

# SEMINAR ON SYSTEM ATTRIBUTES AND PERFORMANCE

## INTRODUCTORY COMMENTS

Daniel Brand

The subject of this seminar potentially overlaps the subjects of each of the other seminars. Therefore, the diagram shown in Figure 1 (with apologies to the conference organizers and other seminar leaders) may yield a sharper and more productive definition of our topic. The diagram is not intended to be a complete analysis framework for planning innovative demand-actuated transportation systems (DATS). Rather, the boxes and arrows show how the subject matter of this seminar relates to the subject matter of the other seminars.

When we talk about attributes and performance (1 in Fig. 1) of demand-actuated transportation systems, we are describing supply characteristics as opposed to demand. We are defining and characterizing the transportation and nontransportation outputs of the demand-actuated system. Values for these are estimated by simulation (10) as a function of the system design and technology (7), including operating policies, capacities, network characteristics, control schemes, and regulations as well as pricing policy (8). The latter, pricing policy, is the subject of another seminar. System attribute and performance values are also a function of the usage of the system, as shown by the feedback loop from demand (2) to simulation (10). Finally, we are not concerned with whether the impacts are good or bad. This is covered from both the economic and system points of view in later seminars.

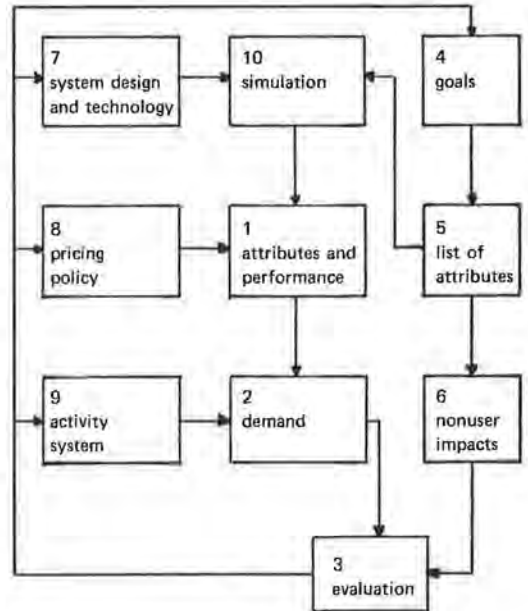


Figure 1.

One important way to define attributes and performance is from the point of view of the user. That is, the simulation (10) must output attribute and performance measures defined consistently with what drives consumer (traveler) behavior. This requires that the behavior of travelers be characterized in terms of their values and responses to the choices open to them. An important objective in this seminar, therefore, is to define and describe the choice variable of DATS, namely the DAT system attribute and performance variables, in terms of how they relate to demand (2). (We are not demand modeling, however. This was the subject of a previous seminar.)

A second important way to describe the attributes and performance of demand-actuated transportation systems is in terms of their nonuser impacts (6), that is, how their impacts on the environment and on suppliers of transportation and other services are viewed by nonusers. Thus, we are concerned in this seminar with attributes and performance from 2 points of view. We want to discuss hypotheses and research results as to how the attributes and performance of demand-actuated transportation systems affect users and nonusers of these systems.

We begin with a discussion of the attributes and performance of innovative demand-actuated transportation systems from the point of view of nonusers. These are the impacts on users of other transportation systems, on operators of transportation systems and subsystems, on persons and the environment near the system (or formerly occupying the same space as the system), and on government.

#### NONUSER IMPACTS: OPERATOR AND GOVERNMENT

Daniel Brand

To assess the impact of innovation on an industry, we often find it useful to go back a bit into history to see how that industry evolved. Richard Solomon did just that with respect to the transit industry as part of the CARS Project at M. I. T. (1).

Richard J. Solomon

Most of the men who guide the transit industry today either were founders of the bus systems that they still head or were young assistants in electric street railway companies that evolved into today's transit operations. In other words, the current generation of transit operators is also the generation that introduced the last major innovation in transit, the motorbus.

The modern bus was widely introduced in this country between 1925 and 1936. However, a gestation period of some 10 to 15 years before that time set the pattern for the last 40 years of transit development. Had the, even then, currently prevailing forces of urban development been clearly seen by the transit industry, perhaps public transportation would have followed radically different lines of development. As it was, it was not technology that guided transit development but acquiescence to certain socio-political forces that guided technology. We want to avoid the same thing happening to the concept of computerized dial-a-bus as happened to many other transit innovations during the years.

As in any prosperous industry, transit tended to be quite conservative toward innovative practices at the beginning. Any departure from the standard or any new method of carrying passengers on a common-carrier basis was (and still is) viewed only as a threat to the existing infrastructure and not as a way to offer better or more desirable service to the public (and perhaps gain a larger share of the urban transportation market).

Prior to 1912, electric street and rapid transit railways were prosperous monopolies carrying almost all urban passenger trips. Per capita ridership on street railways rose faster than the urban population until the end of World War I; hence, investments in those days in street railway companies were extremely attractive. Most street railway operators anticipated that ridership and earnings would increase indefinitely as population grew; costs were expected to decline as utilization of their investments increased.

Given the absence of competition, there seemed to be no reason for operators to change practices. Franchise laws also prevented established operators from trying new types of service or equipment. For instance, most operators had to have new laws enacted simply to permit the introduction of motorbuses, or even to reduce the crew on street-cars from two men to one. Because fixed routes, a single standard of service, and generally inflexible fares are still part of the transit scene, we expect similar problems in the implementation of dial-a-bus beyond the federally sponsored demonstration stage.

Daniel Brand

Are there any historical precedents, for example, jitneys, for this gloomy prognosis?

Richard J. Solomon

The history of the jitney and other similar "nonestablished" carriers shows this. Jitneys have challenged traditional transit operations in one form or another to the present day, even though the industry often has pretended that it was regulated out of existence. The jitney is quite relevant to the dial-a-bus concept and is the basis for existing motorbus systems as we know them today.

