PUBLIC TRANSPORTATION RESEARCH NEEDS

Highway Research Board
Special Report 137

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RESEARCH IN THE TRANSIT FIELD

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The history of research in the transit industry is one of fragmentation of purpose and not one of long-range planning or development. Although individual transit operators are partially responsible for the situation, it has resulted primarily from lack of financial resources. Until recently, most transit properties were privately owned and were not oriented toward research in the traditional sense. Some planning and experimentation did occur; however, for the transit field as a whole, research has been meager until recently. When operations began to become unprofitable, transit operators did not attempt to redirect their operations and apply new techniques and new concepts in the field to capture their share of the demand for travel. They generally performed various cost-cutting measures that in turn resulted in a lesser demand for transit services.

Many individuals who have operated transit properties have not been professionally oriented toward research, and in many instances they have viewed research and planning as a waste of money. Only within the past few years has there been a relatively large allocation of resources for transit research. These resources have come primarily from the federal government, with some participation by local and state agencies. There has been more money generated for research and planning purposes in the transit field within the past few years than has been available in all of the preceding years.

It is interesting to note that the control of these research moneys does not lie in the hands of the transit operators. There are arguments for and against this method of research control. Many would argue that past experience of transit operators dictates that research money should not lie within their control but should be controlled by those outside the transit properties. The federal government has established a relatively large research program under the Urban Mass Transportation Administration and allocated a portion of the federal budget for planning and research in the public transportation field.

Most of the individuals who are connected with the federal research program are not traditional transit people. In most instances they have not actually had any operating experience with transit properties. This is viewed by many people as an excellent characteristic, whereas many transit operators view this as a mistake. Because of their differences with regard to research orientation and communication, there is a strong need to bring together researchers and transit operators.

In working with transit operators, one finds that many of them are only concerned with short-range improvements. There is some justification for this, or at least one can understand why they take this position. Most operators are concerned with operations on a day-to-day basis. They have a difficult task in keeping the equipment operating each day. It is difficult for them to plan for long-range programs because they must concern themselves so fully with daily operations.

*The author was affiliated with Purdue University when he wrote this paper.

Also one finds that the transit operators are generally concerned with gross improvements in their systems' operations. Their problems have been so enormous that it has become difficult for them to be concerned with the optimization of a specific segment of the total operations.

Generally transit operators have desired only a minor amount of experimentation. They have not normally been willing to permit radical changes in operations unless it could be proved that such changes would result in profitable benefits to their operations. This attitude has been largely due to the type of research staff maintained by transit operators. In general, these staffs lack the proper motivation and capability in the research area. Further, relative to the total amount of labor required for a transit organization, the staff that is available for research is extremely small. In many transit properties across the United States, there is not a single individual who has the background, training, expertise, or inclination to do research and planning. The budget for transit research and planning reflects the attitude of the operators in this area.

There is a different outlook on the part of those outside the transit industry who are performing research in the transit area. Most of these research programs are concerned with both short- and long-range improvements.

Many of the transit researchers are new to the transit field and really have not had operating experience. They are often concerned with particular subsets of the total system. Frequently, the requirements to perfect an optimization require a tremendous amount of training on the part of the employee of the transit operators. These researchers are, however, interested in all phases of research in the transit field including hardware, regulations, labor, and management. A large portion of the funds being utilized for research in the transit area, however, is directed toward hardware technology.

AREAS FOR RESEARCH

Because the current interest seems to be in technology, it is appropriate here to review those activities that significantly affect capabilities in the public transportation field. It is very common to find public transportation systems that are 85 percent labor intensive. This means that only 15 percent of the budget allocated is concerned with capital improvements. Vast amounts of money are being put into personal rapid transit (PRT) systems and other hardware development. The basic question is whether new technology will attract a large demand for public transportation. If the demand does not come, capital programs of improvement will have been a failure.

Labor often becomes the controlling factor in public transportation operations. Exorbitant wages, far beyond what the same skill demands on the open market, are being paid to transit drivers. Public transportation systems are being dominated by labor contracts that do not encourage demand for public transportation but promote the economic welfare of the individual employee. This is not to say that labor is wrong and management is right, but it is to say that, at this point in time, there is not a proper balance between labor and management in the public transportation field.

Another serious problem that hinders the development of the full potential of public transportation is that of regulations. Our regulatory schemes do not enhance public transportation in urban areas, but actually limit its full utilization. Most public service commissions were established to protect the general public but now in many instances operate to its disadvantage. There are many regulations in existence, such as the prohibition in some areas of moving freight and passengers together, that deny operators the opportunity to optimize the use of equipment and labor. Some states prohibit taxi systems from operating a shared-ride or dial-a-bus system.

Other regulations concerning fares, areas served, and changes in the system (which are subject to prior approval and are time-consuming) do not necessarily enhance public transportation. Many of these regulations tend to limit the ability of the public transportation operator to provide good and equitable service to the community and at the same time make a profit.

Most transit systems are not as flexible as they could and should be. This, in part, contributes to the low demand that exists for public transportation. In large urban

areas, if 20 to 25 percent of the travel demand uses public transportation, the system is considered sucessful. In small urban communities, the demand may drop to 2 percent or even lower. The traditionally restrictive public transportation system is not really competitive with the automobile, and outlays for capital intensive programs do not necessarily make the system more flexible. One can logically argue that an individual will not walk ½ mile to ride a PRT system any more than he would walk ½ mile to ride a bus system or rail-rapid transit system. As the flexibility of a system goes down, its ability to attract patronage also decreases. The inflexibility of many systems is due in part to labor and its control, to management and its inability to implement new innovations, and to the regulatory bodies that control these systems. It is often argued that the quality of transit property management is just a little bit above that of the railroads. In many operations this is difficult to dispute.

Another problem in this area is that which occurs when transit properties become publicly owned. Without exception, as the public takes over ownership of a mass transportation system, the percentage of the system that is labor intensive increases. No one seems to be able to control the allocation of funds for labor once a system becomes publicly owned. There seems to be an unlimited amount of funds available from the public sector to support the demands of labor. It would seem then that public transportation should remain in the private sector; however, this is difficult to achieve.

The basic question in reviewing the research needs in the transit field is where will our research lead us. It is not readily apparent that research in the technological field will lead us in the direction of increased public transportation use. It would seem that research of the constraints placed on transit by labor organizations, regulatory bodies, and public bodies would lead to more fruitful results. If technology enabled one to operate without any capital expenditures, one would only reduce the cost of operating by about 15 percent. The argument, of course, is that new technology will decrease the labor intensiveness of public transportation systems. It would seem that a change in job description is more likely to occur with an equal amount of labor still required.

It is difficult to envision a PRT system costing from 10 to 15 million dollars per mile that will have the flexibility to compete with the automobile. PRT systems have their use, but they are not a solution to all the problems in the public transportation field. More research, it would seem, needs to be done on labor and its control of public transportation, on management and its capabilities, and on some very restrictive regulations.

One should always keep pace with technology and see that proper technological innovations are incorporated into any existing system. Yet the payoff in the long run is not found in equipment but in other areas. Those within the transit field differ quite substantially from those outside it with regard to the direction that research should take. If research performed outside the transit field indicates that certain improvements should be made, but the research is not sanctioned by the operator himself, how likely is it that the research findings will be implemented? On the other hand, if the research that the operator requests will not lead to lasting improvements in the field of public transportation, why undertake it?

CONCLUSION

There are great differences in the thinking of researchers and transit operators, differences that must be resolved if one is to solve the many current transportation problems. The expenses for operating public transportation do not prohibit a system from being economically viable. The lack of demand for service is the crippling factor. If one desires to make public transportation economically viable, he should address himself to that which has the most influence on the economics of system operation.

TRANSPORTATION RESEARCH IN CHICAGO

George Krambles, Chicago Transit Authority

The Chicago Transit Authority (CTA) operates the second largest transit system in North America, providing service on 135 bus routes over 2,000 miles of streets and on 6 rapid transit routes over 90 miles of right-of-way. On weekdays, CTA's 2,600 motor buses, 200 trolley buses, and 1,200 rapid transit cars serve 1.2 million passengers, of whom 400,000 use rapid transit lines and the remainder use buses. Ninety-nine percent of the population of Chicago is within $^3/_8$ mile of a CTA service.

Unlike many transit operators, CTA and its predecessors have had a small but proficient planning department since the 1920s. Tasks assigned to this group are primarily related to service, marketing, operation, and capital investments. Research and development needs in these areas are endless. The size of the planning staff has been modest, following the industry's characteristic response to its struggle to meet operating costs while avoiding fare increases. The planning department's budget represents only $15 out of every $1,000 of total cost of CTA. Taking into account work done in other departments, the total expenditure for research and development and marketing together is probably no more than 5 percent of gross revenues.

Consequently, research has taken a back seat, and planning is typically concentrated on the most urgent, short-range problems. The following examples of significant progress at CTA in research and development indicate that such research has been profitable.

As early as 1939, the predecessor of CTA began operating its own radio station to obtain 2-way communication between centrally located dispatchers and supervisors' cars throughout the city. This was an early breakthrough in supervision of surface transit operations, and radio remains today an essential tool in real-time control of operations.

In 1951, line-supervision technology was completely modernized on the rapid transit system. The scheme key is automatic train dispatching from terminals and stations on the periphery of the downtown area. The departure schedule program, stored on tapes that are scanned in response to signals from a master clock, activates starting signals precisely when a train is scheduled to begin its trip. Track circuits activate graphic recorders that indicate to the line supervisors in the operation control center whether trains are on schedule. Platform public address loudspeakers at key stations are used by trainmen to communicate with the public.

The usefulness of this system was enhanced in 1960 by the addition of train telephones affording communication between each train and the operation control center. This enables motormen to report problems directly to the control center supervisors, who are experienced troubleshooters as well as knowledgeable dispatchers. They work with the men on the trains to correct equipment malfunctions and to solve a wide variety of other problems. Delays in service are minimized through a combination of effective troubleshooting, respacing of train intervals, and various other maneuvers appropriate to each situation. Simultaneously, inconvenience to passengers is minimized by keeping them informed of special operating procedures, such as nonstopping trains, through the platform and train loudspeakers.

Currently, the system of communication and the supervision of operation are being expanded through a project called Monitor-CTA, which is being developed by CTA with funding assistance from the Urban Mass Transportation Administration (UMTA). This project will extend the principles developed for rapid transit supervision to the bus system. Utilization of electronics and computer technology to distinguish buses from other vehicles in traffic will provide data that can be used to take corrective action when service deviations occur. The size of the bus fleet (3,000 vehicles) and the complex gridiron of its routes present a severe information management problem. The project also provides 2-way voice communication with the operation control center. With a secret alarm, the driver can summon police aid in the event of an emergency. The bus monitor system is sorely needed to provide real-time quality control of transit service.

In the field of transit marketing, insights were gained with the opening of the Dan Ryan and Kennedy rapid transit extensions. These extensions, and the accompanying bus route changes, have demonstrated the value of a high degree of coordination between modes of transit—in this case between buses and rapid transit. About 60 bus-route changes were made in connection with these new lines. Bus lines were changed to feed into rapid transit, not to run parallel to it. Buses do the collection and distribution, and rapid transit performs the line haul. With coordination planned from the first, station spacing could be made quite wide on the new rapid transit lines, so that the average speed and overall marketability of service are improved. Each mode does the part of the job it can do best.

The policy of having buses complement, rather than compete with, rapid transit has proved itself in the 2 years that the new rapid transit lines have been open. During this period, 26,000 new rides daily have been generated, and at least another 140,000 rides per day have changed travel mode, using the new lines for a shorter journey time. At some of the new stations, as much as 70 percent of the riders arrive by feeder bus lines. After 2 years, the new lines are continuing to show increases in patronage, whereas the overall trend in transit patronage is one of slow decline.

Continual study has yielded ideas for adding and modifying more bus routes to give access to the high-speed rapid transit lines from as many areas as possible. There is an ongoing requirement for continual review and modification of the system to keep pace with the changing needs and opportunities to better serve the people of Chicago.

A unique plan, a cross between regular and charter service, has been developed by CTA in recent years to meet the transit problem of firms that move out to suburban areas. A large communications equipment manufacturing company relocated its plant from the inner city to a suburb just outside the Chicago city limits and beyond any existing transit service. Most of its employees began driving to work, but a vociferous minority convinced its management to request CTA bus service.

Although studies showed that the service would not break even at standard fare levels, the manufacturer agreed to guarantee a minimum level of ridership, reimbursing CTA if the number of passengers carried on any trip is below the minimum. Passengers using it continue to pay their fares and are entitled to all the usual transfer and other privileges that they enjoy elsewhere on CTA.

Participation by the employer is, in this case, a form of subsidy that provides transit service to light-density outlying areas that would otherwise not be served by transit. Such participation also has potential as a means of developing new routes that initially need subsidy but may later become self-supporting. Such service benefits the employer because it enables him to hire persons not having their own transportation. In the case cited, the manufacturer was able to expand his plant on land that was acquired originally for automobile parking.

The plan allows the subscriber relative freedom in specifying the number and scheduling of bus trips. It also places on him the cost of any trips that are lightly used. Monthly bills to this manufacturer for 6 trips each weekday range between $40 and $500. Since establishment of this initial service, similar plans have been developed in other areas on the CTA system.

An unsatisfied need in transit research and development is that of improving the speed and dependability of bus operation. A brief look at the trend in Chicago's transit patronage since World War II is helpful in connection with this.

In 1948, buses and streetcars in Chicago generated 2.7 million fares on an average weekday. Today buses generate more than 1 million rides a day, a loss in patronage of more than 50 percent. In this same 20 years, rapid transit has experienced no loss in patronage, but has held steady at 600,000 rides per day.

Rapid transit has been able to retain its riders principally by providing dependable service, comparable or faster in average speed than the automobile. Buses, facing the same traffic congestion as private automobiles, and operating at much lower average speed than rapid transit, have not been able to provide the quality of service necessary to keep their customers.

Research and development are needed to determine how to improve bus speed and dependability. The bus monitor system is one step in this direction, providing better state-of-the-service information and being an effective tool for correction of delays or gaps in service, but it will not alleviate the primary problem—traffic congestion. More work is needed on techniques that reduce or eliminate the conflicts between buses and other vehicles. It is unreasonable that buses, which carry 50 or more passengers, should not receive preferential treatment over automobiles, which carry only 1 or 2 passengers. Examples of successful techniques that need much broader development, testing, and application include the following:

1. Giving buses the right-of-way over other vehicles, as has been started in Dayton and Kent, Ohio, where approaching buses activate traffic signals in their favor.
2. Reserving lanes in express highways for buses, as has been introduced on Shirley Highway near Washington, D. C.; on the approach to the San Francisco-Oakland Bay Bridge; and in the Lincoln tunnel leading to New York City.
3. Reserving lanes in arterial streets for buses, as has been done in Chicago. The exclusive bus lane in Washington Street enables buses to travel through downtown in much less time than is required on parallel streets without such a lane. This also results in more dependable service and reduced operating costs for the routes using this street.

Further research and development are needed not only to improve the speed and dependability of bus operation but also to determine market aspects in terms of funding and public acceptance. A recently completed study of the southern one-third of the Chicago metropolitan area recommended installation of a number of transit corridors that would have upgraded bus service and would operate with preferential treatment of some type. The problem at the moment is how and what to implement.

Bus design is another area that needs continual research and development. Neither transit operators nor bus manufacturers have done much recent research leading to improved circulation of passengers boarding, alighting, or moving within vehicles. This affects speed, safety, and passenger comfort. The reluctance of bus passengers to move to the rear of the bus, and their insistence on using the front door for alighting, often delays buses at stops, thus slowing down operation. It sometimes results in buses passing up passengers who could have boarded if those on the vehicle had moved to the rear. Improvements in the interior design of buses might solve this problem with complete analytical review of the number, width, location, and control of doors, the seating arrangement, and the width of the aisle. Another problem that needs a better solution is the height of bus floors and the steepness of bus steps.

Rapid transit car equipment presents its own array of problems, the most severe of which in recent years has been the extremely long debugging period, which is often years.

Public information and marketing are other areas having great potential for fruitful research. Earlier, we mentioned the benefits CTA was able to give its riders from a market-oriented planning effort, where rapid transit was made conveniently accessible to a great number of riders by rearranging many bus routes as feeders. Such rearrangement of bus routes still involves many indeterminates. Through research and development we need to find better ways to quantify the trade-offs of route changes.

Research and development in psychological and visual-audio communications might open up new markets for transit through improved information, maps, schedules, stations, and vehicle graphics. In connection with the recent Dan Ryan and Kennedy extensions, CTA revised its graphics standards and researched a whole new strategy of passenger information signing. Much more work needs to be done in this area.

