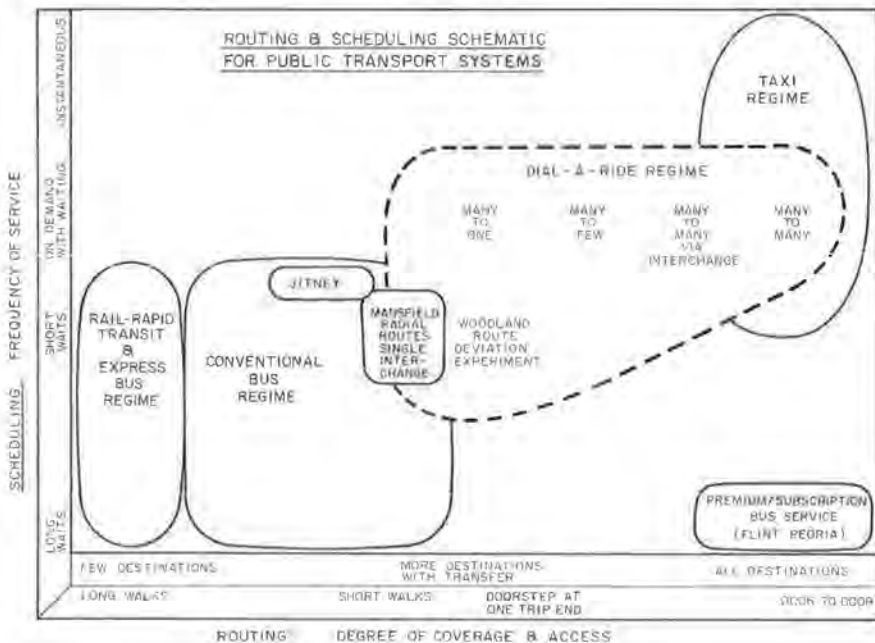


Figure 2 Routing and scheduling schematic for public transport systems

Route-deviation, doorstep service with a single vehicle in a well-defined service area has been operating in Mansfield since January 1970. A fixed-route loop in the Woodland neighborhood (Fig. 3) forms the basis of the service. In response to specific requests, the driver deviates from the regular route for doorstep pickup and drop off. A radio telephone for receiving calls for passenger pickup at home or other trip origin point within the defined service area is fitted to the vehicle (Fig. 4) and permits dialing directly to the driver. After picking up the caller at his doorstep, the driver returns to the fixed route at exactly the point he left it. A passenger may leave the vehicle at any point on the fixed route or transfer at City Square to other routes. Users boarding at City Square or along the fixed route may request doorstep drop off, and the vehicle will deviate as previously described and return to its fixed route. The service operates six days a week from 7:15 a. m. to 6:15 p. m.

An increment of 15 cents, in addition to the basic 35-cent fare, is charged for the extra service. Transfers to other routes cost 10 cents. It is important to note that the existing fixed route is retained and traveled by the same vehicle on normal half-hour headways. With doorstep deviation, two distinct classes of service at different prices are being offered simultaneously by a single vehicle with a single driver.

The single vehicle runs in harmony with the rest of the city buses, making its call at City Square each half hour as do all the other buses. Thus, a complete interchange with the entire system is provided.

Data collection consists of daily ridership and revenue tabulations by class of user; a 100 percent sample of all doorstep pickups and drop offs by time of day and address; a real-time record of vehicle speed and distance collected via recording tacograph; and comprehensive surveys of users and potential users. The results found to date have been encouraging. On a typical weekday, 76 riders use the bus, of which 15, or about 20 percent, elect the doorstep service. This is particularly impressive because of the excellent quality of fixed-route service that provides the basis for comparison. The route at present does not cover full operating expenses but has generated a 14 percent increase in revenue per household served. Route deviation has been found totally feasible from every standpoint. The driver is able to perform his tasks, including answering the telephone and collecting data, without feeling overworked. Customers understand the service and find it easy to use. Schedule adherence has been 100 percent since January although there have been as many as 8 deviations per half-hour tour.