The first jitneys were modified 5- or 6-passenger touring cars used for common-carrier service between some western American cities in 1910. They were essentially motorized stage coaches and were initially ignored by both the regulatory bodies and the railroads. An early urban operation was between central Los Angeles and several suburban towns in 1911. A 5-passenger Ford Model T would cruise along the route of a downtown trolley and, for a 5-cent fare, pick up passengers who were destined toward some suburban location such as Long Beach. A practice was made to deliver these passengers as close to their destinations as was deemed feasible without a major diversion for the other passengers—an intuitive premonition of the one-to-many dial-a-bus algorithm.

Instead of trying to compete by introducing better and more varied public transportation services, the transit industry's response to the new competition was to regulate it out of existence. Legislation in most cities by 1920 temporarily reestablished the public transportation monopoly position of the electric street railways. Almost every city had some form of restrictive anti-jitney bus ordinance, usually with franchise rules for fixed routes to be established according to the determination "of public convenience and necessity." These regulations still exist and may prove to be a major stumbling block to the implementation of new systems without major new legislation.

Daniel Brand

How did the street railways around 1920 perceive the automobile as possible competition?

Richard J. Solomon

When the street railway companies wrote their franchises, they could not conceive of any urban transportation technology becoming viable other than street railways. They even resisted electrification until the economics of horse-drawn vehicles began to overwhelm them and financial interests forced the issue.

Daniel Brand

What were the attributes of jitneys that made them so attractive so early as an urban transportation mode?

Richard J. Solomon

The main attributes were frequent service along corridors, seats for all, and occasionally door-to-door operation. Some say "personalized" transit. Jitneys had a resurgence during the 1930's. There were probably 2 major reasons for their reappearance. The first one was the same unemployment pressures that spiked the original jitney boom. In addition, urban travel was reorienting itself spatially, temporally, and quantitatively, and the conventional transit industry was not changing its routes and services rapidly enough to meet new demands.

Daniel Brand

What existing institutional problems now work to prevent the introduction of, specifically, dial-a-bus?

Richard J. Solomon

No matter what we think of dial-a-bus, and where it fits in the public transit spectrum, the industry will look at dial-a-bus as its competition and not as another tool to compete with the automobile. The regulator may look on dial-a-bus, though, as another form of transit but not the way we might think. Let us use a recent example of Monarch Associates that until recently leased minibuses for car pools in northern New Jersey and Rockland County, New York. They put the car pools together and then leased the vehicles making it very convenient to get into a car pool. If you changed your job or your residence (in their territory), they would attempt to put you in another car pool. By acting as an organizing agent, as well as a leasing agent, they managed to avoid many of the problems of car pooling. However, they were also in the public transportation business as innovators in a very real sense. For obscure reasons, they decided to go to the Interstate Commerce Commission to get permission to run their service. The ICC did not know what to do with them because the mode did not fit under the rules. The ICC suspected, however, that Monarch was doing something wrong and, therefore, said, "You can't do it." Monarch is appealing this in court. The first thing is that the court will have to decide what kind of "mode" Monarch has, and it will turn out to be a bus. If the court cannot think of anything else, then it will consider the mode a bus in terms of how it competes with bus lines and not how it fits into the total urban transportation picture. [Since this conference, that is exactly what the court ruled. Monarch was permitted to operate but only as a bus route with defined corridors. Monarch has since discontinued this business because of heavy losses incurred from the change of operating practices to a conventional system.]

Daniel Brand

A worthwhile project would be to differentiate in clear terms the service attributes of the various modes and submodes. In particular, we should differentiate how dial-a-bus separates itself from fixed-route and scheduled service and from taxis and private cars, i. e., where it falls into some hierarchy of modes.

Richard J. Solomon

We must not fall into the same trap as legislators, regulators, and operators. Legislators say, What kind of mode are we going to regulate today. Then they set up an agency like the ICC, which has jurisdiction over some limited set of modes. Then that agency assumes it has authority over everything, so as not to dilute its authority. Is that what we want from regulation? We want to encourage the lawmakers to think in terms of functions of service, reliability, and safety instead of the technological details by which we now name modes, i. e., bus.

Daniel Brand

Therefore, in addition to specifying the important attributes, we need somehow to name the modes and keep all the information together for purposes of identifying the mode. That is, the attribute values will really be mode (i. e., activity of riding on the mode) specific. We must not be so naive as to be completely abstract and use only service characteristics in our identification of modes. There are many instances where it is convenient if not necessary to know the technology involved.

Kenneth W. Heathington

We had a similar instance recently of overregulation in Lafayette, Indiana. A private travel agency purchased 3 or 4 limousines a few months ago to run a limousine service between Lafayette and the Indianapolis Airport. The limousines ran about 3 times a day for about a month, and then the agency suddenly found that it came under some existing regulations because the limousines were for-hire. The Greyhound Bus Company, which has no service whatsoever between the Indianapolis Airport and Lafayette, protested. The railway companies also protested, and they have almost no passenger



service whatsoever. To our amazement, the airline companies also protested. So, the service was put out of business but not because of anything related to the system performance. When we look at dial-a-bus or for that matter any other transportation innovation, we must realize that the courts and the regulators are going to deal with these matters in strange and different ways.

Daniel Brand

It appears, therefore, that we need to bring some hard evidence to bear in such cases. But what kind of evidence? Perhaps we need to know how these innovative transportation modes differ in terms of their effect on the travel market. We need to be able to specify or isolate the different travel markets so that one can argue in court that these are different kinds of services. Before we can do that, however, we need to know a lot more about how the range of attributes affects users and nonusers.

#### IMPACTS ON NEIGHBORHOODS

Daniel Brand

Let us leave the government area and discuss another nonuser impact of interest, and that is the impact on neighborhoods. What would be some dial-a-bus attributes and their effects on persons who live on roadways having such service?