A challenging problem, one of greater concern outside the CTA service area, is that of providing service to communities of very light density. There has been a trend toward low-density suburban residential and industrial development for a number of years in Chicago. Generally, newly developing areas of this type have no transit service at all or are in the service territory of suburban bus companies that cannot afford to open new routes. Low density makes conventional transit service economically impractical.

In addition, town planning has tended to disregard the need for reasonable densities that would support transit (as well as other services). The design geometry of streets in these areas often precludes operation of conventional buses.

As a result, citizens of these areas are almost totally dependent on automobile transportation. Many families require at least 2 cars, resulting in heavy traffic congestion on main arteries. In many cases, suburban rail lines serve these areas, but an automobile is required to reach the station.

To fill the void, some type of demand-actuated transit service, perhaps the use of small buses operating over nonfixed routes, may well have application. Dial-a-bus has had limited testing in parts of the country. Further research of dial-a-bus, and other nonconventional transit service systems, will be needed to find ways of effectively serving low-density areas.

Computerization of transit schedule preparation offers promise of saving labor in schedule design and of saving operating costs by eliminating wasteful work. CTA's schedule/traffic department has been cooperating with research in this field for some years now. Thus far, run cuts or schedules produced by this process have not been completely acceptable, but progress is being made.

More meaningful models for estimating traffic on new lines need to be developed. Alleged diversion between modes and carriers when a change is made sometimes leads to bitter arguments and damage claims. Yet existing models and estimates often incorporate behavioral assumptions that do not stand the test of experience.

Fare policy should be a rich field for original research and development. After a century of increasing fares, CTA is now considering the feasibility of operating a downtown distributor subway route free of fare. This idea has definite merit, especially because there will be many entrances close together to be staffed and fitted with turnstile equipment if a fare were charged. A growing body of thought contends that urban transit should operate without fare, like the street system, and meet its costs in other ways.

In any case, intensive research of the entire area of fare collection is long overdue. Comparison and testing of the concepts of fare-free operation versus flat-fare and proportionate-fare plans are needed. Improved methods of fare collection, ranging from completely automatic to manual, should be explored. The new BART system in the San Francisco Bay Area will be watched closely by transit companies throughout the world as to its method of automatic fare collection and automated operation. To complement the proposed test of free operation of the distributor subway, perhaps CTA should also test free operation of a bus line to determine its merits and effects on patronage and costs.

Revenue handling in buses and rapid transit stations needs modernization. The advent of exact fare systems caught the industry without the proper hardware and procedures.

A new field of planning, that is, one formerly used only by engineers and accountants, is capital investment planning and programming. This program, under local, state, and federal grant aid requirements, bears an increasingly intimate relation to regional land use and transportation planning. Research and development in this field will be needed to avoid the growth of a bureaucracy and to develop reasonable procedures for priority rating and project control.

These are just a few important areas of need in transit research and development. Some of the research and development needs are so specialized and difficult that their cost cannot reasonably be undertaken by any of the carriers alone. To assist with projects that offer probability of cost return, UMTA has offered federal aid programs. Governmental aid programs are an absolute necessity without which the industry would probably never research and develop projects that benefit the community.

CURRENT TRANSIT PRACTICES IN ANN ARBOR

John E. Robbins, Ann Arbor Department of Traffic Engineering and Transportation

Ann Arbor, located in southeastern Michigan approximately 45 miles from downtown Detroit, is a unique community that provides a fascinating blend of research-oriented industry and cultural and educational excellence for its 100,000 people. Because it is the home of the University of Michigan, with a student population of 38,000, Ann Arbor's major industry is education.

As in other cities across the nation, Ann Arbor's major mode of transportation is the private automobile, followed by motorcycles and bicycles (more than 30,000), and finally mass transportation. The mass transportation system is provided by the Ann Arbor Board of Education, with 53 buses transporting 9,600 passengers per day; the University of Michigan, with 30 buses transporting 14,000 passengers per day; and the municipal bus system operated by the Ann Arbor Transportation Authority (AATA), with 22 buses transporting 2,500 passengers daily.

What does this have to do with the research needs of the transportation industry?

Ann Arbor, despite its size, deals with the problems faced by major cities—the strangulation of major street systems, air pollution, location of suitable sites for parking structures, and meeting the needs for exclusive pedestrian and bicycle ways.

The city of Ann Arbor has expressed great interest in mass transportation systems and has spent $715,000 during the past 3 years to establish and operate a bus system. Of this, $500,000 has been in the form of operating subsidy. The fixed-route system has shown modest increases in passenger revenues during this period, with increases of up to 30 percent when compared with the same month of the previous year. Even with these increases, the operating costs are twice the revenues; the system operates at a deficit of 50 cents per transit mile.

This, of course, exposes only operating needs and not necessarily research needs.

What is needed for mass transportation research is money to develop a more efficient transportation system in an effort to reduce operating costs. With this in mind, the AATA, through the implementation of a dynamically dispatched personalized bus system, hopes to improve and expand present route service. Although the technical feasibility of personalized bus services has been documented, there have been no full-scale field tests of market response and the possible use of automated dispatching.

The personalized bus service concept offers great potential for the future development of a balanced transportation system in cities by offering an attractive alternative to the private automobile.

Under conditions of low-residential density and highly dispersed trip-making patterns, such as found in Ann Arbor, conventional public transportation is unable to compete with the private automobile. The consequences are then twofold:

1. Ridership on public transport declines to the point where only skeleton service can be maintained, usually at substantial costs to taxpayers; and
2. Those who are dependent on public transportation find service inadequate to meet all of their needs and are forced to rely on more expensive alternatives.

Both of these situations exist in Ann Arbor. Low-income and elderly residents find no evening or Saturday bus service, and many runs during weekdays are maintained only on an hourly schedule.

Personalized bus service is a form of mass transportation in that large numbers of people are carried in a given day. It is personalized transportation in that travelers are given doorstep service and are not crowded together in large groups on a single vehicle. The AATA was convinced that this kind of service offers the best way of discouraging total reliance on the automobile for future transportation needs in Ann Arbor and was anxious to launch a full-scale field evaluation. Because financial constraints made it impossible to carry out an evaluation with local funds, the AATA applied for and received assistance from the state of Michigan.

The city of Ann Arbor and the AATA, in cooperation with the Michigan Department of State Highways and the Ford Motor Company, have recently embarked on an experimental research project to determine the feasibility of a dynamically routed bus system. On September 22, 1971, the AATA began an experimental dial-a-ride bus service in a limited area of Ann Arbor.

The Ann Arbor dial-a-ride project serves a residential area of 3,300 homes by offering doorstep service from homes to a limited number of destinations in central Ann Arbor. The central locations include commercial, office, government, university, and hospital facilities.

The dial-a-ride system has three 10-passenger vehicles. Two vehicles are air-conditioned Econoline vans that were formerly used as minibuses in the AATA fleet. The third vehicle, donated for the experiment by the Ford Motor Company, is a courier vehicle with standup interior and bucket seats.

The communication system is built around a dispatch center. There are 5 incoming dial-a-ride lines: 3 public lines are for the dial-a-ride phone number, and 2 lines are private direct lines to 2 commercial shopping districts. These private lines provide free communication to the dispatcher.

The radio communications use existing equipment modified for the dial-a-ride service. Motorola Quick Call II units were added to 3 existing radios. The dispatcher can therefore selectively call any 1 of the 3 dial-a-ride vehicles. Unless paged, the dial-a-ride vehicles do not hear any other traffic on the AATA frequency.

The dispatching concept used, which was developed by the Ford Motor Company, is the vehicle tour. A tour begins as the dispatcher transmits an order list of inbound pickups to a vehicle. After all pickups are made, the vehicle heads for the appropriate central Ann Arbor destinations. The driver delivers passengers to their destinations and simultaneously picks up outbound passengers. After all inbound dropoffs and outbound pickups are made, the minibus returns to the service area to drop off outbound passengers and complete the tour.

The basic fare is 60 cents, exact change. Discount tickets are sold in strips of 10 for $5, and monthly passes allow multiple rides for a single family traveling between the same 2 points. The passes were sold at an introductory rate of $10 and will be sold for $15 after the price freeze is lifted.

Ridership has steadily increased from an average of 67 passengers per day during the first week of operation to an average of 135 passengers per day in the sixth week of operation. The peak day, Friday of the sixth week, had 165 riders. The ridership has been steadily growing, and a recent expansion of the service area is expected to generate additional ridership. Additional funding is needed to finance capital improvements to put phase II into effect.

The city of Ann Arbor has also expressed considerable interest in developing a truly comprehensive transportation plan, a plan that considers the highway network, mass transportation, parking, pedestrians, and bikeways.

Past practices have generally consisted of separating studies of mass transportation systems from parking facilities studies. It is my feeling that these studies should be performed as a unit.

We need to know, in some detail, the interrelation among the demand for downtown parking, fringe area parking, and the provision of public transit facilities. We need to develop measures of the external costs generated by private automobile operation. By

external costs I mean those costs that are currently not charged, or not fully charged, to those who benefit from automobile operation. These external costs include the widening of streets, building and maintaining parking structures, and the adverse effects of air pollution and street congestion.

We need to learn the proper mix of prices, regulations, and subsidies that would induce a better balanced total transportation system. Such research could lead to another major area of transportation planning in the development of a comprehensive transit program. In the case of Ann Arbor, this type of system would involve the city of Ann Arbor, the University of Michigan, and the board of education. The system design would include a mix of feeder bus system (fixed-route), dial-a-ride service, line-haul bus service, and people-mover transit system.

The city of Ann Arbor, in conjunction with a local firm, is in the preliminary discussion stage of developing such a program. The people-mover system would cost approximately $48 million for a proposed 15.2 passenger miles. This system would certainly require financial assistance from local, state, and federal sources.

TRANSIT INDUSTRY RESEARCH NEEDS

F. Norman Hill, San Antonio Transit System

This discussion deals in part with the transportation planning and research studies currently under way in San Antonio, Texas. These studies were designed to encompass the type of planning and research that the San Antonio Transit System (SATS) regards as essential to the development of recommendations for an immediate transit improvement program and for our future operations planning.

However, there is also an overriding research requirement that goes beyond the transit system needs of any particular urban region. This requirement is as follows: The need to document the fact that our cities simply cannot be structured to accommodate all the present and future travel and parking demands of persons who use private automobiles, on work trips, during the peak morning and evening weekday travel hours.

This research is needed in order to substantiate the fact that urban freeways, arterial streets, and urban public transit facilities can and must operate in a partnership and that diversion of some peak-hour automobile work trips to improved and expanded urban transit systems is in the best interests of both the community and the motorists themselves.

NEED FOR STATE AND MUNICIPAL AID

A need exists to document the common interest of both the community and the motoring public in expanding peak-hour use of transit services because an increase in transit patronage will require substantial state and local financial assistance. It also will require that transit vehicles be given preferential treatment on downtown streets and on urban freeways, so that they can bypass locations subject to traffic delays.

Public support, particularly the support of motorists, will be necessary for the adoption and strict enforcement of measures to give transit vehicles preferential treatment in traffic operations. Public support will also be needed to persuade state legislatures and municipal governments to provide the special financial assistance required to upgrade and expand transit facilities.

Transit vehicles must receive preferential treatment in street and freeway operations because without such treatment transit ridership cannot be significantly increased.

The very attribute of transit service that qualifies it for a partnership operation with automobile transportation—its ability to carry large numbers of people with a relatively small number of vehicles during periods of heavy traffic congestion—is also the attribute that makes it impossible for transit systems to finance the needed expansion and upgrading of capital facilities without state and local financial assistance.

Because most transit patronage is concentrated in the peak morning and evening weekday commuting hours, neither transit equipment nor manpower can be fully utilized for more than about 20 hours per week.

The manpower-use factor is particularly critical in bus transit operations. With the exception of New York City, transit buses account for 90 percent of all urban transit ridership in the nation, and the vast majority of the cities must rely on transit buses

in future transit expansion programs. Driver wages and other payroll costs generally average more than 70 percent of total bus transit operating costs and will continue to increase in the future.

U.S. DEPARTMENT OF TRANSPORTATION PROGRAMS

A recognition of the partnership role of urban highway and urban transit improvements already exists in the U.S. Department of Transportation (DOT): It is expressed in the joint programs of 2 DOT agencies—the Federal Highway Administration and Urban Mass Transportation Administration (UMTA)—which encourage the use of urban freeways and local downtown streets for improved bus transit operations and which provide financial assistance to local transit agencies for acquiring new rolling stock and other capital facilities.

This recognition also exists in many state highway departments and, of course, in the new state departments of transportation, which are cooperating in DOT transit assistance programs.

Unfortunately, most state legislatures, and many municipal governments, have not yet given similar recognition to the necessity of implementing programs to increase urban transit patronage. These remarks are not meant to be critical. State and local governments have not taken action because the necessity for doing so has not been documented with sufficient clarity and force.

RESULTS OF URBAN TRAFFIC GROWTH IN TEXAS

Travel trends in the larger Texas cities are a good illustration of the problems that have arisen over the past 15 to 20 years because of the total commitment to developing new urban freeways and more off-street parking facilities and the lack of concern with regard to providing new facilities for public transit service.

If the large cities of any state could successfully adapt to an all-automobile passenger transportation system, this would be true of Texas. Although 80 percent of the state's residents now live in urban areas, and half of our residents live in 27 cities having a population of more than 50,000, these areas have exceptionally low population densities, characterized by dispersal of residential areas, employment and shopping centers, and other major activity concentrations.

San Antonio, with a city population of 654,000 and an urbanized-area population of 770,000, has a central-city density of only 3,500 persons per square mile. This is the highest density of any city in Texas. Yet it is only about half the population density of Los Angeles and is less than one-quarter the density of cities such as Chicago, Philadephia, and San Francisco.

While the state population increased 45 percent in the past 2 decades, motor vehicle ownership increased 125 percent, or nearly 3 times as fast. Texas now ranks second only to California in total motor vehicle registrations as well as in number of cities having a population of more than 50,000.

The Texas Highway Department has done an outstanding job of responding to this rapid growth in motor vehicle use. More than 1,200 miles of new urban freeways have been built since 1950, and a tremendous expansion has taken place in off-street parking facilities in downtown areas, at regional airports, hospital-medical complexes, major shopping centers, universities, office parks, military bases, and at cultural, convention, and sports centers.

During most hours of the day, the freeways handle traffic with greater safety and higher operating speeds than ever before attained. Yet congestion and delays still exist during peak travel hours. Similarly, only a few cities in Texas have been able to keep pace with parking demands in downtown core areas, at airports, and at other major trip-generating locations.

IMPLICATIONS OF TRAFFIC GROWTH FORECASTS

Regardless of what future success our large cities may have in increasing public transit patronage, in Texas or any other state, these cities will become steadily more

automobile-oriented in the future. This will be an inevitable result of the population and employment growth that is taking place in automobile-oriented metropolitan areas.

The 30 largest urban areas of Texas are expected to almost double in population by 1990, from 7.1 to 13.8 million. Urban automobile travel is expected to double in 15 years, creating a need for the continuing development of new urban freeways, major thoroughfares, crosstown arterials, and off-street parking facilities.

It is clearly uneconomic, however, to attempt to add sufficient new capacity to the urban freeway, the boulevard system, or the arterial street network to fully eliminate peak-hour congestion because the extra capacity would be needed for only a few hours each day. Highway officials state that, once the present Interstate and other planned urban freeways are completed within the next 5 years or so, no additional freeways will be built in the more heavily developed portions of existing large cities because of the prohibitive cost.

Similarly, if cities have been unable to meet parking demands in downtown areas and other major trip-generating locations with the extensive parking developments of the past 2 decades, they certainly cannot hope to accommodate a doubling of these demands during the next 15 years.

Even if the parking-space requirements could be met, the capacity of downtown streets and major access corridors would become the limiting factor—as it already is in many of our downtown areas and other locations of heavy parking demand.

TRANSIT'S POTENTIAL AND LIMITATIONS

A realistic appraisal of the potential for increasing urban transit patronage is that the routes are limited to certain major travel corridors and that the patronage consists primarily of morning and evening work trips during peak travel hours. However, these are the very corridors and travel hours in which current automobile traffic volumes create the greatest overloading of city streets and freeways—and in which the prospect of a doubling of traffic over the next 15 years poses a clear threat to the very survival of our established cities. Any help, then, that improved transit facilities can give in reducing the severity and duration of traffic congestion will benefit both the community and all highway users, regardless of the type of vehicle they use.