No promotional campaign whatsoever has been undertaken because the existing communication system is already overloaded at times. To correct this, application has been made for an exclusive channel dedicated to dial-a-ride use only. Detailed statistical analysis of the first 6 months of ridership, revenue, customer response, and operating data is now under way and will be reported in full to the transportation research community in a forthcoming paper.

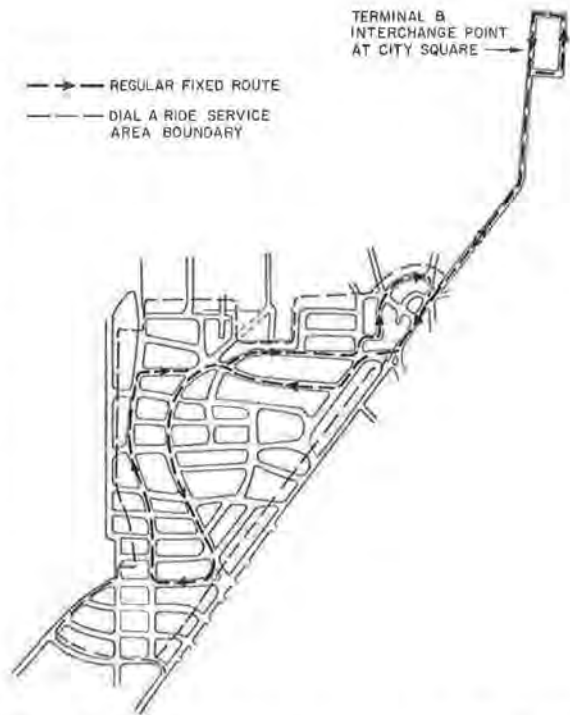


Figure 3. Route-deviation service area in Woodland neighborhood of Mansfield, Ohio.

We recognize that the Mansfield experiment is small and that economic results obtained with the prevailing labor rate there are not transferable to larger urban areas. Nevertheless, this test is a particularly important one for the hundreds of small- and medium-sized communities that are having difficulty keeping their transportation systems solvent.

Another important many-to-one dial-a-ride experiment is the dynamically routed transit feeder demonstration recently launched by the government of Ontario in connection with its GO Commuter Railroad Service. Ontario is demonstrating how dial-a-ride can be used efficiently to feed a line-haul transportation system. Market studies revealed that a very high proportion of those who had walking access to transit stations here used rail service, as data given in Table 1 show (12).

The relatively lower transit use with decreasing accessibility to stations is also demonstrated by the data given in Table 1.

The offering of demand-activated personalized feeder service is an attempt to expand the contour of easy access for a suburban station beyond the usual walking distance. Simultaneously, this service precludes the need for capital expenditure to erect parking structures on high-valued land.

The Toronto test has no fixed-route basis like that in Mansfield, so that the vehicle tours in a given service area correspond only to demands that have been registered. However, as in Mansfield, a fixed schedule at the focal point is retained; in this case, it is determined by train arrivals and departures.

The next sequential step in the dial-a-ride spectrum is to eliminate the fixed schedule. To do this, vehicles can be dispatched into the service sectors either when a certain number of demands have accumulated or when a specified time has elapsed since the earliest unserved demand. A proposal for operation of this type of service in a many-to-one mode has been made to a midwestern city of 100,000 population, and we hope it will be implemented within the next few months. The next subsequent stage, many-to-few dial-a-ride, is an extension of the many-to-one service concept and serves more than one activity center or focal point. This can be accomplished by overlapping many-to-one systems with a separate fleet of vehicles serving each focal point or by providing



Figure 4. Bus driver in Mansfield receives radio-telephone request for doorstep pickup.

a fixed-route "tail" connecting several closely spaced activity centers at the end of the dial-a-ride tour.