H. J. Bauer

My comment has to do with DATS vehicles in residential areas. I think this is one case where the nature of the vehicle is going to be a detriment to the whole concept. People build cul-de-sacs and pass local legislation to preclude through traffic. They even go so far as to build barricades across streets to restrict travelers to main arteries and prevent shortcuts. We must be very aware that people, users as well as nonusers, are going to be very sensitive to the running of these "commercial" vehicles in their neighborhoods where children are playing on streets and sidewalks. I would like to ask Harriet Curd if she remembers from our GM surveys the response to the question of how people feel about the various kinds of vehicles coming into residential neighborhoods.

Harriet N. Curd

In general, people liked a smaller bus and a stylish vehicle.

Daniel Brand

Did you also look at the problem of vehicle size and style from the standpoint of the user in these neighborhoods? One envisions conflicts between user and nonuser design requirements. That is, from the standpoint of the nonuser, the buses should be as unnoticeable as possible, and looking like automobiles might be the norm. From the standpoint of users, however, perhaps big conventional buses that stand out and are noticed by nonusers would lead to later increases in usage by these same people?

H. Norman Ketola

We have been concerned with small vehicle design for a number of applications, dial-a-bus being one. To date, our ideas call for a vehicle that is able to go into any residential area and be unobtrusive and accepted. We have spent a good deal of time with communities, with operators of transit systems, and with people who may be considered potential users of the systems. I think that they all definitely want a small vehicle, both exterior and interior. This is going to be extremely important in selling the dial-a-bus concept and other advanced concepts for bus transit in residential areas.

Daniel Brand

It appears there may be arguments for a vehicle that stands out and is a traveling advertisement for the service and that is also unobtrusive.

Arthur Schwartz

Regarding acceptance by local residents, there are 2 criteria that really have little to do with visual appearance. These are that the vehicle be small enough to operate in a residential area without having to back up twice to make turns or otherwise tie up traffic and that the vehicle be quiet. It should not shake all the houses as it comes down the street, and, when it accelerates, it should not produce large clouds of smoke.

Daniel D. Morrill

I know of a city that runs 45-passenger, GM buses on as many of the residential streets as can be negotiated. There have been no complaints to my knowledge from nonusers about the presence of the vehicles.

Arthur Schwartz

All of the attributes we have discussed are important and desirable, but here is one example where they have not been implemented and nobody has complained. We should remember that frequency of appearance is also important. If something happens once a day, people are not likely to complain. If something bothers them every 5 or 10 minutes, they are much more likely to complain than if it bothers them every hour or half hour.

Frank L. Ventura

I would like to list some attributes that would be of concern to the nonuser: noise, vibration, pollution, intrusion into the tranquility of the residential area, scale of the vehicle, safety, and speed. I feel that we would have a mild revolution in some residential areas if a Greyhound type of vehicle were to come pounding down the pavement every 15 minutes or even every hour or two. People have adjusted to the size of the car as being in scale with their own immediate environment. I think we have to get a vehicle more on that scale. In new developments, the lots on cul-de-sacs sell first and the lots on short loop streets sell next. Why? The residents do not want any traffic that does not belong there. Speed is also another safety consideration.

Daniel Brand

I have small children who sometimes run into the street. I am always mad when I see a car going by too fast.

H. J. Bauer

In fact, in some areas, there are bumps deliberately built into the streets near the corners to curb high speeds.

William T. Howard

Let me introduce one other dimension on the plus side. From experience, we know that, prior to 1967 in the Bay Ridges area of Toronto, homes could barely be given away. After the introduction of the GO transit rail service, the home values increased by as much as 50 percent. I think the nonusers of DATS in this area who might otherwise want to complain about the increased use of streets by dial-a-bus will think twice because I am quite sure they expect another 50 percent increase in their property values.

Karl Guenther

We experienced something quite the reverse of what some of you seem to be saying. The Woodland DATS vehicle is a different color from the rest of the city buses in Mansfield. It was immediately adopted by at least a portion of the residents as being their bus. This includes users and nonusers. We have had a lot of people walk up to the thing as it is sitting on the main downtown square and talk of it as being their bus.

William F. Kail

It appears that most complaints in residential areas come from women. I seriously doubt that men will complain. For one reason, they are not home all day, unless they are unemployed. For another reason, women are primarily concerned with safety for children. At home I get two complaints from my wife. One is the noise from the motorcycle that goes up the street, and the other is the speed of the contractor's trucks going up and down the road. She is concerned about noise and safety. It may be wise to take a look at what women think in regard to dial-a-bus vehicle design.

Kenneth W. Heathington

I would also like to share a few personal experiences with my neighbors. We live on a street on which one of the greater Lafayette (Indiana) buses travels. The buses were probably purchased in 1910. Although nobody, so far as I know, from the neighborhood goes out and complains to the city (who now owns the transit company), they still come to me and say, "Gee, look how dirty the thing is and how bad it looks. Can't they have a better looking design? Why does all this smoke have to come out of it?" There is an underlying theme to their complaints: There is something better that can be done. I do not think their dissatisfaction is at the point that we will see protesting and signs and things of this nature. However, we should not wait until people march on city hall or the bus company with signs of protest.

Joseph H. Stafford

This raises the point of the image of the conventional transit coach. It has not changed, and that carries over in the name "dial-a-bus." We might keep that in mind in the use of that name for the system.