For example, although motor buses make up only 1 percent of total vehicles entering or leaving the downtown areas of our large Texas cities each day, they account for 15 to 30 percent of all daily person-trips to and from these downtown areas. If this bus ratio increased to slightly more than 2 percent of total vehicles, a 25 to 50 percent decline in peak-hour automobile traffic on downtown streets would result.

Similarly, because about three-fourths of typical downtown parking space demands today are for work-trip parking, anything that can be done to divert some of these work trips to transit vehicles, or to fringe or outlying parking facilities linked to the downtown center by express bus service or other types of high-capacity people-mover systems, will help to keep downtown parking-space demands within manageable levels.

The downtown area would benefit from this sharp reduction in peak-hour traffic congestion and the easing of parking-space demands, but so would those motorists who continued to drive to and park downtown. This is why it is in the self-interest of urban motorists to support programs and measures to promote increased transit patronage during the peak travel hours.

SAN ANTONIO TRANSIT OPERATIONS

The exceptionally low population density of the San Antonio area does not provide a naturally attractive environment for a strong transit operation. Despite this condition, SATS has maintained during the past decade a relatively stable patronage, in excess of 20 million revenue passengers per year, and is one of the few U.S. transit systems that has operated in the black while it has increased its bus-miles of service since 1960. SATS's 25-cent base fare also is the lowest of any city of comparable size.

The need for increased bus service resulted from a 20 percent increase in population of the urbanized area during the past decade. By 1990, the urbanized-area popula-

tion is projected to be about 1.3 million, or 66 percent more than the current total. We, therefore, are in the midst of a substantial expansion and modernization program and are undergoing comprehensive studies of our present operations with the objective of finding approaches to attract new ridership.

The transit system modernization program calls for expenditure of $7,441,200 through July of 1975, with two-thirds of this cost to be met from a grant from UMTA. This will provide SATS with 157 new air-conditioned buses. By 1975, our fleet of approximately 260 buses will include none that is 10 years old.

The modernization program also includes the construction of new buildings and the acquisition of additional equipment at our administrative and maintenance headquarters, plus installation of a number of attractive bus passenger shelters at key transfer points and other heavy passenger stops.

CURRENT TRANSIT RESEARCH PROJECT

In order to provide guidelines for planning transit improvement programs for the next 5 years, SATS has begun a comprehensive study of its transit operations under a separate project co-sponsored by UMTA.

The research is being conducted by Wilbur Smith and Associates, international transportation engineering consultants. The first phase consisted of an on-bus questionnaire survey of passengers to determine trip origin and destination, trip purposes, walking distances to and from bus stops at each end of the trips, automobile ownership of riders, and various other passenger characteristics. Included in this phase were passenger load counts by hour of day and at specified locations along each transit route as well as bus load and headway counts at downtown cordon boundaries.

A second phase involved interviews of a cross section of residents in local neighborhoods throughout the transit service area to determine why they do, or do not, use the transit service, their normal daily travel patterns, and their basic attitudes concerning transit service.

These surveys have been tabulated and analyzed, and a series of specific recommendations for improvements is now being considered. These recommendations will be discussed in detail with civic, business, and neighborhood groups to seek their reactions and suggestions and to inform them of the transit system's commitment to providing good and appropriate service.

ANTICIPATED RESEARCH OUTPUT

The research has been structured to provide new information to guide evaluation of a number of possible changes in transit service. These include the following.

1. Express service: Some past urban transit studies have indicated that a strong demand exists for express bus service for downtown work trips by suburban residents and for similar service to major employment centers, such as the large military bases encircling San Antonio.

The express buses would pick up passengers in local residential areas or at fringe and outlying parking lots, then travel nonstop to the trip destination, generally using a freeway. On some test routes, the first few stops on the morning inbound trip, and the last few stops in the evening, are the heaviest passenger-loading stops. On such routes, the low-volume intermediate stops might be eliminated. The few riders lost at these stops may be more than offset by increased patronage generated by the resulting higher trip speeds.

2. Reverse commuting: Rapid growth of employment centers in suburban areas points to the possibility of 2-way ridership of buses on particular routes, serving inbound suburban residents on morning work trips, and on outbound trips carrying central-city residents who work in suburban locations. The process would be reversed at night.

3. Crosstown service: Transit trip origin-destination surveys in various cities have indicated that 20 to 25 percent of the transit trips are made to and from locations other than the downtown area and are not related to the central business district (CBD). Such

travel patterns have resulted in requests for additional crosstown routes, which would provide direct service among these particular nondowntown locations. The crosstown service would modify the normal transit route configuration, which requires some riders to make unwanted trips downtown in order to transfer to a route serving their trip destination.

Although we are confident that the current SATS study will provide useful data for evaluating the potential of new crosstown service, I think it should be pointed out that there actually are 3 categories of crosstown transit service already provided in cities where the population is reasonably evenly spread among the various quadrants of the community and where the downtown area is in the approximate center of the urbanized region.

One type of crosstown service involves a transit route that is located well outside the downtown area. It focuses on a major employment center, links it with a number of transit routes, and serves some riders along the crosstown route itself. We have 2 such crosstown lines in San Antonio. They operate only in the morning and evening peak periods, and their main patronage consists of riders who transfer to or from other transit lines.

A second type of crosstown service is provided by through-routing—routes that cross the city from one side to the other and in the process pass through the CBD. In San Antonio we have 28 individual lines hooked up and routed to permit riders to travel from one area of town to another without the need of transferring.

The third type of crosstown service requires that a transfer be made from one line to another within the CBD. We have only 3 transit lines in San Antonio, out of a total of 33, which terminate in the CBD, and the riders having destinations elsewhere transfer to another line in the CBD. In addition to these transfers, of course, riders whose trip destinations are not served by lines that pass through the CBD also transfer downtown or at an outer transfer point more convenient for them.

Crosstown transit service already is provided by 30 of our 33 transit lines. Yet by its very nature, crosstown trip demand that is not already met by no-transfer service will probably always require a transfer from one line to another, either within or outside of the CBD.

Where the outer area no-transfer crosstown patronage demands are of sufficient magnitude to make the service economically feasible, such service probably already exists. However, this will not be known for certain until the results of the transit study are evaluated and analyzed.

In the home-interview portion of the study, travel patterns of motorists on work trips are being plotted into travel desire lines. This could indicate that some additional transit ridership potential exists along routes that do not converge on the downtown area.

4. Outlying park-and-ride facilities: Interviews with motorists who use park-and-ride transit service in a number of cities indicate a preference for locating the parking lots some distance away from downtown (4 or more miles, depending on city size), with nonstop or limited-stop service to downtown.

This suggests that new park-and-ride lots might be located at a number of strategic points along radial freeways or in other major travel corridors in order to "intercept" motorists and encourage them to complete their trips by express bus. To be successful, of course, such facilities must provide both parking and round-trip transit service at a lower total cost than that of all-day parking downtown and with a trip speed faster than that of driving and parking downtown.

5. Public awareness of transit service: Some studies have indicated that many potential transit riders use their cars, or arrange to ride with other car owners, because they are simply not aware of the locations and schedules of the local transit system.

The current San Antonio transit survey is expected to indicate the extent of this lack of awareness of available transit service, which will guide us in taking steps to meet the problem.

PREFERENTIAL TREATMENT OF BUS OPERATIONS

As was stated earlier, significant increases in bus transit patronage can be expected only if buses are given preferential treatment in use of city streets and freeways so that they can bypass locations where automobile traffic is delayed in peak travel hours.

We already have made a small beginning in that respect in San Antonio. An exclusive bus lane is provided on a main downtown street fronting the Alamo Plaza. The street carries one-way traffic, with one curb lane reserved for "wrong way" operation by buses. A virtue of this operation is that motorists, warned by overhead signs and by lane markings, keep out of the bus lane to avoid a head-on conflict with buses. As a result, the enforcement problem takes care of itself.

Another type of preferential treatment (reverse lane) for buses on the expressway is the Shirley Highway experiment in Washington, D.C. This service is growing in popularity and has been extended from 4.5 to 12 miles in length.

The current transit study is reviewing a number of other possible measures to improve bus operations including the following:

1. Reserving lanes on more downtown streets for buses only;
2. Reserving certain downtown streets for exclusive use by buses and taxicabs, permanently or in peak traffic hours;
3. Using electronic controls on buses and at selected traffic signal locations so that signals can be adjusted on bus transit routes to favor bus movements;
4. Metering of urban freeways by traffic controls at selected access ramps to keep the roadways free-flowing in peak travel hours (as is now done on freeways in Houston, Dallas, and a number of other cities around the nation), with buses given special freeway access ramps and preferential lanes on parallel service roads; and
5. Constructing special busways within freeways or on exclusive rights-of-way so that buses can bypass traffic congestion locations.

FINANCING THE NEEDED TRANSIT IMPROVEMENTS

It is generally recognized that fare-box revenues will, at best, meet only operating costs. New sources of financial aid will be required for such capital improvements as exclusive busways, expansion and modernization of bus fleets, and installation of electronic controls to adjust traffic signals to favor bus movements on particular routes.

The Urban Mass Transportation Act of 1970, providing for $10 billion in federal grants to urban transit agencies during the next 12 years to meet up to two-thirds of capital improvement programs, can go far in modernizing and expanding urban bus fleets—but this will require that both state and municipal governments adopt fiscal programs to cover the required local share of the cost.

Similarly, the Federal-Aid Highway Act of 1970, which authorized use of highway trust fund revenues under certain specified conditions for building exclusive or preferential bus roadways or bus lanes, has a tremendous potential, if state highway departments give it more than token implementation.

Justification for use of both federal and state highway tax revenues for such special bus facilities lies in the fact that increased use of buses can very substantially reduce the need for additional highway expenditures to increase peak-hour roadway capacity.

RESPONSIBILITY OF TRANSIT INDUSTRY MANAGEMENT

In the final analysis, it is up to transit industry management officials themselves to take the leadership in capitalizing on the new opportunities now emerging.

We need to tell our story, and tell it clearly and convincingly, to our local governmental, business, and civic leaders; state and local highway officials; state legislators; and state and local automobile clubs, trucking associations, as well as the automobile and petroleum industry organizations and other groups that have a natural and very proper interest in sound highway development and financing.

We will be better able to tell this story if the overriding research need previously mentioned is met. When this need is met, the required support for implementation of transit improvement programs should not be difficult to generate.

The results will be that vehicles will serve the city rather than the city serving the vehicles, that city streets and urban freeways will serve more person-trips and in fewer vehicles, and that both the severity and the duration of traffic congestion will be substantially lower than without these transit programs.

Both the community and the highway users—whether they be riding in automobiles, trucks, or buses—will benefit. Therein lies the basis for a partnership between the transit and highway interests.

RESEARCH NEEDS OF THE TRANSIT OPERATING INDUSTRY

Alan L. Bingham, AC Transit

The great need facing the transit industry today is an increased capability to respond fully to public desires. This capability can be achieved if transit receives proper funding, improves its management, and increases the quality of its service.

A current administration report, not yet submitted to Congress, discusses the problems that the transit industry has been facing since World War II. One sentence, which follows, is particularly significant: "The cycle in which transit is caught results from its failure to adapt to new patterns of urban development, respond to changes in public preferences and expectations, and compete effectively with the private automobile."

Although this report may be revised before it is issued, the quoted sentence shows that the administration is aware of the problem transit has had in effectively competing with the private automobile.

Transit has been faced with this problem since the 1920s when the automobile came into nationwide use. Financial problems resulted immediately as ridership began to decrease. Following the stock market crash in 1929, bondholders in many cases took over operation of the transit companies. Their main concern during the Depression was to retain as much of their investment as possible. Then followed the boom years during World War II. After the war, the great cost-price squeeze occurred, and, once again, the owners were faced with the problem of attempting to retain their investment. During the 1950s and 1960s, most privately owned transit companies went public. On the west coast today the largest privately owned transit system is in the city of San Jose, a system that comprises 50 to 60 coaches. All other systems, in major west coast cities, now are publicly owned.

As transit became increasingly publicly owned, in many cases it took the public to approve and to fund it, indicating a gradual awakening on the part of citizens that transit is a necessity. Also there is now public concern about the effects of new freeway programs on urban environment.

As a result of public concern, Congress, in 1964, took action to provide capital funds for transit to use in acquiring equipment. Last year the Congress added several billion dollars for use by public transit. Citizens themselves, through their state legislatures, city councils, and direct vote, have approved property, household, and retail sales taxes as well as bridge tolls for transit. In short, transit has become a public concern, and I think there is a growing willingness on the part of the public to use it.

Yet, if we look at national statistics, ridership on a nationwide basis still is declining. What is needed? In my judgment, research is a vital need. We also need improved management in the transit industry, management that is enlightened, competent, enthusiastic, innovative, and creative.

In looking at the role of research in the transit industry, I separate it into 2 distinct categories: (a) research that affects the riding public or the potential rider of the service, and (b) research pertaining to in-house activity, i.e., lowering costs, increasing productivity, and improving the efficiency of operations.

First I will comment on a few areas that pertain to the role of research as it directly affects the public.

Routing, for example, is a critical factor that needs to be researched. A bus line that serves the University of California at Berkeley travels through a neighborhood area on the edge of the campus. Ridership on the line has been decreasing since 1960, but the transit scheduling department is not able to state why with any degree of conviction. Perhaps what is needed is a survey of citizens who live along the line to determine what can be done to increase ridership. Perhaps an origin-destination survey would be useful. Perhaps an intensive interview of citizens on a selective basis would reveal psychological problems that may be involved in the public's rejection of that line.

A research and planning official has said the following about trying to research routing: "...transit planning has one handicap almost too difficult to surmount, which is that most plans are processed on the basis of cold, statistical estimates—which might be satisfactory in some industries. However, in the transit industry, where the business is to provide service for people's needs, all efforts in research and planning should take into consideration the needs and wishes of the people served. The very nature of our business makes it difficult to determine our customers' desires and needs because of a lack of personal contact."

Transit routes that follow old streetcar lines exist in every major city in the United States. Such routes serve a purpose because commercial and residential developments grew up along those lines. Yet, some research time should be spent determining whether people along these lines could be better served. The routing of transit in new neighborhoods is another area that needs research.

The use of dial-a-bus is possibly an answer in some service areas. Yet, in the next 10 years, if labor costs continue to increase and if ridership does not grow, we will have to use driverless vehicles to escape financial failure. This is especially true if we lose public support.

How important are headways to a prospective customer? AC Transit uses 90-sec headways during commuter hours on one line; on another line, during midday, the headway is 1 hour. I do not think that an hourly headway is adequate, but I do not know whether the public is dissatisfied.

The bus line having an hourly headway will be serving a rapid rail station in the near future. The line operates every hour during midday, whereas the rapid rail line will run every 12 min. If the line operated every 30 min during commuter hours, as it currently does, the rapid rail line would run every 6 min. On the surface, this does not sound like good service, but what is? Meeting every single train may not be financially feasible. What is needed is basic research of the feelings of the people who will use the line.

Speed is a frequently discussed factor, and I suspect that it is the most important quality sought by the commuter. In the San Francisco Bay Area, voters approved bonds for a rapid rail system in 1962. They agreed to tax themselves $792 million plus interest to fund it. I believe that they voted affirmatively because of the speedy ride offered by a rapid rail system. A bus specification currently being developed by the Urban Mass Transportation Administration is indicative of the effort to increase speed capabilities. Additional speed can be acquired by changing the operating characteristics of the coach itself, by adopting better fare collection procedures, or by improving the general movement of people within the coach.

AC Transit's experience in replacing a local coach with express operation has been favorable. During midday AC Transit operates 12 lines between the East Bay and San Francisco; during the peak AC Transit operates 38 lines. This moves service on the freeways and eliminates transfers in many cases. As a result, passengers get home sooner.

AC Transit's experience indicates that speed is important. Yet, how can transit compete with the private automobile? An AC Transit employee made the following comment: "In competition with the automobile, one of the primary deficiencies that faces transit is the relatively slow travel time. Many factors that affect travel time involve things over which the transit operator has no control, and only cooperation with city officials and police departments can offer relief in these areas." Further research in providing better loading zones, preferential operating lanes, and traffic signal controls

would be most desirable, and it should be emphasized that local, public jurisdictions must cooperate with transit if service, in terms of speed, is to improve.

Controlling traffic signals from the bus has been discussed as a possible way of expediting service. Not much research has been done on this; yet it is this type of suggestion, and the research that follows it, that is needed to justify obtaining improvements from the cities in which we operate. Obtaining an exclusive curb lane along a street in the downtown area is in itself a very difficult task. The transit operation in Houston has been discussing this for quite some time with city officials and has finally received approval. Chicago has done quite a bit in this regard. I consider it an awakening on the part of the California State Legislature and the Congress when they agreed to set aside on freeways, built with gas tax funds, exclusive lanes for buses.