In a large number of communities, a many-to-few pattern will serve a majority of the desired trips, providing that the focal points are properly defined and perhaps dynamically shifted according to the time of day. Because a substantial percentage of the trips also have one end at home, the service sector concept appears to be broadly applicable. However, numerous areas that have combinations of

TABLE 1
VARIATION OF TRANSIT MARKET SHARE
AS A FUNCTION OF ACCESS TO STATIONS

Distance From Suburban Station	Distance From Union Station for Trip Ending in CBD (percent)			
	Short Walk	Transit Ride		
		Short	Medium	Long
Short walk	66	34	20	16
Automobile ride				
Short	47	19	8	6
Medium	19	11	4	3

low-density, sprawled land use and topographic features do not have markets that can be adequately served by a many-to-few dial-a-ride. In these cases, a true many-to-many taxi bus service may be justified. Its viability will be governed by the diffusion of trip-making in the urban area under consideration. The critical question becomes whether the increase in demand can offset the increased costs due to more complex dispatch logic and lower vehicle driver productivities. (The work reported by the Massachusetts Institute of Technology suggests a productivity relationship of as high as 2:1 for many-to-one versus many-to-many dial-a-ride service.)

Our program at Ford Motor Company consists of going carefully through all of the steps between the conventional bus regime and the taxi regime, learning as we go, and basing our next implementation moves on experience gained with the previous experiments. We feel that certain cities and some areas within other cities will probably never proceed all the way to the many-to-many dynamically routed and scheduled dial-a-ride system. Learning about all of the potential dial-a-ride spectrum is, therefore, very important.

CRITERIA FOR EVALUATION

How is "success" in dial-a-ride field experiments to be judged? The answer to this depends on one's viewpoint of what success in a public transportation experiment really means. The first question asked invariably is, Will dial-a-ride make a profit? Surely, from a private operator's standpoint, the profit criterion is the most important one. However, in an industry that nationwide has operated at a deficit since 1963 and that posted losses of \$129 million in 1968, operation at a profit would, indeed, be a revolutionary achievement. The real question people are asking is, Can dial-a-ride service reverse the trend of deficits in public transportation? We are indeed encouraged in this respect by the experiment in Mansfield where we are finding a revenue increase per household served on the order of 14 percent over fixed-route service in the same neighborhood.

Measures of success other than the fiscal definition are equally valid. A broader evaluation of costs and benefits is called for. Public transportation is provided at a deficit in most cases where it is provided at all. The community must, therefore, be concerned with the magnitude of subsidy required and the resulting benefits. Dial-a-ride provides substantially improved service to those who cannot or do not wish to use automobiles for all their trips. In the Mansfield test a substantial number of new job opportunities for domestic workers have been created by offering doorstep service. Dial-a-ride must be judged successful from a user's point of view if it meets his or her transportation needs at an acceptable cost. It, therefore, becomes imperative to measure and quantify all possible aspects of any field experiment undertaken, such that the community has a sound basis for assessment of all potential costs and benefits.

Finally, there is the question of implementation itself. There is some measure of "success" in the actual accomplishment of carrying out a field experiment. Without the cooperative support of city government, the sound professional participation of the local planning commission, and the enthusiastic participation of the private bus operator, the Mansfield experiment could not have been conducted. Overcoming the substantial hurdles to implementation requires real teamwork. This is not to suggest implementation of a system for implementation's sake, but it is to recognize that an important measure of success is, in fact, the existence of a system. Representatives from scores of other communities from North America and Europe have studied the Mansfield operation since its inception, many of them specifically concerned with how to go about solving the problems of implementation.

Ford's Transportation Research and Planning Office has every intent of pursuing dial-a-ride implementation plans beyond Mansfield. Each promises to be as challenging as the first. If there are "universal truths" that apply to all implementation situations, we have not yet discovered them.

Inquiries from numerous cities and towns in the 30,000 to 250,000 population class, transit feeder locations, and some intriguing private applications have convinced us that dial-a-ride, unlike some of the "new" technologies, is not a "solution looking for a problem." It is needed now in countless communities not only in North America but also in Europe and elsewhere.

Doorstep, route-deviation service such as that implemented in Mansfield illustrates how transit services can be upgraded while an important first step is taken toward a dial-a-ride system. The key elements in that service—small, maneuverable, relatively inexpensive vehicles; radio telephone controlled, doorstep service; and efficient, imaginative, and innovative management—can be assembled in other communities. It is our conviction at Ford that incremental implementation schemes provide the most satisfactory method of apply our growing knowledge of dial-a-ride system concepts to solving pressing transportation problems. New business opportunities for Ford may result from this research; but whether they do or do not, it is clearly in our best interest to do whatever we can to make public transportation in our cities more responsive to users and less burdensome to taxpayers.

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