Edwin H. Porter

One thing we sometimes miss when we talk about dial-a-bus is that it is not yet a system. It is more a concept. The flexibility of the concept does not get stressed enough. We tend to think of dial-a-bus as always being implemented on a massive scale—a many-to-many mode. Well, you can do that, but it is so flexible that you can cheaply change the route. If a neighborhood decided that it did not like it, you could say there are no subscribers in that area. Then, if someone wanted it, he could argue with his neighbors to let it come in. This relates also to the transit union's concerns. It is concerned that dial-a-bus will take away the line-haul, fixed-route bus business. It does not need to be. In fact, dial-a-bus could be used to test where line-haul buses ought to be established on the basis of demand for dial-a-bus. I think we should stress flexibility more. You need to know exactly where a railroad goes because after you have put it in you cannot change it. However, dial-a-bus is so flexible that for a relatively modest investment you can put it in service in a neighborhood.

Daniel Roos

When we talk about the impact of the vehicle on the neighborhood, we should also look at the reverse problem, What is the impact of the neighborhood on, not the vehicle, but the people in the vehicle? A typical situation in most cities is a poor neighborhood located next to a relatively affluent neighborhood. I think people choose to use or not to use transit partly because they know where they are going. For example, in Boston, I suspect very few people who boarded the transit vehicle in a \$50,000 neighborhood would use the system if there was a strong probability they would find themselves in the middle of a ghetto. This will have considerable impact on whether people do or do not use the system.

Richard J. Solomon

I want to underline what Edwin Porter said. The flexibility we are introducing with dial-a-bus can change our concept of public transportation. Dial-a-bus can be fixed



route, but it does not have to be fixed route. Jitnies were flexible until they got lumped into the categories of old mode names. Maybe if we emphasized flexibility, public utility commissions might change their regulations so they are functional and address the market, and not only from the suppliers point of view, i. e., the number of wheels, seats, or windows or other arbitrary rules.

Eugene T. Canty

Before we leave this topic, we should reemphasize the point that Frank Ventura made about safety. The operation of DATS vehicles through residential streets will be drastically different from that of conventional buses on fixed routes on arterial streets. There are a number of reasons: There are not necessarily markings on the roadways, there are more likely to be children playing on residential streets, and so on. I think this has a significant impact on desirable vehicle design, in particular, the amount of driver vision. Although the preferable design that we exhibited was called stylish, the primary attribute of this design was the large glass area, not just the above-belt line but in a wide area, vertical and horizontal, at the driver's position. At least a 270-degree horizontal and a large vertical aperture is important to be able to see the edge of the road, curves, children, toys, and what not on the roadside. I think also that the concept of pulling into people's driveways and backing out is a very bad and a dangerous tactic. A large number of child deaths are caused by automobiles in driveways now.

#### IMPACTS OF HIGHWAY CONGESTION, LAND VALUE, AND LAND DEVELOPMENT

Daniel Brand

A final area of nonuser impacts is the systems effects of dial-a-bus. Dial-a-bus cannot be viewed in isolation; it must be viewed in terms of its effects on users of the larger transportation system. Without getting into the attributes that affect demand directly, can we make any generalizations now as to the network effects of dial-a-bus? For example, will dial-a-bus relieve highway congestion? Is dial-a-bus the kind of congestion-relieving panacea that fixed-route and scheduled transit (e. g., rail transit) was once thought to be (or perhaps still is thought by many to be)?

Frank L. Ventura

In our study of the benefit that might be realized by our case study community with implementation of a D-J system, we discovered that the diversion of automobile rides to D-J was not high. The 2 or 3 percent of automobile passenger diversion would not provide substantial traffic congestion relief. As far as a decision-maker is concerned, his decision to go for this type of system should not be based on potential traffic congestion relief.

Daniel Brand

That is an excellent introduction to the problem and one with which I and perhaps others can agree. However, if what you say is true, how does dial-a-bus affect land development and land value? It does not seem to do this through changing the travel decisions of vast numbers of automobile users.

Daniel Roos

Regarding the question about the effect on development, I think one principle of dial-a-bus is that it does not affect development, it responds to land development. So often we planners and transportation engineers sit down and say it shall be this way and I will put a transit route in here and this marvelous thing will develop around it. I think people and things affect development. That seems to be what is occurring in society today. The problem is to provide transportation facilities for that type of development. For certain types of development, dial-a-bus is ideal, regardless of the final form of the development. Regarding the question about relief of automobile congestion, I agree



very much with what was said by Frank Ventura. However, when we talked to people from planning organizations in larger cities, some of them referred fondly to their dream of banning automobiles from downtown. They thought that dial-a-bus offered the first hope that they might be able to do this. So given dial-a-bus, one could in fact legislate a decrease in congestion. I do not suspect that this will happen in the near future, but it is always a possibility.

Kenneth W. Heathington

In one preliminary study, we found that diversion to DATS would be one automobile per lane per hour. This indicates that we would not want to argue for dial-a-bus as offering relief of congestion on busy streets. I myself do not think this is a consideration. There are many good uses for dial-a-bus, but relieving congestion is not one of them.

Frank L. Ventura

In fact, it might add to congestion if the vehicle were permitted to stop at every corner along every thoroughfare. Because there is normally no provision in these kinds of roadways to stop without interfering with traffic, the frequent stops would reduce the effective capacity of that particular lane and result in added congestion, if any exists to begin with.

Fred Tumminia

Dial-a-bus is a functional vehicle that is useful for filling some gaps in providing efficient transit service. On the question of efficiency, I think dial-a-bus is going to succeed because it services certain travel needs in a more efficient and functional manner than other vehicles. On the question of institutional constraints, there should be federal support for removing constraints on the use of transportation vehicles by one regional operator. A regional operator should be able to operate every type of transit vehicle. The operator should be allowed to let efficiency dictate how he is going to meet the travel demands of the people. For example, if there are people who are not traveling because they do not have access to a private vehicle, they should be allowed to have access to a system that transports them in the time and at the price that would allow them to make their trip.

Daniel Brand

Perhaps, then, dial-a-bus is not going to affect land development by decreasing the time or cost of travel for large numbers of present automobile users. However, it may affect land value by offering a convenient and viable travel choice, for example, by increasing the availability and convenience of travel for "the wife and kids." Can we discuss the attributes of dial-a-bus in terms of this aspect of convenience of travel?