Fare structure is another matter that has not been given a great deal of extensive research. Several years ago in a west coast city a scheduling department employee interviewed riders. The riders' first priority was speed, and level of fares was about fifth. Generally, in this country, the transit industry has been trying to keep fares low. It was feared that, if fares were raised, business would decline. I am not sure that this fear is ungrounded. In Chicago, during the period when the fare was increased from 25 cents to 45 cents, nearly 25 percent of the ridership was lost. Certainly, some sort of research would be helpful to know how much of this loss was due to the fare increase. These are some of the answers we need to improve the planning of transit finances.

There has been some research done on the no-fare policy. Charles River Associates evaluated the effect of a no-fare policy in Boston. The objective of the no-fare policy was threefold: to improve job opportunities for people in ghettos, to help revitalize the downtown area, and to try to alleviate some of the freeway congestion during peak hours.

Charles River Associates projected the study results nationwide and concluded that a national no-fare policy would result in an annual deficit of about $2 billion. Of that, $1.7 billion would underwrite current service and $250 million would be needed for additional capacity to handle new riders. The study estimated that ridership would increase some 32 percent if a no-fare policy were established. However, in its conclusions and in analyzing the cost-effectiveness of such a program, Charles River Associates felt that it might be better to use the same money to improve the quality of the service, headways, equipment, and routing—perhaps resulting in an even greater increase in ridership.

Let me give you an example of fare structures involving 2 cities in which AC Transit operates. Currently, the fare is 80 cents round trip. The contemplated fare structure on the rapid rail system that will serve those same 2 cities is $1.40 round trip. If a customer also has to pay 50 cents round trip to ride a feeder bus to and from the rapid rail station, his total round-trip fare will be $1.90, an increase of $1.10 over what he is currently paying. It is uncertain how the public will respond to this additional cost.

The entire fare collection procedure is in need of a lot of work. Certain firms that manufacture fare-box equipment are doing work along these lines. However, not enough is being done. On BART's rapid rail system, and in all stations along the line, riders will be able to buy stored fare. The rider can put a maximum of $20 into a machine and receive a card worth $20 in rides. When the rider uses the system, he checks in and out, and, according to the distance between the stations, the machine automatically deducts the amount of the fare from the card. We should be able to use these stored-fare cards on buses as well as on trains.

Certainly the way in which we get the money from the fare box to the bank could stand a great deal of improvement. Also, the simple business of trying to transfer between 2 vehicles, especially between bus and train, could stand improvement.

On-time performance is one of the most exciting developments that is being worked on. Not only will it help ensure on-time performance of transit, but also, if it is developed correctly, it will help meet immediate demand.

There are many amenities, such as air conditioning, carpeting, and music, that may have significance to prospective customers. What must be determined before these amenities are purchased is the degree to which they will increase transit ridership.

How much space per individual should be allotted on a bus? At present, buses capable of seating 53 passengers are being built. General Motors Corporation has done research on seating capacity and space. It was determined that, if each customer was given the same amount of space on a bus that he has on a first-class airline ride, the seating capacity of buses would be reduced by about 40 percent. More equipment and operators—resulting in a higher cost per passenger—would be necessary to ensure that each rider is given a seat.

Efforts are currently being made to reduce sound levels inside and outside of the coaches. Again, how significant is this in attracting new business? Should transit do a better job with regard to noise reduction? The same questions can be asked concerning cleanliness. AC Transit now has automatic washers that expedite exterior cleaning of the vehicles. Inside cleaning of the vehicles, however, is still a hand operation. AC Transit has some automatic vacuums, but they are as yet unsatisfactory. We need to know what, if any, relation exists between vehicle cleanliness and level of ridership.

Another area that needs research is operator attitude. Should we, as an industry, be putting greater emphasis on prospective employees' attitudes at the time we hire them? Perhaps we need screening tools to help evaluate how a man will treat the public under the conditions that an operator has to face.

What effect does vehicle appearance have on level of ridership? I personally dislike advertising signs on buses, yet AC Transit receives about $200,000 in revenue from those signs every year. If AC Transit eliminated such advertising, would the improved appearance of the coach attract enough additional riders (2 percent would be needed) to offset the loss of revenue? We do not know the answer to this question.

So much for the various factors of AC Transit's research operations as they directly concern the public. As far as our in-house problems are concerned, they are strictly one of cost and operating efficiency. AC Transit's driver wages have increased 100 percent during the past 10 years, with practically no increase in operator productivity. How does a transit system cut costs? One way is to increase bus capacity. AC Transit has been studying the use of an articulated 77-passenger coach to cut costs. Another way is to increase bus speed. Greater use of the computer can also help to reduce expenditures.

Improved equipment is sorely needed to save money and improve operating efficiency. Research has given us fast fueling, which has been of help; however, each night we still run our buses through a fuel island. Why can't we have electronic movement of buses in the yards—something similar to the way freight cars are moved about in a rail yard?

Research on 2-way radios has been helpful in improving operating efficiency, which is proved by the fact that the transit industry now is installing or using 2-way radios in various operations.

In the area of power plants, a great deal of research has taken place during recent years. There has been substantial improvement in the emission control of the diesel engine.

Gas turbine engines (60 are currently being produced), which have lower maintenance costs, greater power, and lower rates of pollution emission than do conventional engines, will benefit the transit industry. The gas turbine engine meets the 1975 emission standards. The steam bus, currently under research, also meets 1975 emission standards. Research also is taking place concerning the conversion of diesel engines to liquid natural gas in an effort to meet 1975 emission standards.

Greater research is needed in the field of safety. Operators have difficulty in accurately measuring distances and changing perspectives as the vehicle moves. New devices and training aids are needed to help operators more accurately judge distances and perspectives.

Promoting the use of public transportation is also a very important part of the transit operation. Essentially what we must do is sell satisfaction to the public—a very subjective matter. At AC Transit approximately 1.6 percent of operating income is spent in promotion of service, including the use of newspapers, billboards, radio, and television. Yet adequate research is needed on the effectiveness of these promotion techniques in converting the public to transit use and also in providing the public with adequate information so that they can better utilize the system.

In conclusion, the main job facing the transit industry today is to promote greater use of transit by attracting automobile users. To accomplish this, 3 requirements need to be met. First, a positive public attitude must exist, as demonstrated through greater financial assistance and through greater use of the transit systems. Second, more research is required to improve our capability of attracting new customers to transit and in improving the efficiency of our operations. Third, the thinking of transit management must be changed such that it can take advantage of research activities and accommodate changing public attitudes.

TRANSPORTATION RESEARCH AREAS

John B. Schnell, American Transit Association

One of the problems in the transportation research field is the lack of bibliographies on particular fields of research and the lack of source data from specific sites.

Some of the organizations that have excellent transportation research libraries are the Urban Mass Transportation Administration (UMTA), American Transit Association (ATA), Institute of Traffic Engineers, and Highway Research Board. The research libraries of many colleges that have transportation curricula also are available.

One document that lists all of the research projects that have been or are being conducted by UMTA is the Directory of Research, Development and Demonstration Projects.

Although ATA keeps statistical data on the operations and many facets of transit system activities, it is frequently difficult to compare the data among the many systems because of the following local and operational characteristics: topography, weather, labor, equipment age, operational policies, population density, local politics and laws, public and private cooperation, subsidy and tax considerations, and public support.

RESEARCH AREAS

The following sections list and briefly describe some of the research subjects that have been given various degrees of consideration in the recent past. Suggestions for research are also given. The subjects are divided into 3 categories: operations, human factors, and equipment. Many of the subjects discussed could apply to more than one category.

Operations

There has been some research made of existing senior-citizen reduced-fare systems, including the following areas: means of determining eligibility, providing identification, use of weekly or monthly senior-citizen passes, standard procedures for allocating periods of day when senior-citizen reduced fares are not operative, effect on the senior-citizen ridership by hours of the day, total increase in ridership of the system, total deficits incurred by adoption of the senior-citizen reduced fares, means of subsidizing such fares, acceptance of subsidizing such fares by the general public and municipal officials, and socioeconomic aspects of the senior citizens.

Some researchers have indicated that the way to make transit more attractive is to speed its operation in downtown service. Because bus traffic speed is normally limited by the flow of other traffic, one of the few areas that might be improved is the loading and discharge speed, which currently averages 3 seconds per passenger. It has been estimated that a 1½-second per passenger loading and unloading speed would be needed to cut 10 percent of the total trip time of bus routes. One means of approaching this might be a more rapid handling of fares, which might include automatic fare collection.

The most equitable method of developing zone fares, including their effect on passengers and their cost-effectiveness, has been studied.

Kent University and the Mitre Corporation have studied the technique and method of developing hardware that will measure the length of a ride and establish a price depending on distance traveled for surface transit vehicles. This hardware should also count the passengers.

Further study should be made of the different means of using transit information systems both at individual bus stops and at transit station transfer points. This would include making available to the public at bus stops information pertaining to bus routes and schedules. A more complex type of information system, including the use of changeable message signs, warrants consideration and further research.

The use of telephone answering information systems in transit operations should be studied. Many complications are inherent in transit information systems. There should be studies made of transit telephone operators, telephone company information operators and management, and the general public with regard to the types of information they want and the restrictions that they would be willing to accept to have a more sophisticated and completely informative transit information system.

It is possible that a computer-oriented transit information system could be voice-actuated (in part) if potential passengers were trained to make a 1- or 2-word initial response to preprogrammed questions asked by the computer answering system. The results of this initial question and response would automatically tie the caller to the person or recorded voice that could supply the desired information most efficiently.

There needs to be more study made of vehicle cleaning and maintenance. The number of personnel, their responsibilities, wages, and duties, and the types and methods of cleaning should be determined.

Specific cleaning procedures need to be established, and vehicle parts that require maintenance and cleaning need to be identified. The procedure would include the following: wet-cleaning, vacuum-cleaning, waxing, material repair, and repair of vandalism. Vehicle parts that require care include the floor, walls, ceiling, seats, and stanchions.

Northeastern University has studied the quality of supervision in the transit field. Because many transit operators and mechanics become supervisors (based on longevity of service), there is a need for training programs that instruct new supervisors on how to deal with subordinate employees.

Although some work has been done by ATA on training needs, very little has been done on the best means of motivating mechanics and establishing a certification program that would be acceptable to the strong transit unions.

The Ottawa Transit System has done some excellent work in establishing an average time allotment for specific types of mechanical work. At the same time it has increased productivity and maintained high employee morale. A study of how this can best be done and how it has been attempted at other locations might be very helpful.

ATA has submitted a proposal to UMTA entitled FARE, an acronym for Financial Account and Reporting Elements. This proposal was not aimed entirely at requireing all transit systems to follow a particular single accounting system. Its purpose was to find the elements of the different types of accounting systems that would require least modification to provide absolutely uniform systems where necessary and provide rules of thumb for changing data in other types of accounting systems so that they can be interpolated with the standard system.

Several research projects pertaining to scheduling have been carried out by UMTA. An analysis of whether any of this computer-oriented work is actually related to the operational and human elements of providing bus service would be helpful. Various studies have been made of bus shelters, busways, bus lanes, traffic signalization, and street closings and malls. More work needs to be done in these areas.

There is need for a study of the procedures that can be followed to provide a truly intermodal region-wide transportation system. In Hamburg, Germany, there has evolved a system in which the fares, operations, schedules, and all aspects of the region's transportation systems are under one administration. Thus, there is a high level of scheduling cooperation among the several modes of transportation in the Hamburg area.

One of transit's largest problems is its high labor costs, which average 60 to 80 percent of all operating costs for the average transit system. Except for the 3 or 4 peak-ridership hours of the day, bus and rail service is generally maintained at a low level, and as a result there is a great deal of unused labor during most of the day. Although there would be many labor union problems to surmount, an obvious means of providing a more efficient utilization of manpower would be a more diversified use of the men and equipment during the nonpeak hours of the day. For example, in Switzerland transit vehicles carry the mail. Two major problems that would occur in the United States are the effect of competition with private enterprise and the labor unions' resistance to such a program.

Human Factors

A bibliography and analysis are needed of commuter motivation publications that concern the conscious and subconscious means of motivating people to use mass transit. Some ideas that might be helpful in motivating the public to use transit are as follows: transit is cheaper, transit use is a civic duty, transit is safer, and transit is more convenient.

There are various human factors areas that need further study. Several suggestions for studies are as follows:

1. Determining how to measure the impact and cost-effectiveness of promotional work,
2. Studying the cost that employers incur by providing parking facilities for employees as opposed to paying transportation costs,
3. Studying the merits and feasibility of employers providing employees with free transit passes,
4. Determining the cost and convenience of automobile versus transit use in metropolitan areas,
5. Compiling a bibliography of and analyzing previous studies concerning transit subsidies,
6. Compiling a bibliography of and analyzing previous studies concerning automobile subsidies,
7. Completing the UMTA directory of research projects,
8. Summarizing and analyzing the results of the YOPHU (young, old, poor, handicapped, and unemployed) projects,
9. Compiling a bibliography of and analyzing articles related to noise created by transit vehicles, and
10. Studying vandalism and developing passenger security projects.

Equipment

Studies concerning improvement of bus design are being made by General Motors, Rensselaer Research Corporation, and Booz-Allen. There may be merit in undertaking a study of the cost to both public and private transit systems of a newly designed bus insofar as the initial purchase funds are concerned. This study would relate to a newly designed bus if it cost 20 percent more than buses currently on the market or if the cost was 100 percent more than current prices.

A study should be made of the optimum economical life of each type of transit vehicle—rapid transit, car, and bus—taking into consideration the effect of capital, operating, and maintenance costs and the vehicle life on the marketability of transit.

A bibliography and analysis of the current state of the art in bus propulsion systems should be undertaken. This research would include the cost, principal characteristics, and effect on ecology of such systems.

A bibliography and analysis of the cause, prevention, and extinguishing of tire fires are needed at this time.

A bibliography and analysis of the state of the art of automated vehicle monitoring systems (as concerns their use as bus and rail transit vehicles) would be desirable. UMTA is currently responsible for some research in this area.

The effect of the introduction of the metric system on the transit industry should be studied. A bibliography and an analysis of existing articles on this subject might be helpful.

Railroading and all of its many fields of knowledge in the transit industry have rarely been recorded in textbook fashion and not at all recently. A bibliography and analysis of all existing texts in the following areas of rail transit would be very helpful: power and signals, way and structures, operations, and car equipment.

Recent retirement rules at some of the major rail transit properties have hastened the early retirement of the most knowledgeable senior employees. Much knowledge has been transferred from supervisor to employee over the years, but very few texts have attempted to record any of this knowledge.

A bibliography and analysis of all articles and publications in the field of harmonic vibrations and wheel spalling might be quite helpful. A proposal has been made for such a study, but no current research is under way. UMTA's Pueblo, Colorado, test track and testing facility may be ideal for testing some of the vibrations and other conditions found when steel wheels meet steel rails.

The subject of uniformity versus free enterprise is currently a controversial topic in the transit industry in several areas. For example, the San Francisco Muni recently received bids for new streetcars of a very sophisticated and modern nature. The bid prices reflected a cost in excess of $500,000 per car. This amount is too expensive if streetcars are going to be competitive with buses. One solution might be a standard streetcar that the remaining streetcar properties would have to use in order to obtain Federal Capital Grant funds. Thus, any manufacturer could bid on the standard plans, and the components for the Boston streetcars would (generally speaking) be compatible with those for streetcars in Toronto or Philadelphia. Thus it would also be possible for Philadelphia, Boston, and San Francisco to bid for streetcars at one time, which would produce substantial savings generated by the ability to produce a large number of vehicles by a single manufacturer.

A bibliography and analysis of the literature on tunneling would be helpful to transportation personnel.

There is a need for a bibliography and analysis of the current state of research on the subject of guideways and people movers.

RESEARCH AND REALITY

Michael Cafferty*

For most of the period since World War II, public transit in the United States has been viewed as a dying industry. This characterization of transit, though unfortunate, is understandable. With few exceptions, there has been very little innovation in transit and little encouragement for research and development.

The development of this situation has been due in large part to the belief that the private automobile is the best means of traveling within urban areas. This has led to huge highway building programs on the federal, state, and local levels, with inadequate consideration given to public transit. The political process concentrated all of its efforts on development of highway facilities and therefore did not encourage technological breakthroughs in transit. At the same time, the expansion of the U.S. economy was making it possible for more and more persons to acquire private automobiles. These factors led to a greater degree of decentralization of activity in urban areas. This made it more difficult for transit, which is most efficient in concentrated activity centers, to effectively serve an increasing number of urban trips.