Arthur Schwartz

Yes, the principal effect of dial-a-bus on automobile travel will be to reduce somewhat the large number of automobile trips that are made for the purpose of getting a non-driver from here to there.

Daniel Brand

These are the serve-passenger trips.

Richard L. Smith

In new subdivisions or communities, one of the primary problems is the trips that the housewife has to make in shuttling children to and from school and making convenience shopping trips. Dial-a-bus service could fill a temporary need in a developing community where the density of trips is not great enough to justify scheduled service. The demand-actuated service could be instituted on a temporary basis to facilitate people moving out from boundaries of existing communities.

Daniel Brand

How did the developer of the new town of Columbia, Maryland, view transit service in general and dial-a-bus in particular? Did he have an expectation of additional payoff from transit in terms of selling houses more easily, for example?

Richard L. Smith

Generally, the developer of Columbia considers transit service necessary for drawing people to the community. People should be given the opportunity to use bus service if they do not have a car for convenience purposes or if they are teen-agers or nondrivers. However, the development of the new community demands a more efficient transit service in the future than dial-a-bus.

Robert D. Stevens

The initial planning of Columbia called for a scheduled bus system on an exclusive right-of-way. This has been used in the selling of houses in Columbia. Real estate salesmen display pictures of minibuses in advertising houses. There was quite a problem with possible misrepresentation of what the bus system was going to do and where it would be located in the neighborhoods. The expected bus service was greater than what was really there. I think they have resolved that problem. There was bus service but it was not really clear to the people whether it was only on the right-of-way or whether it would go into the neighborhoods. The original intention was just for service on the fixed right-of-way. However, the bus service had been advertised, and people were told they would only need one car. Some people actually sold their cars when they moved to Columbia. They have since brought another car, going back to a 2-car family.

Daniel Brand

Therefore, the presence of good transit service could affect the total cost of living in a new community by reducing the need for a second car. The resulting savings could be capitalized in the additional value of housing. People might pay more for a house or be more apt to pay the same price for a house, given the savings on a second car.

William T. Howard

The real estate ads in the particular area of Toronto served by the GO transit trial have gone one step further. They say now you do not need to own an automobile at all!

H. J. Bauer

In Columbia, the notion of the village concept was ordained initially to reduce the need for people to use anything other than their legs to get from home to the convenience shopping. Every village has a small general store. Walkways were designed to be separated from all vehicular traffic. One of the developer's ideas was to vitiate the need for a vehicular transportation system, as far as the daily lives of housewives and children are concerned.

Robert D. Stevens

An elaborate walking system was designed for Columbia to serve both the neighborhood and village centers. However, there still are, probably more than expected, a large number of short automobile trips to neighborhood stores. The parking demand at both the neighborhood center and the village center was greatly underestimated. The assumption was that people would walk, but people are not walking. They are driving.

Daniel Brand

The achievement for a true walking-scale community is going to require much higher densities than those currently planned for Columbia!

H. J. Bauer

And a lot of brainwashing!

Daniel Brand

We have spoken already about the longer run "travel" decisions related to car and residence purchases. Are there any other possible longer run consequences of dial-a-bus?

Eugene T. Canty

There are decisions in plant and shopping center location and layout that would be affected by increasing transit service by dial-a-bus. With increased transit service, employers can minimize parking requirements and locate their plants to be more accessible to people not owning or having access to an automobile. Regarding the potential increase in accessibility to shopping centers, it is possible to consider a subsidy of dial-a-bus operation by shopping center proprietors.

Frank L. Ventura

The relatively low land consumption by dial-a-bus could be of significant importance to cities that are hardpressed for vacant developable land. The relatively low land requirements of dial-a-bus could mean that there would be little or no displacement of families. There is also an economic impact in the sense that the community's tax is not decreased by the amount of land required for the system.

Eugene T. Canty

Another impact on neighborhoods is that dial-a-bus may allow for more heterogeneous neighborhoods. We found in some of our in-depth interviews substantiation of the notion that older people move from houses to apartments to a large extent because of mobility. I think mixing people of different economic and age levels in a community has positive value.

#### ATTRIBUTES OF SYSTEM OPERATION AFFECTING USAGE

Daniel Brand

Let us shift over now into the area of user impacts. Are there any hypotheses or results about operating procedures or performance of dial-a-bus that affect use of the system. For example, in the Northeast Corridor study it was found that standard operating procedures relating to business purchase of air tickets was an important determinant of intercity modal split. Are there hypotheses or results relating attributes of system operation to usage of dial-a-bus?

Kenneth W. Heathington

The length of time the system is in operation is one. We must have a system that is not just an 18-month demonstration. It must be something that users will consider to run for a long while. I think this has substantial impact on the long-run decisions people make regarding housing purchases, which in turn affect system usage. In my experience with the North Shore area of Chicago, I observed that buying a house along the railway was very important, particularly if one worked in town. Farther away from the railway, one had to pay for an extra automobile to get to the train station. Dial-a-bus feeder, on the other hand, on a long-run basis will allow families to purchase houses away from the stations at less additional cost. In other words, they would be more apt to take the money that would be used for extra transportation and put it into housing or land. The funds would be redistributed so it may not be as important to live as close to the station as before. I think we may see these considerable changes, and they are not short-term changes. They are going to evolve over time. We are going to have to have demand-actuated transit systems that are reliable and permanent, insofar as anything is permanent.



Frank L. Ventura

Another long-run benefit will be that those now without cars who are forced to live in the inner city where transit systems now exist will be able to live in suburban, lower density areas without fear of being without transportation. They will have greater housing opportunities.

Fred Tumminia

There could be more use of institutions because of the availability of dial-a-bus to gather people together. For example, when the mayor found that the Wax Museum in Philadelphia was foundering, he asked his transportation people to do something about it. I found the way that worked successfully was to go to the neighborhoods that had bus service and talk up the idea of the Wax Museum to women's clubs. We gave them the idea of going in groups, and we arranged car pools and special buses. This met the mayor's needs and aspirations for the Wax Museum.

Daniel Roos

Dial-a-bus is the one new transportation concept that involves new technology and that might be implemented in, say, a couple of years. Depending on how well or how badly we implement the first systems, we are going to lend credibility to the idea that innovation in transportation is possible, or we are going to set it back a good number of years.

Daniel Brand

In the New York area, which attributes of transit seem to affect people's choices of travel mode and travel routing decisions in a transit network?

Arthur Schwartz

An important problem not confined only to the New York area is economically providing feeder bus service with conventional buses to outlying commuter railways. We had several experiments in the New York area where we tried to provide a conventional feeder bus system in an area of good ridership potential, e.g., one having a rather high bridge toll. It did not work because, when there are 2 infrequently running services that have to be scheduled to meet each other, people are not willing to risk missing the connection. The person who arrives at 8:43 at a train connection that runs relatively infrequently cares very much if he missed the train that left at 8:40. I think that a flexibly designed dial-a-bus system can provide feeder service to such line-haul facilities. In addition, we find ourselves in a situation where the demand for transit service in the suburbs and smaller cities cannot be viably supplied with fixed-route vehicles. It is not a large demand. It is also not a demand that if not accommodated would cause the areas to fold up overnight. It is that the conventional bus transit service has dried up.

Daniel Brand

What are some of the characteristics of those markets?

Arthur Schwartz

One market is the station-to-home trip that is now made by calling up someone and saying, "Joe, come get me." There is a lot of this in a suburb of Trenton, where I live. If someone comes in on the train after the bus service has quit around 6:00 p. m., he can use a cab or he can call up one of his neighbors and have him come and pick him up.

Fred Tumminia

You would replace dial-a-neighbor with dial-a-bus!



Kenneth W. Heathington

We might see some behavioral changes in trip-making characteristics over a longer range period. A high-reliability vehicle coming to the door would allow putting a child on at the door and allowing him to be dropped off where and when he is supposed to be. He does not have to go to a bus stop and get on and off by himself. In this way, serve-passenger trips, such as parents carrying children to school, music lessons, and things of this sort, would be reduced or converted to single person trips.

#### ATTRIBUTES AFFECTING DEMAND

Daniel Brand

Let us switch finally and firmly into the area of attributes and their impact on demand. What are some additional results and hypotheses as to how attributes of dial-a-bus affect demand for the system?

Joseph H. Stafford

From the urban transportation planning surveys in the M. I. T. CARS study, about 15 to 20 percent of total automobile trips are serve-passenger trips. These trips serve people who for some reason are not driving an automobile. In most cities, an average modal split of 3 to 5 percent makes up the total bus system market. At the same time, perhaps 5 times as many trips are served by somebody else driving the automobile. Tapping this serve-passenger market may radically alter the break-even position of a bus company. What does it take to tap that market? We can look at this from the same perspective as other consumer expenditures. A whole host of convenience items like dishwashers, prepared foods, and wash and wear fabrics are a normal part of the consumer budget. Dial-a-bus is a convenience item in relation to this serve-passenger market. We can cast the demand for it in the framework of what we are willing to pay to let our wives stay home and do what they want to do instead of being chauffeurs. What are we willing to pay to save their time? The time in question is not just the value of time of the person who wants to go somewhere but also the value of time for the person who is going to have to drive him there, drop him off, go back home, and then go down later, pick him up, and bring him back—or go down and wait for the person! We can use the value of time-consumer choice framework to look at the serve-passenger trip as a separate segment of the market.

One other thing I want to suggest is disaggregating the different components of time. That is, we should calculate willingness to pay for minutes of time spent walking exposed to the elements differently from minutes of time spent standing at the curb waiting for a bus. This should be done in the context of willingness to pay for the opportunity to use the time in a different way. The Mansfield dial-a-bus experiment has been a unique opportunity to test the usefulness of this disaggregation. By looking at which households are walking to the bus and which are choosing to pay the extra 15 cents for door-stop service when all the other characteristics of the service are equal, we have a nicely controlled experiment. The average distance of door-stop users was about 800 ft from the fixed routes. There seemed to be a threshold of about 300 ft. That is, if residents (not domestics coming into the area) were within 300 ft of the fixed route, they did not use the door-stop service. This makes it possible to put things into some sort of cents per minute framework. I believe that they are paying 5 to 10 cents a minute to avoid time outside in the elements. There are limitations as to what could be inferred because we did not know the maximum waiting time, but the results check out with Lambe's figures of about 5 cents a minute. It also checks out with Lisco, Lave, and Quarmbly's figures that the willingness to save time is on the order of 40 percent of the wage rate for time spent at home and 80 percent of the wage rate for time spent at home rather than in walking. In summary, people are willing to pay quite a bit for a higher quality service that prevents their having to be out in the elements or to stand at a stop, even if it is close by!

Arthur Schwartz

I must object slightly to your assumption of equal availability to 2 classes of service. There will be an incentive to use the new service because the introduction of the dial-a-bus feature means the times of arrival of the bus at fixed-route locations are not as exact as they were before the dial-a-bus service. There will be 5- or 10-minute variations on the fixed-route arrivals. A rider must now walk to the regular stop to arrive at the earliest time the bus could possibly come, with the expectation of having to wait a few minutes.

Joseph H. Stafford

I quite agree, although there was some variation in the arrival time before. Nonetheless, making allowances for this, we concluded that roughly 5 cents a minute is what people are paying in this Mansfield neighborhood for not walking and waiting out in the elements.