All of these developments served to encourage wider use of automobiles and discouraged use of, and improvements in, transit. Transit became an unattractive "last resort" mode of travel.

In the transit industry, pressure was always greater to minimize fare than to improve the quality of transit equipment and service. Under such conditions almost no funds could be allocated for research and development. This was true even in earlier days when automobile use and the highway network were not as far advanced as they are today. At that time, a 1- or 2-cent fare increase would have gone a long way to upgrade transit systems, but even such minimal fare increases were blocked. The result has been continual postponement of equipment replacement and capital improvement. Physical plant and equipment have in effect been confiscated so as to avoid fare increases even in the face of unavoidable operating cost increases. Research and development were neglected to save capital, and as a result created long-range problems. At the present time, many U.S. transit systems have fallen decades behind in capital renewals.

So we see a picture of deteriorating transit systems, left to make their own way on meager fare revenues, alongside a modern, expanding, heavily subsidized highway network. Two tragic mistakes were the assumptions that transit could yet survive under these conditions and that everyone who could afford to drive his own car could be accommodated by expansion of highway facilities.

The folly of this approach to our urban transportation problems, and the need for a balanced system, is becoming increasingly apparent to transportation experts and government officials at all levels. Specifically, the U.S. Department of Transportation is recognizing the deficiency in transit research and development and is taking corrective action.

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*Deceased January 1973. Mr. Cafferty was Chairman of the Board of the Chicago Transit Authority when he wrote this paper.

An example is the recent inauguration of the high-speed ground transportation test center in Pueblo, Colorado, which will provide railroads and transit companies with one of the finest research and development facilities in the world. Not only will new concepts in ground transportation such as the linear induction motor and the tracked air cushion vehicle (TACV) be tested here, but also work will begin on solving work-a-day operating problems faced by railroad and transit companies.

Another example is the program of demonstration projects, under the direction of the Urban Mass Transportation Administration (UMTA). Under this program, the federal government pays at least two-thirds of the cost of projects designed to test new transit service concepts. In Chicago, the Skokie Swift rapid transit and O'Hare airport express bus line, which now carry about 9,000 passengers per weekday, are 2 notable examples of successful services that were begun as demonstration projects.

The Skokie Swift project developed and tested the concept of using a high-speed, 2-station, shuttle rapid transit line that travels into a light-density suburban area, with low-cost parking provided at the terminal. It operates nonstop over a 5-mile portion of former interurban railway, connecting with Chicago's main rapid transit line. The acceptance of this service was immediate and overwhelming. The project demonstrated the superior ability of rapid transit with wide station spacing and resultant high average speed to attract riders, as compared to the older concept of closely spaced stations, which put rapid transit within walking distance of more people but operated at average speeds too slow to make the service marketable. The Skokie Swift provides access to suburban job opportunities for many inner-city residents as well as transporting daily thousands of suburban commuters to the Chicago central business district.

The O'Hare express bus line, which connects Chicago's rapid transit system with O'Hare airport, has proved its worth by opening up airport jobs to inner-city residents and providing low-cost ground transportation to airline travelers and employees. The combination of travelers and employees using the O'Hare express has made it nearly self-supporting, allowing the Chicago Transit Authority (CTA) to operate the line, at premium fare, as part of its regular system.

Monitor-CTA is another type of UMTA-assisted research and development project, being concerned primarily with the generalized problem of improving the technology of supervision of motor-bus operation.

These examples show that progress is now being made in transit research and development. Nevertheless, much still remains to be done, and problems are yet to be resolved in this field.

Planning must be adequately tied to implementation; i.e., for the present, research and development resources should be used more for development than for pure research. Failure to be pragmatic in this judgment would result in downgrading the role of the planner and hindering the progress of research and development in transit.

An important job of research and development is that it must first categorize the type of research that is being done.

For example, if the goal of a research project is to make improvements within a conventional rail system in important areas such as noise and vibration, the project must be clearly defined as one designed to produce results within the context of a given existing technology, the rail system, with an eye to specifically how and when the improvements can be implemented. Similarly, if a research project is to be geared to improving the average speed and dependability of bus operation, the project should be well defined and categorized as one built around the technology of existing bus operation, with much concentration on the "how" and "when" of implementation.

On the other hand, perhaps our research should be exploratory or nonconventional, such as investigating the feasibility or application of new technologies to transit, which cannot be expected to produce immediate results. We must then recognize and define this to be the case from the beginning so that the research is not considered an unrealistic function having no relation to current situations.

For example, consider the TACV, a new transportation concept that has merit and is being studied as to its feasibility and applicability in future urban transportation systems. It is unrealistic to expect from TACV an immediate solution to the problems

of currently operating transit systems. A proposal to suggest TACV as an extension of an existing rail line, for example, would defeat the merit of the concept and make TACV itself sound unrealistic to transit operators and the public, whereas it may well be a sound concept when properly tested and then applied in the right situation.

The physical plant and equipment of the present CTA system have a reproduction value of more than $1 billion. This includes more than 90 miles of 2- to 4-track rail rapid transit right-of-way: subway, surface, expressway, median, and elevated structure. More than 4,000 buses and rapid transit cars serve about 1.2 million passengers per day. An existing system of this magnitude is in need of research and development that will lead to improvements compatible with the established operating plan and the present massive capital commitment.

Introduction of a completely new rapid transit technology in Chicago would require special justification. Its application would have to be on a line completely separated from the present system, or its advantages would have to be overwhelming, in terms of service or cost, to warrant its introduction into the CTA system.

Disadvantages to be overcome in introducing new technology include the need for separate maintenance, terminal facilities, and right-of-way, which might increase construction and operating costs. Equipment would not be interchangeable, complicating operation and requiring greater investment in spare rolling stock. Passengers might be inconvenienced if the number and difficulty of transfers were increased because the technology of an extension was not compatible with an existing main line. Connections between old and new lines would be more difficult to make because the same trackage might not be usable by both modes.

CTA is most interested in areas of research that will lead to improvements in its existing bus and rapid transit system, in important areas such as safety of operation, passenger security, cleanliness of facilities, speed and dependability of service, matching of routes and service to trip demand, aesthetics, and reduction in noise and air pollution. We are continually striving to better serve our 1.2 million daily passengers. We want to improve the attractiveness of our service to increase ridership.

Once we have identified needed areas of research, and performed the actual studies, we must then successfully apply our conclusions. The job of implementing new concepts is often the most difficult part of the research and development process—and this is especially true in transit.

For example, if research has revealed that certain measures will significantly reduce noise in the subway, but funds are not available for implementation, the research recommendations are unrealistic; i.e., they cannot be implemented.

Let us assume that research has shown that exclusive bus lanes on a street will cut bus travel time in half, speed the journeys of thousands of people each day, reduce operating costs, and make the service more attractive to those not now using transit. If influential businessmen along this street who do not realize that 90 percent of their customers use transit block the proposal because they fear it will hurt their business, our research has again stopped short of reality because the implementation phase has failed.

Transit research and development must continually involve political representatives if research and reality are to be worked together. They must be familiar with what is going on in research and development, what conclusions are being reached, and what beneficial programs are being recommended for implementation.

It is their understanding and support that will make the funding of needed projects possible. If worthwhile transit improvements are being opposed by special interest groups, only informed representatives will understand and support the improvements.

It is through political representatives that citizens must be made aware of the importance of programs beneficial to transit. A good example of where this worked well in another field was with the establishment of the National Aeronautical and Space Agency and its program. First, Congress was convinced of its importance and decided that it was needed. Consequently, this multibillion dollar program was launched, and the public was made aware of the program and its importance.

In Chicago, one of the biggest assets we at CTA have is the support and understanding of Mayor Daley, who recognizes the importance of a healthy urban transit system

to the vitality of a large city and is willing to support and fight to improve the CTA system. Transit planning and improvement are greatly hindered in cities where the mayor does not understand the importance of a strong transit system, or the need for public support to transit.

This backing is essential to our survival. Only with the Mayor's support has Chicago been able to construct the first 3 median strip rail rapid transit lines in the country. The first such line was opened in 1958 in the Eisenhower Expressway, and to date Chicago remains the only American city that operates rail rapid transit in expressway medians. But these lines have been a testimony to the efficiency of this concept, and plans call for a portion of the new BART system, which will serve the San Francisco Bay Area, to operate in an expressway median.

Within the last 3 years, $100 million worth of urgently needed rapid transit extensions and improvements, including the 2 newest median strip lines in the Dan Ryan and Kennedy Expressways, have been placed in operation. The city of Chicago provided the one-third local share for the capital cost of these projects through a general obligation bond issue, and the federal government paid two-thirds through UMTA. The operating costs of these new lines, however, are the responsibility of CTA.

For the past 23 years, CTA has operated its comprehensive system of local transit strictly from fare-box revenues. However, in an effort to minimize fare increases in the recent period of inflation, we have postponed needed equipment replacement and system modernization.

This year, through the support of Mayor Daley and the Chicago City Council, the Cook County Board, Governor Ogilvie, and the Illinois State Legislature, funds were provided by the state, city, and county so that CTA will be able to operate through most of 1972 without a fare increase. We at CTA are gratified by this development, as the effect of recent fare increases in diverting transit riders to private automobiles operating over subsidized highways is clearly evident to us.

Studies have shown that cities that have maintained low fares and high-quality service through subsidy have experienced less decline in transit patronage than cities that have not subsidized transit and that have kept fares compatible with rising operating costs.

The recent Illinois state legislation will also make possible a $120 million capital improvement program, which funds will help to replace worn-out rolling stock and renovate deteriorized facilities. This urgently needed program will greatly improve the CTA system for our present riders and should attract new ones. This program will be funded through federal capital grants, state bonds, and work performed by the CTA force. Important features of this program are 1,000 new buses and 100 new rapid transit cars. These vehicles will be air conditioned and will replace some buses more than 20 years old and some rapid transit cars nearly 50 years old, the oldest cars still operating in the United States. All CTA buses more than 15 years old will be replaced under this program.

All of these transit improvements for Chicago were made possible by informing the elected representatives at all levels of government of the importance of and the needs in the field of urban mass transit. Transit is on the road to recovery only because public funds are finally beginning to be made available on the scale that can begin to provide truly high-quality transit service.

SEMINAR ON RESEARCH NEEDS IN TRANSIT OPERATIONS

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At the outset of the conference session on research needs in transit operations, an attempt was made to place transit operations within a fairly broad context to increase the likelihood that the full range of research needs related to operations would be discussed. Transit operations were defined to include the operations, in the sense of provision of transport service or capacity, of conventional and new technology, including both scheduled operations and demand-responsive systems. The specific objectives for the session, as suggested by the chairman, were as follows:

1. Identify both short- and long-term problems related to the provision of public transit service;
2. Evaluate current level of knowledge in order to identify needs for research to solve transit problems; and
3. Address problems of coordinating the desires and efforts of those performing research, those supporting research, and the potential users of the knowledge generated by research.

The relation of transit operations to a broad range of problems was discussed. Transit operations, in terms of service area, routes, schedules, and so forth, are directy related to the level of transit service provided within a metropolitan area. It is the level of service that directly determines the efficacy of the system from the standpoint of existing and potential users, and it is this aspect of operations that largely determines the proportion of the transport load in the area that the transit system accommodates. This is closely related to the necessity for capacity in other modes, such as highways, and in the long term to the need for expansion of those facilities. Level of service is also related to the spatial pattern of land uses and activities in a metropolitan area, in the sense that level of service and land use patterns will determine to a large extent transit demand. Also, the quality of transit and other transportation service in an area will tend to shape the spatial pattern of land uses in the area. Thus, transit operations include one of the most significant sets of decision variables under the control of the management and planners of transportation systems within a metropolitan area.

Operations are a prime determinant of the cost of providing transit service, and, because they largely determine the need for capital equipment as well as labor, most transit costs are determined by operating choices. These operations may be very much constrained by the characteristics of any shared facilities, such as the operation of buses on public roads. Also there are institutional constraints, as may be imposed by regulatory authorities and system charters, which may take the form of requirements to provide certain types of uneconomic services, limitations on fare levels, and labor agreements. The existing level of transport technology, of course, will to a large extent limit the options with respect to capital stock and operations, and there is little that an individual transit operator can do to change the state of technology.

Thus, transit operations seem to influence the attainment of objectives of various groups upon whom fall the effects of transit service. Operations are closely related

to adequacy of service from the standpoint of existing and potential users and to a large extent determine the effect, if any, that the transit system has on the general spatial and temporal pattern of activities in an area. They also are very important from the standpoint of the transit operator himself, largely determining the level of cost that is incurred and being the primary control variable in affecting the quantity demanded and hence the revenue.

SEMINAR DISCUSSION

The seminar discussion, as edited by the session chairman, is presented in the remainder of this paper. Every effort has been made to include all significant discussion, although the order of presentation has been altered to group together discussions of identical topics. Material on short-term research needs is presented first, followed by discussion of long-term research needs.

Short-Term Research Needs

There are 2 major sources of problems that call for immediate solution: the transit carriers and the public. The carriers are facing a financial crisis, in which they are unable to meet operating costs with revenues. Closely related to this is the problem of the public that depends on transit, a public that in many cases finds itself without any transit service whatsoever and in other cases often finds the service to be decreasing in quality and usefulness.

Despite efforts to control costs, and the transferring of responsibility for many costs (especially some capital costs) to others, transit operators find it increasingly difficult to meet costs for which they are responsible out of revenue. Hill expressed the view, which was shared by many, that operating subsidies will be necessary in more and more cities to augment existing capital grants and subsidies. This immediately raises a number of difficult questions regarding the appropriate nature and amount of subsidies and the way in which subsidized carriers should be monitored and evaluated in terms of the efficiency of their operations. Despite efforts to control costs, costs per unit of output (for example, per vehicle-mile) are increasing, primarily because of increases in wage rates and the increasing concentration of transit traffic during the peak hours, resulting in much unused labor and equipment time.

In view of these trends, the transit industry is extremely interested in any technological or institutional innovations that might reduce costs of operation. Bond described experiments using a new bus, which has much more capacity than existing buses, thereby spreading the essentially fixed labor cost of a driver over more units of output. He concluded that adequate data on transit operations to support studies of cost and demand are lacking and that they are needed if we are to be able to identify ways of improving the economic viability of transit. Much interest in this type of short-term, readily implemented innovation was expressed by representatives of transit carriers. Many participants felt that far too much emphasis is being placed on radically new technology, which would take many years to develop and implement, and that more emphasis should be placed on more evolutionary and easily implemented technological improvements that would be of immediate benefit to the transit industry. Even simple innovations, such as the use of 2-way radio on rail rapid transit lines, are not easily implemented. Craig and Schnell suggested that more research be devoted to the writing of specifications for the design and implementation of new subsystems on conventional transit lines.

Morlok and Saltzman stated that, although technological changes such as operating larger vehicles might reduce unit costs during peak periods, they might also lead systems toward increasingly poorer service during both the peak and the base periods. This is particularly true where technological innovation cannot reduce manpower except by increasing labor productivity at the expense of quality of service. This may lead to a cycle where an innovation designed to reduce costs actually reduces the quality of service, which in turn reduces the number of riders and hence revenues, leading to a further reduction in costs through reduction in service and so on. Alternatives that attempt to increase revenue through tapping new markets and that obviate

the necessity for reducing costs, which might have the undesirable effect of simultaneously reducing the quality of services, should be explored.

Although little attention has been given to changing the institutional and regulatory constraints under which transit lines operate, there certainly are many options in this area that might reduce transit costs. One option would be the sharing of the labor, used to operate transit vehicles for passenger service, with intraurban freight carriers. This might be done by having a man operate a transit vehicle during the peak period in the morning, then using him to operate a pickup and delivery truck during the remaining hours of his workday. Another option, which would probably be much more difficult to institute, is to attempt to relax constraints on the employment of labor in 2 separate shifts. Although changing such institutional constraints may seem extremely difficult, other industries, such as the railroads, which have been faced with similarly precarious financial situations, have been able to implement some rather substantial changes in union agreements. An example is the elimination of firemen from diesel freight locomotives.