Daniel Brand

What do the Mansfield results indicate about how dial-a-bus diverts riders from transit relative to diversion from automobiles? Also, do you have anything on induced (new) trips from the Mansfield results?

Joseph H. Stafford

The data we were working with are for households rather than for trip-makers, so we must be very careful about what we conclude. Karl Guenther has also recently worked with these data. There appear to be no new households using transit. In other words, in the dial-a-bus experiment in Mansfield, almost no households using the Woodland route with dial-a-bus were not using it before. The increases in usage were from members of households that were using transit before, buying the extra service, and taking additional trips.

H. J. Bauer

Were they making entirely new trips?

Joseph H. Stafford

We do not have suitable data on that. We were only trying to discriminate between the households who were using the service and those who were not. We do not have trip-making data per se. However, another significant result was that the residents (and not those who were commuting to the area) were using the service relatively infrequently, 2 or 3 times a week at the most and often only 2 or 3 times a month. These households were all classified as users of transit. To look at the results in a meaningful way, we have to start looking at data in terms of travel decisions over some relatively long period, such as a year rather than at the typical cross-sectional data of what they did yesterday. The latter data are what we get in the typical home interview surveys.

Daniel Brand

Are there results relating the attribute "distance from the fixed route" to demand for the new dial-a-bus service in Mansfield?

Joseph H. Stafford

In discriminating between the group of users who walk to or from the bus and those who get door-stop service, we found the only significant variable to be distance from the fixed route. In distinguishing between the households who used some sort of transit and those who did not, we found the most significant discriminators to be the age of head of household and educational attainment. However, in that neighborhood the latter is so highly correlated with age of head of household that the differentiation is probably not meaningful.

Daniel Brand

Do you suspect there will be seasonal variation in these results?

Joseph H. Stafford

Most of the household data were collected by Ford and the county planning commission before the dial-a-bus service started in December. The start of service was followed with a small early spring survey and a follow-up survey in early summer. We tried to look at seasonal or weather variations, and there does appear to be a weather effect. Statistically, we cannot yet say there is.

Daniel Brand

Are there any more recent Mansfield results?

Karl Guenther

There are many new results. We may have to cover some of the same topics that Joseph Stafford covered. New and induced trip-making was only significant among non-residents and amounted to over 10 percent of nonresident trips. This derives from a survey question that indicates they were taking a trip they would not have taken if the service had not been available. However, as Joseph Stafford said, these represent existing transit riders making more trips.

Daniel Brand

What groups were in your sample universe?

Karl Guenther

We sampled the total transit user population and have broken the survey results down into 4 categories: nonresidents who use dial-a-ride, nonresidents who do not, residents who use dial-a-ride, and residents who do not. The important result is that non-residents did take more trips. The number of residents who would not have made the trips was insignificant, about 1 percent.

Daniel Brand

That does not necessarily mean that the residents would not make more trips or that there might not be any induced travel by these people. It can mean that they simply have an alternative more available in the short run (a car) for their trips.

Karl Guenther

Along this line, there is a very important finding that a large number of people use the service very infrequently. We had a 100 percent sample of the households who had ever telephoned and requested door-stop drop off. We recorded every address and went back to that particular household and asked: "You used it once or twice; why did you quit?" The answers were not dissatisfaction answers. Our consensus is that people were satisfied with the attributes of the service. We gave them the option to comment freely in writing on their gripes. They had almost nothing that they wanted to complain about. We also gave them the option of checking specific boxes for things that they might not like (e. g., the driver or the vehicle). We got almost no response on this.

Daniel Brand

What were the reasons for the infrequent use of the service?

Karl Guenther

All the normal kinds of things that fell into a category we called personal circumstances: Somebody was on vacation and had taken the second car out of town; a son was home on leave from the service; the second car was laid up for repairs temporarily; or someone



took a part-time job downtown for a few months. It appears that there is a market that will view dial-a-bus as a temporary convenience and use it that way.

Daniel Brand

We can characterize this as a short-run response to a short-term or new service. The longer run adjustments to the new service (selling the second car or not replacing it when it wears out) take a long time.

William T. Howard

One of the interesting things that turned up in our Toronto DATS operation was that we consistently carried more people home in the evening than we brought in on dial-a-bus in the morning. This leads us to believe that the attribute of waiting time at the residence leads a lot of people to divert to kiss-and-ride or car pool in the mornings but to remain with dial-a-bus in the evenings.

Richard J. Solomon

On that point, the experience of the Washington, D. C., transit people is that more people use cabs in the evenings to get home from the Silver Spring transit terminal than come by cab in the mornings. They attribute this to calling home at 5:00 p. m. when the wife says, "The kids are screaming, get a cab."

Arthur Schwartz

We have just the opposite in New York where the feeder transit peaks are higher in the morning. The absolute volume, though larger in the evening, is spread out. New York is one city that does not close down at 5:00 p. m. However, in southern New Jersey, the traffic is heavier and more concentrated in the afternoon. Philadelphia, therefore, does close down at 5:00 p. m.

Daniel Brand

Let us highlight a very interesting difference between some of the Mansfield findings and the GM findings presented yesterday. The Mansfield findings show dial-a-bus riders to be mostly diverted from the existing transit service, with some induced travel from nonresident households. The GM case study findings are that relatively few trips are diverted from the existing, admittedly very poor, transit service. They either were diverted from automobile travel or were induced trips by members of automobile-owning households. Might this have been caused by the survey method? If you describe the concept of dial-a-bus to people who are not familiar with it, are you in effect selling a product in competition with the "old" product, i. e., the automobile?

H. J. Bauer

Responding to part of your question, you say that Mansfield ridership consisted mostly of diversion from transit. I wonder if that is the right way to look at it because the new service is an adjunct to a fixed-schedule system. People are not so much diverting from transit as they are taking advantage of the additional convenience and facility that are offered by the dial-a-ride doorstep transit service. There are not many new riders evidently. So it is not really a diversion.

Joseph H. Stafford

I would agree with that. The other difference is that Mansfield already had pretty good fixed-route service in that it still went downtown.

H. J. Bauer

There was also one line in Mansfield to begin with. There is no diversion from any other radial line, is there?



Karl Guenther

That is right. There is no diversion from the fixed-route Lexington Avenue bus line that runs parallel to the Woodland neighborhood.

Daniel Brand

Would you, therefore, go so far as to say that dial-a-bus is not going to cut into the automobile market any more than good, or perhaps very good, fixed-route and scheduled transit service?

H. J. Bauer

My statement was merely relative to your comments about Mansfield. I wanted to clear that point up.

Joseph H. Stafford

We should bring out the fact that, in Mansfield, dial-a-bus essentially served only a few zone pairs. In another city (Manchester, New Hampshire) where we have done a small paper study, the overall modal split to transit is about 3 percent. However, the modal split between zones that have a direct or nontransfer type of transit service is up to about 7 or 8 percent. A many-to-many dial-a-bus system would give direct non-transfer service between all zone pairs. So this distinction between type of service must be kept in mind when these experiments are looked at.

Daniel Brand

Before concluding that modal split will be similarly increased by many-to-many dial-a-bus service, we must also keep in mind that the 7 to 8 percent Manchester modal split is to destination zones having unusual private automobile attributes like congestion and parking charges. To switch the subject somewhat, I was interested that the most important of the 32 attributes GM had on its questionnaire was arriving when planned. Was this just a reaction to the bad taxi service in that city? Also, does this attribute have some explicit and "modelable" relationship with speed or travel time?

Harriet N. Curd

People did place a very high value on time. We concluded from the study that people want good service, they want to arrive at the time they expect to, and they do not want to wait for the bus. Also, they will pay a little more for the good service.

Daniel Brand

What fare difference do you think they had in mind when you asked the question? Are they thinking in terms of a 5- or 10-cent difference, or a 50- or 80-cent difference?

Harriet N. Curd

In this questionnaire, we did not quote specific fares at all. They were forced to make a choice between 2 attributes as to which was more important to them, for example, arriving on time or a lower fare.

Daniel Brand

Can you elaborate on the relationship between arriving at a fixed time and duration of travel time? Did asking about arriving when planned cause travel time or speed to be lower in the importance groupings of 8 or 19 attributes, or were travel time and speed not very important in absolute terms?

Eugene T. Canty

Arriving when planned was essentially a reliability factor, separate from travel time and speed.

Daniel Brand

This is consistent with the Maryland study results on the same subject.

Richard L. Gustafson

I could say something about some of the ratings and the particular characteristics you are talking about. The reason we lumped the eight characteristics together was that they were not significantly different from one another. The three that were rated separately were a significant distance above the other characteristics. Arriving when planned was far above. In making paired comparisons, we used zero as the low value. Stylish vehicle was the lowest. Each of the other characteristics is rated relative to every other characteristic within the scale. Arriving when planned received a rating of greater than 1.8, and being assured a seat on the vehicle was second with 1.65. I do not know whether these numbers mean anything because the relative difference is the important factor. No transfer was third. On top of the next group of eight is being able to call the system and arrange for a pickup without being delayed. I think this is important for the same reason as that in Mansfield; namely, in Mansfield, there was a problem that people found the telephone busy and were deterred from using the system. People are also concerned with dependability and would trade off extra time in order to be able to plan exactly when they are going to arrive at their destinations. If one is going to the doctor's office, one wants to be there at 10:30 for the appointment instead of 10:20 or 10:40.

Daniel Brand

Were there any speed or travel time factors other than those you have mentioned?

Richard L. Gustafson

Our alternative questionnaire also had some interesting results. We traded off various travel times by saying that, if it took you 10 minutes by car, would you accept a 15-minute dial-a-ride trip or a 30-minute dial-a-ride trip. So we input our travel time ratios at 1.5, 2.0, and 3.0. We found that the size of the ratio was only of marginal importance. The important thing was the absolute extra time involved in traffic. That is, a 15-minute dial-a-ride trip for a 5-minute automobile trip was about as acceptable as a 20-minute dial-a-ride trip for a 10-minute automobile trip. Both involved the absolute difference or extra time of 10 minutes. Of course, between the trips with the two 10-minute differences, the one with the better time ratio was preferred, but again the major difference was explainable by the absolute time difference.

Daniel Brand

A waiting time of 15 or 25 minutes as reported in your paper seems rather high?

Richard L. Gustafson

One of the reasons that waiting time was set at those levels was the size of the case study community. Within a 6-mile by 6-mile area, vehicles dispatched in the morning from the central part of the city will take at least 15 minutes to reach a demand on the periphery. Therefore, a guarantee of less than 15 minutes may not be possible to meet.

Daniel Brand

Why put all vehicles in the center?

Richard L. Gustafson

They could be dispatched from all over, but that was not part of our simulation.

Eugene T. Canty

If you can guarantee a 15-minute pickup, you increase the number of vehicles that can be considered as possible pickup vehicles, and you can get a slightly better optimum utilization of vehicles. However, that is a different kind of a trade-off.

Kenneth W. Heathington

There are also some other things that were interesting in the GM questionnaire. We found in this survey that things experimented with in Peoria rated a very low priority as far as dial-a-ride is concerned. Coffee on board and magazines were of very little importance. Use of credit cards also had very low importance. These results go directly opposite to some of the marketing thinking as to what characteristics or attributes a system should have in order to induce people to use it. People are more concerned with travel time, waiting time, and availability of seats.

#### REFERENCE

1. Solomon, R. J., and Saltzman, A. History of Transit and Innovative Systems. Urban Systems Laboratory, M. I. T., Cambridge, Paper USL-70-16, 1970.