Although the tapping of new markets to increase revenue or the increasing of revenue through price changes would seem to be very attractive, a major obstacle is that very little is known about the response of the public to changes in service and fares. Although general estimates of fare elasticity have been developed, they do not seem to apply well in individual situations. Krambles presented 2 examples of situations in Chicago—on the Dan Ryan rail and O'Hare airport bus rapid transit routes—in which both fares and traffic have increased, presumably due to improvements in the service. He also discussed other cases where traffic has not responded according to the generally used rule of 30 percent fare elasticity. Both Krambles and Heathington cautioned against the use of aggregate data, such as those for the nation or an entire city, in the estimation of elasticity of demand with respect to service and price changes because many other factors are usually changing simultaneously and can drastically affect the conclusions. McDonald suggested that a major determinant of modal choice may be the status and symbolic characteristics of the modes, which would obviously favor the automobile now.

Couts presented some preliminary results from a study of the fare and level-of-service elasticity of demand for transit, based on data of patrons' behavior in Pittsburgh. One major conclusion is that people seem to value walking time 3 to 5 times as much as they value the time spent in the transit vehicle or in transferring between vehicles. This means that coverage of an area is extremely important for determining transit ridership and that coverage is much more important than the speed of the journey in the vehicle. That this is in contrast to conclusions reached on the basis of aggregate and crude analyses in the past further underscores the fact that very little is known about the effect of service and price changes on transit patronage. Maxman presented cases in which it would have been desirable to have better demand models for purposes of corridor planning.

Bingham presented some examples of the effect of certain service changes on the AC Transit system. Lower headways were introduced during the base period on some routes; however, it was found that, although riders increased their traveling, there was not a sufficient increase to make the service profitable. The AC Transit system has also experimented with advertising to build up the social acceptability of transit but has no way of assessing the effect of this factor. Bingham believes that many potential users of transit are unaware of the service available, so they do not consider the use of transit in their travel planning. Hill felt that convenience and an uninterrupted ride are important in determining ridership, but again no detailed studies of the importance of these factors have been carried out.

All this suggests that more research on the determinants of demand for transit service is absolutely essential to rational planning. There was a general feeling that the demonstration program of the Urban Mass Transportation Administration (UMTA) has been of some help in this regard but that the effects of changes have not been identified and presented in a manner that makes it possible to readily use the conclusions generally. Morlok stated that closer monitoring of the demonstration projects would be necessary in order to obtain data that are useful for purposes of identifying the factors

that influence transit use. Clearly this is essential for purposes of modeling or developing an ability to predict the effect of service changes on demand and revenue. Heathington further pointed out that it is generally not possible to identify the effect of one change if simultaneously many other changes are being introduced. Yet, very often in past demonstrations many changes have been introduced at the same time. Rather, it is necessary for changes to be introduced one at a time; the system must be allowed to respond and settle down, and the effect of the change must be identified before another change is introduced. There is, therefore, a greater need for care in designing transit demonstrations so that they will yield information on the efficacy of improvements, which can be generalized to other situations. Without this, the demonstrations are really of little value from the standpoint of increasing knowledge that would be useful to other transit operators.

Another possible approach to understanding the demand for transit service would be to survey both current riders and potential riders. Although this may yield information as to what is needed to increase ridership, it was felt that the results of this type of survey are somewhat suspect.

A major problem in carrying out any changes in transit service, regardless of the method used, is the substantial difficulty in changing the schedule or route structure of a transit system, or both. The difficulty is not in implementation; it is found in the substantial expense and time required to plan for the change, in making up the new schedule, and in assessing its impact on costs and riders. Currently, the entire process is often carried out manually, requiring many man-months of effort to institute a route change or a substantial schedule change on even a moderate-sized system. Although computer models have performed some of these functions, the models have not been entirely successful and do not perform the entire task. This is in marked contrast to the airline industry, where computer models for route structure planning, scheduling, crew and vehicle assignment, and maintenance scheduling have been developed and are now widely marketed and used. It would seem that much research with the potential for very substantial payoffs could be directed toward the development of such management and planning decision-aiding tools.

There was much discussion of transit problems and research needs from the standpoint of existing or potential users. One major source of problems from the standpoint of the user is that transit service in most cities is deteriorating in some respects, such as elimination of some routes or reduction in the frequency of service (especially during the off-peak periods) in others. As Couts pointed out, another source of difficulties is the changing pattern of activities in urban areas. As the population and industry are spread out more thinly, the pattern of trip origins and destinations becomes much more diffused, resulting in a relatively low potential volume for many transit routes. Also, the advent of the automobile, and its convenience for shopping, multiple-person, and linked trips (trips with many destinations), has resulted in a shift of most nonpeak travel away from transit.

Large-vehicle systems, such as conventional bus and rail transit, do not seem particularly appropriate for the provision of transit service in low-density areas. An obvious alternative is the operation of small vehicles, where vehicle trips are made in response to demands. An example of this is the dial-a-bus system (of which there are many variations in form and name), in which a small vehicle is operated between the actual origins and destinations of travelers in much the same manner as is a taxicab. Riders wishing service call a central dispatcher who then assigns a vehicle to pick up the rider. The primary difference between taxicabs and dial-a-bus is that, with the latter system, vehicles are somewhat larger and are dispatched such that many travelers share the same vehicle trip, which reduces costs. The cost of dial-a-bus lies between the cost of conventional taxicab and conventional mass transit. Much research is now under way on these systems, and a few are nearing the implementation stage. Craig mentioned that some examples of this type of system already exist, such as in Manhassett, Long Island, and Mansfield, Ohio, and that these seem to be successful from a financial standpoint.

In a lengthy discussion, the merits of such small vehicle demand-responsive systems were questioned. Krambles and Hill, in particular, presented many of the reasons why

jitney operations (which are similar to dial-a-bus but do not involve call-in service) have been curtailed or prohibited in many cities. They stated that jitney operators generally choose to provide service in the same areas as the most profitable transit lines, simply diverting transit passengers and revenues and generally operating unsafe vehicles and being unwilling to provide service in low-density areas and at times of low demand. If dial-a-bus is introduced, history might be repeated.

Some members of the transit industry went further and stated that they do not feel jitney or dial-a-bus service—even with good management—has any real place in the larger metropolitan areas. Because it is not really a mass transit service in the form of operating high-capacity vehicles on high-volume routes, their firms have no real interest in this type of transit service. Although it is not clear to what extent these views are shared within the industry, this discussion clearly indicated that it may be very difficult to institute a dial-a-bus service in a metropolitan area that has an existing transit service, much less coordinate the 2 services.

This dialogue suggested a number of important areas for research that probably have not been studied in most of the work related to the dial-a-bus concept. One is the institutional problems associated with implementing such a service wherever it might be appropriate and the need for changing many existing regulations against jitneys, which would prohibit such service. Of course, these changes would have to be made in a manner that provides for the new service yet still protects the interest of the conventional mass transit operator where that is proper. It also suggests that the integration of dial-a-bus service and conventional transit service may be extremely difficult, not only from a technical standpoint but also from an institutional-organizational standpoint. Means for implementing such coordination must be carefully developed.

Of course, the overriding concern should be the development of a public transit system that balances the needs or desires of various groups for public transit service and the cost to society of providing that service. Morlok commented that each technology should be used where it is most efficient and that the overall system should be integrated in such a manner that the resulting total service is optimized. Although strong views seem to be held regarding the viability of both conventional transit service and dial-a-bus service, the conflict among these views suggests that much more needs to be learned regarding these 2 types of service, and their ability to complement one another, before rational planning and integration can be undertaken.

Bingham stated that there was little question that the transit industry could meet the requirements of the Environmental Protection Act in terms of vehicle emissions. Morlok suggested that this Act, and others like it, may have the effect of forcing a shift in travel in urban areas away from the automobile, which contributes as much as 75 percent of some pollutants to the atmosphere. If this occurs, where will the trips go—to transit, to destinations within walking distance, or will they be eliminated? Stoner wondered whether this will require enforced reductions in automobile use and perhaps rearrangement of land use patterns.

A major conclusion on which all participants agreed is that more resources need to be devoted to research in mass transit, especially research directed toward solutions to problems that can be implemented in the short term. Bond pointed out that mass transit carriers receive very little funds for research, in contrast to the massive amount of money distributed to state highway departments and their agencies for research. Federal policy in this matter seems to be inconsistent with the objective of providing adequate mobility services for all. Even those funds that are spent on transit seem to be misallocated, in the opinion of many, with far too much being devoted to the development of new technology that will be available only in the long term and that may not be of value then. Some of these funds should be used to solve short-term problems.

A closely related problem is that of attracting well-trained men and women to the transit industry. Many of the participants knew of cases where young college graduates interested in the transit industry were unable to find suitable employment. Although some of this difficulty may simply stem from a desire on the part of the college graduate to have a position of authority and responsibility before he has sufficient experience, the transit industry is clearly lagging behind other industries in attracting and retaining well-trained personnel. If some federal funds were distributed to transit

firms for research and operations planning, many of these well-trained and highly motivated persons could be hired and their talents used to improve the industry. Without such funds, the amount of money that can be spent by any individual firm for planning and research personnel is negligible. Furthermore, if such talent cannot be brought into the industry and research and planning staffs cannot be expanded, much of the research and techniques developed by the current UMTA program will not find use in the industry.

Long-Term Research Needs in Transit Operations

The discussion of long-term research needs was considerably shorter than that dealing with short-term research needs. Perhaps this reflects the greater difficulty in identifying and being specific about long-term research needs, but probably it reflects the general concern for the viability of the transit industry in the short term.

Morlok raised the question of whether there would be any role for transit in its conventional form in the distant future. Clearly, land use patterns have changed markedly in the past and are continuing to change, and the daily pattern of human activities is changing toward less emphasis on work and the work trip and to a greater dispersal of origins and destinations. Technological advancements may make it possible for people to work at home and to work shorter weeks; therefore, the demand for transportation in the future may be radically different than it is now. If it is radically different, then existing technologies may be inappropriate in the future. Couts suggested that, if it is desired to accommodate large portions of urban area trips on conventional transit, altered land use patterns may be necessary. Heathington raised the question of whether we should provide options in transport mode, in view of the fact that no choice is offered in many other public services, such as water and telephone. Why retain wasteful competition? Stoner further suggested that land use patterns might be altered so as to reduce the demand for transportation.

Because transportation is so inextricably intertwined with the spatial and temporal patterns of activities in metropolitan areas, long-term research should be undertaken jointly by the U.S. Departments of Housing and Urban Development, of Health, Education and Welfare, and of Transportation. Clearly the programs and policies of one will drastically affect the efficacy of programs and policies of the other.

There was widespread agreement that the development of radically new transport technologies should only follow the identification of a need for such new technology, based on expectations of travel demands in the future. Krambles and Craig expressed a concern that the federal government may be spending far too much of its resources on new technology, without knowing whether new technology will in fact be useful in the future. Craig suggested that much of the new technology may in fact be inferior to some existing technology, in particular comparing some of the newly developed people-mover systems with the PCC streetcar design of the 1930s. He felt that we have in many cases lost sight of our goals of providing mobility efficiently and have wasted much effort in attempting to develop new technology for its own sake rather than for meeting real needs.

In conclusion, it seems as though any long-term research program in urban transportation must be one that is coordinated with, if not an integral part of, research related to the general character of urban society in the future. The future seems so uncertain in terms of the spatial pattern of land uses and activities within metropolitan areas, the mix between work and leisure time, needs to curtail certain activities (such as automobile use) in order to maintain a high-quality environment, and changes in the distribution of income to provide a more equitable distribution for all that very long-term research on transport needs and technologies can only be rationally considered within a much broader context.

CONCLUSIONS

As would be expected, there really was no general concensus on priorities among the various research topics suggested during the session. However, there seemed to be substantial agreement among many participants regarding the high priority of the following research areas:

1. Given the general feeling of high priority associated with research that would yield short-term payoff, there was general agreement that we really know very little about the response of travelers to changes in transit operations. Clearly, such response must be known to adequately evaluate various alternatives, such as changing prices, changing frequency of service, introduction of new routes, and introduction of dial-a-ride service. Existing knowledge of demand functions is based on aggregate analyses and often leads to erroneous predictions in specific situations.

One valuable tool for increasing our knowledge of demand is the demonstration or experiment. More care must go into the design of experiments so that the effect of each individual change is clearly identified. The experiment must be monitored until the system settles down to a new stable pattern, so that the effects are accurately identified and measured. These demonstrations should be consciously designed and monitored to provide information that will be helpful in estimating the demand for public transit, in a manner that enables use of the conclusions in other situations.

2. Much research is warranted in the identification and evaluation of various options within the context of conventional transit technology. Such options include increasing the size of vehicles, sharing of labor costs between passenger and freight movements, and innovative labor agreements that would cut down on labor costs. Also, much research is needed on the guidance of transit lines in the implementation of more sophisticated technology, particularly in the writing of specifications and the introduction of new subsystems.

3. There seems to be little consensus on the efficacy of innovative transport technology, such as the dial-a-bus. Much research is needed on the financial and operational aspects of such systems and on the institutional problems of implementing them or perhaps incorporating them within existing mass transit operations.

4. Making substantial changes in the operations or service of a conventional mass transit system seems to be a very time-consuming and expensive process, primarily because of the lack of tools and techniques (such as computer models) to aid management and planners in the design and implementation of such changes. Although some very useful work has been conducted in the area of operator assignment and vehicle scheduling, there needs to be developed a comprehensive set of transit management and planning tools that would deal with various problems, ranging from route structure and service area planning to detailed scheduling and maintenance. Those related to broader questions should clearly be compatible with the planning models developed by the Bureau of Public Roads and used primarily for highway planning.

5. Although there was general agreement that short-term problems are of much higher priority than long-term questions in terms of research needs, it was generally agreed that the future role of transit in its conventional form is very much in question because conclusions depend so heavily on the future form of metropolitan areas and activities within them. A long-term joint research program between the U.S. Department of Transportation and the U.S. Department of Housing and Urban Development was suggested, with transport needs as defined in that research being the basis for any long-term planning and technological research and development effort undertaken in the sphere of transportation.

6. Even in the short run, if the travel demands of urban areas are to be met well, there must be substantial cooperation among all agencies and the various modes. The Federal Highway Administration and UMTA are cooperating now on many projects, and this cooperation must be continued and expanded at the local level if the present system is to be well matched to current and future needs. Much research is needed on the best use of available road capacity, the reservation of lanes, priority treatment for buses and streetcars, and coordinated freeway-parking-transit schemes. Provided that an attitude of cooperation rather than of competition prevails, much improvement can probably be achieved quickly and at little cost.

7. To be able to use the results of research conducted by UMTA and other agencies concerned with transit and urban mobility, the transit industry must develop staffs that understand how to make use of the results of this research. Also, such staffs are needed in order to plan specific changes within individual metropolitan areas. In order to do this, the transit industry needs research and planning money, perhaps distributed

in a manner similar to that distributed to state highway departments and their agencies. This will enable the transit industry to attract the talent that is now coming from universities under the UMTA research and training program. Without such research funds and the development of such staffs, much of the research currently being undertaken might not be used.

SEMINAR ON RESEARCH NEEDS IN TRANSIT EQUIPMENT

Alan T. McDonald, School of Mechanical Engineering, Purdue University

Based on the preceding seminar discussions, I have abstracted 4 major problem areas that face the transit industry: money, politics, public acceptance, and equipment. I will discuss briefly the first 3 areas before moving on to the fourth, equipment, which is our seminar topic.

The most pressing problem of the transit industry is money. Operating cost is a function of service level and vehicle size. Once operating cost and capital needs, including modernization, are met, the development of new programs can be started.

Figure 1 shows the relation between operating cost per passenger mile and vehicle passenger capacity. The vehicle with the highest operating cost is the private automobile. For a fleet of taxicabs, there is a lower operating cost because of the advantages of fleet operation and because more people are carried generally in a taxi than in a private automobile. Next is the type of system that includes demand actuation, such as dial-a-bus. Conventional bus systems using articulated vehicles can carry approximately 200 passengers per bus. Finally, the train is least expensive with regard to operating cost. The overall concept is that operating cost per passenger mile generally decreases as the number of passengers increases.

An interesting variable that affects demand is convenience. Individual transportation, like the automobile, maximizes convenience. A taxicab delivers its passengers without making side trips. A dial-a-bus system takes a little longer to deliver its passengers because it has more than one destination. The relative order of buses and trains of course depends on their operating headway.

The important thing is that we can predict exactly, I believe, on the basis of data readily available, the cost of a given service level. For a given frequency of service and size of equipment, there is no problem in predicting the operating cost. The question is, Will there be enough passengers to make it pay?

As Cafferty has pointed out, politics is a very important area. Two problems in the political arena were pointed out that we should note. The first is viability. Only plans that have some chance of being implemented should be proposed. Radical proposals, such as those that would require the immediate restructuring of land use, are not politically viable.

Implementation is also an important factor. No matter how well structured a research program is, there is always the possibility that nontechnical observers, including politicians, will expect too much from the program. The nontechnical observer can only interpret what we have done based on what we have told him. We must make certain at the outset of any research program that the goals and aims of the program are clearly defined so that no one will have expectations that are unrealistic. Pilot studies, for example, must be identified clearly in the public mind as being experimental and not immediately utilizable.

Public acceptance is an extremely important area; however, it is considerably less well defined than the area of operating cost. Public acceptance is a function of 3 variables: economics, service, and public attitudes.

The important point is that, having computed the operating costs for a given level of service, in order to meet those costs one has to multiply the number of passengers by the fare. Therefore, if the number of passengers is small, the fare has to be large. One has to assume that there is a relation between fare level and patronage size.

Figure 2 shows my projection of what the automobile population trend would be if the true operating cost were known by the general public. The number of automobiles, if the cost were zero, would be limited only by the size of the population; therefore, imum use equals the total population. If the cost is 1 cent per mile, only a small fraction of the population cannot afford to drive. If the cost increases to 10 cents, which is a reasonable figure, then the number of people who can afford automobiles decreases. If the cost increases to 1 dollar per mile, it is very likely that the number of people that could afford to run private automobiles would decrease substantially further.

We do not know much about consumer attitudes and acceptance. I propose the functional relation shown in Figure 3, where travel cost is related to the convenience of the transportation mode. In other words, what will a passenger pay for a specific level of convenience? What is it worth to him to be able to sit back and read a newspaper on the bus as opposed to fighting the traffic on the freeway? This value would take the form of some arbitrary, ill-defined curve such as the one shown in Figure 3. The curve would vary for different individuals. Perhaps through sociological or psychological studies, we can quantify this value for the average person.

Political considerations can affect the relation shown in Figure 3. For example, a vehicle tax would change the cost in dollars per mile to the individual and would alter the relative effect of price versus convenience.

Morlock suggested a program for research in this area, in which each variable would be controlled individually until the relations could be defined. The problem is that this type of research would take years to complete.

The entire area of convenience versus cost involves research needs that the industry must be aware of. The public, in general, is totally unaware of what it costs to operate an automobile. However, we do not know exactly why transit is considered a second-class transportation mode.

Vigorous lobby activity is necessary to convince those in the political sphere of the necessity for public transportation. I suspect a fair amount of this is being done by groups like the American Transit Association. However, it needs to be a continuing effort.

There is also the semantic distinction between consumer needs and consumer wants. Perhaps what we are really after is the definition of consumer wants. Let us find out what the consumer wants and then try to satisfy him.

Now let us consider equipment. I have divided the subject into 4 areas: interfaces, communications, right-of-way, and maintenance.

I believe that the interfaces are the principal problems with regard to increasing patronage and improving the operating efficiency of transit systems. It has been noted that fare collection is still a problem. Perhaps an automated system like the new BART Central Credit Card System is the answer to this problem. It seems unrealistic, though, to increase fare collection time because this, of course, increases the length of time that the vehicle must be stopped and therefore unproductive. Transfers are a problem, even on the same system, because they affect both the rate schedule and the time it takes for the individual to complete his journey.

The intermode problem is severe in the interface situation, and this affects all of the other problems. An intermode activity is one in which a person transfers between public transit modes or between a private and public mode.

Communication between the system and the commuter is important. At Kent State University in Ohio, a university-supported bus service transports students around campus. At each stop there is a clock that indicates approximately the time interval between buses. Students, by referring to the clock, can decide whether waiting for the next bus is quicker than walking. This system responds to the customer and gives him more options than perhaps any other method now in use.

Communications within the system are also of paramount importance. This area involves such factors as location and real-time analysis of the positions of all the units

in the transportation system. Computer software, which allows the work to be programmed out of it, is needed. It is unrealistic to expect a person to be able to simultaneously manage all of the information that he can get from a computer system. It seems reasonable, therefore, that computers should distill this information into a manageable form. Some real innovation is necessary here as well.

With regard to right-of-way, various schemes have been proposed for traffic control, including bus-actuated signals and separate lanes for buses. Speed is a problem and interacts with control: The better the control is, the higher is the average speed that can be maintained over a given piece of right-of-way. However, it is conceivable that new rights-of-way might have to be built in order to obtain substantial increases in speed.

Safety is also a problem. Lots of steps have been taken in this area, particularly in the rail transit field. Displays have been built in the cab, which indicate to the motorman the distance between him and the next train and what action he should take.

Routing and operation are also very important considerations in choosing a right-of-way. Does it make sense to have all lines funneling down into one arterial street? Is there some optimum way of distributing coverage? Again, it seems that limited analysis has taken place in this area, and this analysis could be augmented to build mathematical models for ideal systems. All of this hopefully then would be computerized so that the system could respond to changes in consumer demands.

The limits of cost of the dial-a-bus are difficult to determine. They involve the number of people to be carried and therefore the size of equipment, which is related to the operating cost. There is also a trade-off with service. However, the most important factor is scheduling. The basic problem is to determine on a real-time, continuously updated basis where to send vehicles, making optimum use of the vehicle and minimizing the transit time of all the passengers. Clearly, more analysis is needed in this area.

Equipment is also an important area. In general, it is very expensive to dress up equipment and make it aesthetically pleasing. No one knows what the real trade-off is between cost and aesthetics. There is a need for additional new concepts, and these have to be carefully evaluated within the given constraints as we proceed. An example might be convertible equipment for multiple uses.

SEMINAR DISCUSSION

Heathington:

An American Transit Association (ATA) committee, in cooperation with Booz-Allen, is working on new specifications for vehicles. I wonder if we might start our discussion with a look at the requirements of a new vehicle.

Schnell:

Simpson and Curtin, a principal consultant on the project, established several basic goals. One goal was to design the bus for expressway travel; therefore, the specification called for a speed of 75 mph, which would give the bus the capability of accelerating up an infinite 5 percent grade. Another goal was to try to cut the passenger loading and unloading times from 3 sec per passenger to 1½ sec. This would be accomplished by decreasing the floor height from 32 to 17 in. For passenger comfort, the consultants suggested the elimination of fiber glass seats.

There were many other suggestions related to speed, comfort, and ease of boarding; however, the costs of these improvements made them impractical.

McDonald:

Was this bus designed for all services or for intercity travel only?

Schnell:

We are talking about a 40-ft bus designed for intercity service. The 40-ft dimension was used because it is the legal requirement in all except 3 states.

Figure 1. Relation between vehicle passenger capacity and operating cost.

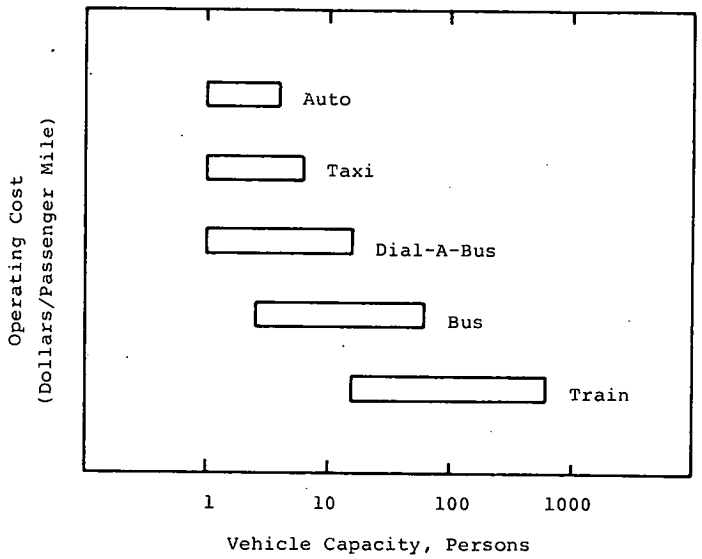


Figure 2. Trend of automobile population as a function of operational cost.

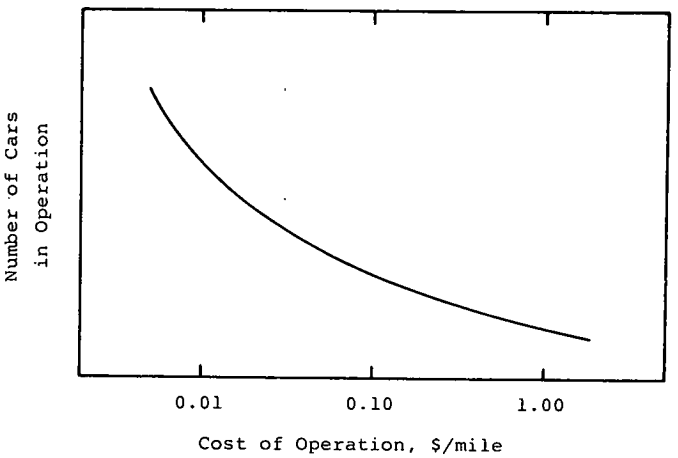
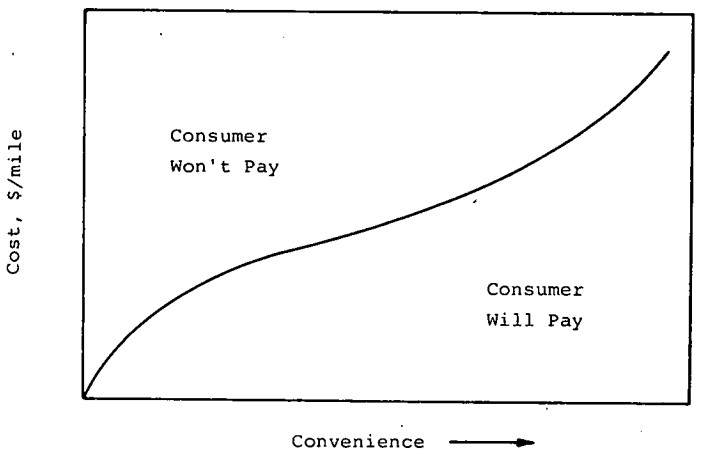


Figure 3. Relation between cost and convenience of service.



Heathington:

Do we have the technology today to build such buses?

Bingham:

One of the goals is to connect the seats to the bulkhead rather than to the floor. The manufacturers indicate that this can probably be done, but we are not certain that the coach construction will hold the weight. This is being done on the BART cars.

Floor height is a problem, but we are going to use power train technology to solve it. We are working on destination signs, a problem that will probably be solved through the use of electronics. In fare collection, the objective is to permit 2 persons to board simultaneously. The front door will be widened, and new hardware will be developed that will speed up fare collection.

Booz-Allen is not confident that a prototype, having all of the improvements, can be constructed by next fall; therefore, the project has been divided into 2 phases. The preliminary model would be delivered in the fall of 1972, and the prototype would be ready by April 1973.

Schnell:

One of the interesting aspects of many of the specification line items is that sometimes the goals conflict. For example, it is likely that the aisle of a bus would have to be made narrower if the seats were widened.

Philosophies of operation vary among cities. What is appropriate for transit operations in New York or Chicago is not necessarily appropriate for operations in smaller cities or in cities having different physical characteristics.

McDonald:

A classic example of poor vehicle design is the F-111. The F-111 was supposed to be a multimission vehicle, but it failed to operate as such. Thus, it would seem that one should design specific-purpose vehicles for specific kinds of service.

Schnell:

There is a lot of merit in specific-purpose vehicles; however, the production of such vehicles has its disadvantages. Last year there were 1,400 buses purchased in the bus industry, a decrease of about 1,600 from previous years. As the number of buses built decreases, the unit cost increases. If bus production is subdivided to allow for the construction of specific-purpose vehicles, the unit price cost increases greatly.

Bingham:

There are 2 types of services that this bus will perform. One is basic transit, workhorse operation; the other is a high-speed freeway express operation. At the risk of oversimplification, I think that the only major area in which the 2 services are incompatible, in terms of bus capability, is in the seating capacity. However, this problem can be solved by the property owners on an individual bus basis.

Scott:

A basic problem that faces the transit industry today is the lack of coordinated effort between governmental bodies at all levels and private industry. Frequently, the absence of such effort results in decisions that are based on only limited information, particularly in the area of determining research priorities and establishing research programs. For example, there is no unanimity of opinion regarding the development of new transit technology. Many experts firmly believe that, before new buses are built, a reevaluation of the role that transit plays in our urban areas is called for. Yet new buses are being built, which indicates that there is an equally strong voice, if not stronger, calling for increased technology. What we need is a forum or program that will allow all views from both industry and government to be heard and considered in solving the many problems that confront the transit industry.

Krambles:

The transit industry operates about 50,000 to 60,000 city buses in the United States and Canada together. Bus equipment purportedly has an average life of 15 years; however, a 10-year life span, I believe, is a more realistic figure. The difference is significant in terms of equipment replacement.

If we replace 50,000 buses at a rate of 5,000 buses per year, we should be able to accommodate the changing needs and desires of the public. It is difficult to believe that the public today wants exactly the same type of bus or transit service that it used 25 years ago.

We are not primarily interested in major changes in bus technology; we are interested in incremental improvements in our current system. If we can implement an improvement quickly, it is to our benefit to take action. By making improvements, we can make transit more attractive to the public.

Again, how many citizens are satisfied with owning a 1957 Ford? Why should they be satisfied with a 15-year-old bus?

Heathington:

I am a firm believer in the replacement of old equipment and the reduction of maintenance costs. However, where does progress stop in terms of improving bus technology? We have already increased the speed and comfort of vehicles many times over. Are we going to be expected to transfer matter instantaneously someday?

McDonald:

I think that most of our problems can be solved by using the modeling technique. Capital costs and performance can be modeled, which allows one to determine operating costs. I do not think that this is a research problem; it is an applications problem. Improvements are needed and can be recommended, but it is up to the individual operators to implement change.

If I understand Scott correctly, he is proposing a NASA-like body in the transportation field. Through such an organization, government-sponsored research, with a vigorous program to direct research outside the government also, would be carried out.

Scott:

I think that this is a fine idea. The decision-making function would be centralized, and the needs of the industry would be given consideration.

Schnell:

Such an organization would probably create some problems, as has UMTA, for the transit industry. For example, bus manufacturers cannot include proprietary items in their specifications for a new bus if UMTA funding is involved. Also, there is the problem of the low bid, which does not encourage the development of new equipment.

Hill:

At one time, there were 11 bus manufacturers in the United States. Because of intense competition among these companies, which has resulted in higher quality products and therefore a decrease in bus production, very few are still in business. One company, General Motors Corporation, dominates the industry. GMC has a very large research department, but it is in the uncomfortable position, because of its monopolistic position in the industry, of having to turn over to other manufacturers the results of its programs. Understandably, this reduces GMC's aggressiveness.

The cost factor is also a serious problem. Local governments that want high-quality equipment are many times forced to accept mediocre specifications because they are using federal funds and therefore constrained to accept the low bid. Overall, I think that we are getting inferior vehicles because of this situation.

Stoner:

Is there a cost ceiling for a new vehicle? For example, if a new vehicle is produced that costs twice as much as the old one, the operating cost per mile would have to be

increased 5 or 6 percent. To cover this cost, the company would have to pick up one more passenger for every 3 miles of operation.

If this new bus did offer the amenities that would encourage an increase in ridership, would the transit industry be willing to make the initial capital investment for the new vehicle?

Bingham:

I would be in favor of such a capital investment. This reflects my philosophy of business, however, and I could be wrong.

I would like to make a few comments concerning the development and production of new buses. Because of the small number of buses being produced, production costs are very high, especially when innovations are involved, and there is general doubt that the transit industry can afford to meet these costs. Further, the manner in which the Federal Capital Grants Program has been administered has perhaps stifled innovation in coach design. UMTA is now trying to solve the problems created by the low-bid policy.

With regard to an industry-government body that would oversee the whole area of public transit, there are now the beginnings of such an organization—UMTA's Bus Technology Committee. This committee works with the transit industry in an advisory capacity; it has hired private consultants to serve as managers of the program. I think that this is an optimistic sign that the government and private industry can work together.

Heathington:

I still think that this is an institutional question. If an automobile (regardless of make or model) does not sell at least 100,000 a year, it does not have a good market. This is not true of transit buses.

So long as there are constraints placed on the transit industry by the government, especially with regard to the low-bid policy, the industry will be handicapped. Perhaps as much emphasis needs to be placed on how to change the constraints as on how to implement new design.

Schnell:

In response to Heathington's discussion of institutional constraints, I would like to make the following comment. If UMTA could adopt legally a policy of $^2/_3$ funding of the base price of the bus, competition would be restored because minimum standards of safety and service could be set. This would mean that transit companies would be in a better financial position to purchase buses having new equipment. However, there is a limit to the amount of capital that can be used for buying new buses. We need a practical, modern, efficient, safe bus that is reasonably priced. I think that it would be a mistake to invest in buses that are "glamorous" as well as functional.

McDonald:

We have spent a great deal of time discussing the bus problem. There are other areas of technology, such as communications, that should be discussed.

We can summarize the bus discussion by saying that there are problems involving lack of competition among manufacturers but that technology permits a solution to be reached. Whether a solution that is economically feasible can be reached is the question.

Heathington:

Communications is an area in which a lot of progress has been made. For example, the Chicago Transit Authority (CTA) has a sophisticated communications operation that deals with 3,600 to 4,000 buses a day.

Of particular interest to me is the area of demand-actuated systems. Communication between the vehicle and the system center is necessary, I think, in this type of operation.

Saltzman:

I am not convinced yet that such systems need direct communication to operate more efficiently; I am referring to the dial-a-bus system. Based on some of the work published by M.I.T., it appears that the advantages of knowing exactly where a bus is located every moment may not be that substantial. In the case of the CTA, such knowledge may be very valuable, but I do not think we can mix different technologies and different systems to form a generalization.

McDonald:

It seems to me that, when dealing with a very small dial-a-bus system, you are probably correct. With such a system, we do not need to know where each vehicle is. However, where computerized scheduling is necessary, for example, in order to make the system operate at its maximum efficiency, locations of the vehicles must be known. Data processing will have to be done at a central location, from which the driver can be given instructions.

Saltzman:

I was not saying that communication between the driver and the control point is unnecessary. Obviously, he has to receive pickup and delivery instructions. What I am questioning is the need for enroute vehicle monitoring.

McDonald:

The point is that, if the system becomes large enough, the driver will have to make these decisions enroute. He will not be able to wait until he gets to his delivery point because scheduling will be continually changing.

Saltzman:

Based on research conducted at M.I.T., having the ability to redirect a driver in the middle of his trip is not very advantageous. In fact, I cannot think of many cases where such an action would be desirable with a dial-a-bus system. How necessary is such a capability with regard to traditional bus operation?

Bingham:

We have never been able to know where all of our buses are at any particular time. We do think that such knowledge would be beneficial. Chicago, with the help of federal funds, is going to experiment with this idea.

Craig:

I would like to comment on this subject from the rapid transit operator's standpoint. The priority for us to know where our trains are has always been high.

We received $700,000 to install train-to-wayside radios to improve communications between vehicles and stations. Emergencies such as the Northeast power failures had convinced us that we needed 2-way communications with our train crews and also between wayside control points and passengers.

After the equipment was installed, we found that only half of it was working at any given time. We went back to our board of directors and requested another $700,000, which was needed to correct operation of the new equipment. Unfortunately, this type of problem is not uncommon when new technology is introduced into an established system.

Heathington:

Would Krambles comment on how the 500-bus demonstration in Chicago is doing under the new vehicle detection system?

Krambles:

The 500-bus demonstration has been in progress for more than a year now. By using this system we can supervise any bus network by supervising selected points

within the network. We do not use continual monitoring; we sample performance at, for example, time points along the route. Locally operated transmitters are installed at the time points. These little transmitters have a low-powered signal that beams continuously toward vehicles that may be approaching. When a bus gets close enough, its receiver picks up the time point transmission and records it along with the time of reception.

On a regular basis the master transmitter at some central location scans the entire fleet of buses very quickly, and it accepts from all the buses a report on their location. This information is received at a central headquarters and is stored in a computer.

The problem at this point in the operation is what to do with all this information. Unfortunately, we will not be able to solve this problem until the technological phase is perfected a little more, especially the data links.

A third aspect of the system is a secret device that allows the bus driver to summon help in emergencies. The device transmits an alarm that is received by the control center.

We would like to include these features in all of our new buses; however, there is still a funding problem. The UMTA federal grants department is not convinced that such features warrant funding.

McDonald:

Why is it much more difficult to operate a communications system on trains than on buses?

Craig:

The Port Authority Trans-Hudson System is a small interstate rapid transit system connecting New York with New Jersey. Based on our studies of similar systems in Chicago and Toronto, we thought that we could implement a communications system without much trouble. However, we have been faced with an equipment quality control problem. The communications equipment, installed at great expense, just has not functioned the way the manufacturer said it would.

Venable:

We at the Indiana State Highway Commission have experienced similar problems with quality control of equipment. Although there is a problem with the low-bid policy when federal funds are involved, we have found that federal agencies are flexible with regard to cost if the safety factor of new equipment is stressed and made clear in our funding justifications.

Hill:

One possible solution is to get the government to accept the best bid instead of the low bid. Or perhaps a combination of the best bid and low bid would be acceptable. We have started to receive federal funds, and the results so far, with regard to equipment quality, have not been satisfactory.

SEMINAR ON RESEARCH NEEDS IN TRANSIT MARKETING

Frank M. Bass, Krannert Graduate School of Industrial Administration, and
Gilbert T. Satterly, School of Civil Engineering, Purdue University

For various product categories, one can collect data that describe the behavior of various groups of consumers in terms of average purchase rates in a given segment of the market. These data would provide an answer to our first question, that is, Who buys the product? The second question, more difficult to answer, is, Why do they buy the product? At this stage in the development of marketing we would like to know why people behave as they do, why they make one choice as opposed to another choice. Not much, however, is known about this subject.

One approach to solving the problem has been developed recently. It consists of studying specific properties of the product and measuring consumer attitudes with respect to those specific properties. If toothpaste is the product, for example, the consumer's conception of the toothpaste's properties, as they concern such things as decay prevention, teeth whitening, and taste, would be studied in order to determine the relative importance of each property. For example, how important is taste relative to teeth whitening or relative to decay prevention? How do consumers perceive the alternative brands with respect to each of those properties? You could think of this also in a public transportation context. What are the relevant properties of public transportation from a consumer's point of view? How important are properties such as convenience, speed of travel, and price? How are the alternative forms of transportation perceived by consumers? This approach might provide data that can be used to modify a product or to give consumers information through advertising.

Work in marketing has been extended to look at choice as opposed to just preference; however, the problem is somewhat more difficult. It is more difficult to predict what consumers will actually do than to determine what they say they prefer. Nevertheless, we can make significant predictions of what people will do, i.e., their choices, with information of this type, i.e., the perceptions of the individual attributes of the product category. It is possible to determine something about what consumers want with respect to individual properties of products. This has been done with automobiles, industrial equipment, and airline travel. The marketing problem then is to try to adapt the resources to satisfy consumer wants. First, the consumers' needs must be determined, the properties of interest identified, and the motivation understood. Then this information must be translated into action.

Product satisfaction is a category of some importance in terms of initial purchase. There is also the issue of the repeat purchase. Basically, I think that most marketing professionals believe that it is possible, if enough money is available to spend on completely new ideas, to induce initial purchase. However, repeat purchase is much more difficult to obtain and predict because it depends crucially on the consumer's experience with the product. Consumer attitudes and perceptions of the properties of the product are critical, and ultimately experience is a more important determinant than is marketing. Advertising cannot overcome a poor product or a product that consumers do not like. Therefore, if you have a fixed product, it is very difficult, if not impossible, to modify consumer attitudes without changing the product. The product itself, not advertising or marketing, is of primary importance.

SEMINAR DISCUSSION

Heathington:

Let us assume that I operate a public transportation system and that I wish to improve service, for example, by increasing the frequency of headways and by purchasing new equipment such as air-conditioned buses. Should I promote the new service before it begins operation? Or would such promotion be self-defeating (if new customers find the old service discouraging and quit before operation of the new service begins)?

Bass:

A railroad is now offering service to Florida whereby the passenger can ship his automobile on the same train that he rides. This service has been so popular that the railroad is unable to meet the demand. As a result, the railroad is running an advertisement that informs the public of future increased capacity of that service. Quite often early demand is underestimated in a new service. Then if the product succeeds, another type of mistake is sometimes made; i.e., the potential market for the product is overestimated.

Maxman:

In Louisville we initiated an express bus service from the south end. For a couple of weeks prior to the beginning of the new service, we advertised by means of public service and news reports on radio and in newspapers. We also distributed pamphlets and schedules and put up posters and signs to make people aware of the new service. We found that ridership increased on the existing service, especially the day before the express bus service began. In the morning about 600 people per day utilized the existing local service. The day before the express service started, the number went up substantially. The express service, which has only been in operation for about 2 or 2½ weeks, has added approximately 100 new morning riders to our patronage. It seems as though marketing has helped in making people aware of transit service.

Bass:

Where consumers have an awareness of a product category, they generally think about the product even if they do not purchase it. There are a few examples where clever advertising has in fact rejuvenated the sales of a declining product.

Couts:

Some of the attributes of transit trips are door-to-door time, walking time, number of transfers, waiting time, cost, and comfort. An important difference between transit and grocery products, though it might not be a complete distinction, is that with transit the product defined by these attributes is different for everyone. For example, walking time to the nearest station depends on where the individual lives.

Bass:

Are you measuring consumer perceptions of these properties?

Couts:

We use revealed preference rather than attitudes. We determine the locational characteristics of consumers, the reason for trips of various purposes, and demographic facts.

Bass:

So you know who your customers are and what their behavior is in terms of the extent to which they use the service.

Couts:

Yes, it's what they do that we take as being expression of behavior, not what they state their preferences are.

Millar:

Dr. Bass, is there any general relation between consumer preference and consumer choice?

Bass:

If the preferences of the consumers are known, one can make statistically significant predictions about their choices. The accuracy of the prediction varies from product category to product category. In general, for product categories in which consumers' attitudes differ very little among alternatives, predicting individual choice based on preference measures is very difficult.

People do not necessarily always want to do the same thing. There is a stochastic element to choice behavior. For those product categories in which the stochastic element is greatest, predictions based on preferences are not very reliable. A much better job of predicting can be done if one takes as a measure of choice the relative frequency of purchase or relative frequency of choice over a given time span. If one has measures of preference that are scaled such that it is known how much more "x" is preferred to "y," then a fairly decent job can be done of predicting the relative frequency with which "x" is chosen as opposed to "y."

Hobeika:

In my opinion, there is an inherent disadvantage in marketing public transportation because we are offering a product to consumers who differ in tastes, wants, and willingness to pay for the product. Should we divide the market into different groups of consumers and then try to meet each group's demands with different products at different prices?

Bass:

Yes, this was part of the idea that I wanted to get across. It seems to me that our current viewpoint with respect to marketing transportation is perhaps a bit narrow. I think that you are suggesting that it might be broadened a bit. I wonder to what extent it might be possible for public transportation agencies to have different products. For example, I wonder why public transportation companies do not get into the rental car business. Such a system is working in France.

Bingham:

Suggestions of dial-a-bus service are made from time to time. The rental car concept in the context of public transit is new to me. Perhaps the reason that we have not pushed in these areas of service is that the primary job of transit is to move large numbers of people in areas of heavy population concentrations. I am admittedly thinking in terms of large urban areas. I am not thinking of, for example, Lafayette.

In the large urban areas we have not felt, at least up until this time, the need for something other than a conveyance that can accommodate a large number of people generally going in the same direction. There has been some discussion at this conference of at least two of the immediate needs of the transit industry, retention of current passengers and conversion of automobile users to transit.

What will we have to do to achieve this? We will have to change the ride that we are currently providing in one manner or another. I submit that we are willing to do that but that we do not have sufficient information on which to base a decision.

Bass:

It seems to me that the problem is basically one of a shortage of customers. Those who are not using transit are basically rejecting the product.

I do not believe that marketing can be effective in the long run if the product itself is not changed. One must start with a knowledge of the consumer, what he wants and what his alternatives are. For example, whether to put on a new train for a certain area at a certain time depends on the market demand, which is a very specialized kind of knowledge that probably is only attained after the service has been made available.

Bingham:

This is an approach we have been using for some time. Based on public response, through phone calls or letters, and patronage, we decide whether to retain the service. However, this is not the best form of research. To justify experimental efforts, especially with the use of public funds, we need more information on which to base our decisions and with which to persuade policy-makers to cooperate.

Bass:

Collecting such data is a very difficult job, particularly when there is no opportunity to simulate service in an experiment. People do not always do what they say they will do. In product marketing, for example, only 20 percent of the new products introduced are successful, and there is a lot of commercial research that precedes the introduction of new products. So the fact is that, even with a great deal of money and considerable expertise, the success rate of new products is not very great. You can certainly get information that will be suggestive of success or failure, but I think it's asking too much to expect that information to be extremely reliable. This is especially true with regard to train service, where experimentation is limited.

Heathington:

Let's look at the differences between marketing public transportation and such products as television sets. A television manufacturer may market a whole series of sets from the large cabinet model color set to the small, relatively inexpensive, portable black and white set. Each part of the line of sets is aimed at a different group of consumers of the product.

We have a different situation in the transit industry. The philosophy of the industry in the past has been to not offer a wide range of public transportation products to meet the consumers' needs and desires.

About a year ago General Motors studied cost models for supplying certain levels of service. We found that we could make a profit with a dial-a-bus type of activity. The level of service would be very high, but the number of people served would be very small and the price for the service would be very high. If we tried to perform the usual function of public transportation, that is, move a lot of people, we would lose a lot of money. We could move a lot of people, but to attract a large number of people to the service the price would have had to be low, which made it impossible to meet costs. The dial-a-bus service has a high level of service but also a high cost.

What makes marketing difficult in public transportation is that we are attempting to meet the demands for transportation of the whole market by using a single product line. The market contains groups having a wide diversity of transportation needs, yet the transit operator is constrained by the group that can only afford to (or is only willing to) pay for low-cost, low-level service.

Hill:

I think that the transit industry's big problem is in the type of service that can be merchandised to the so-called mass category of riders. The industry does a relatively good job in certain locations of merchandising separate features of service that constitute really a small part of the total program. For instance, in San Antonio we operate successfully a Grey Line franchise. We also have sight-seeing services that are rendered in various fashions. For charter service, we operate special vehicles with baggage compartments to handle certain group movements from the airport or from military bases. These categories of service have been used in other places profitably, but the big problem is to attract the mass rider. Providing service to the mass rider is what constitutes the backbone of the business. Our problem is competition with the automobile and its convenience and accommodation.

Bass:

If the product's function is to move masses of people, the question is how can that product be modified? What services can you offer? And how can you make that product

compete with the alternatives? I think you can get information about this by studying consumers. In the end a product is going to be accepted on its merits.

Stoner:

Is marketing the short-term answer to the transit industry? For instance we do have a transportation industry that has a great deal of product differentiation at this time. However, even if we improve transit service to the point where there is little product differentiation between automobile and transit, will this be enough? Does the automobile industry so control the demand for transportation that we must aim our marketing efforts only at the captive rider and not attempt to gain new riders?

Bass:

You have a great deal more confidence in the ability of demand manipulation than I do. I think that the public's choice of transportation mode is not influenced so much by advertising as it is by the experience of the consumers.

Your last point was that the market is being shrunk to the point where the only people that use public transportation are those that do not have alternatives. Is there anything that you can do by way of advertising to induce people that do have alternatives to use the service? The answer is that you can get their attention and perhaps get them to try it, but ultimately whether they continue to use it is going to depend on their experience with it.

Heathington:

In the Watts area in Los Angeles, California, after the riots a few years ago, a public transportation system was instituted to enable people in that area to take advantage of job opportunities. As soon as their income went up, they purchased automobiles and they no longer rode public transportation to work. Apparently the level of service on public transportation as perceived by the workers in Watts was not of the quality to attract them to be permanent riders. The level of service provided by public transportation is going to have to change if new riders are going to be attracted to the system.

Herman:

In reference to the need for transit research data, the transit industry lacks the funds necessary to gather significant information. For example, the interrelation of product attributes (and their effect on ridership) needs to be studied further.

Craig:

We provide a product that is a service not a commodity. In looking at how we should market transit, we have to recognize that it is a time-oriented product. A person decides among transportation alternatives at a specific time and place.

We probably have a small number of captive riders on our rail transit system. Because our riders and potential riders have alternative modes of transportation available to them, we are now carrying one-third the number of people that we carried in 1927. I think we have to kill the captive-ride myth. Of the 145,000 daily rides that are made on our system, I doubt that more than a few thousand are made by captive riders. The remainder of these rides are a result of the public choosing among alternatives.

We are trying to make the option of public transportation preferable to more and more people, and we have been reasonably successful. We are now carrying 15 percent more people than we were 4 years ago with almost no changes in the geographical coverage of the system. We have a new fleet of rapid transit cars, and our fare structure has remained stable. Another factor in our favor has been that the privately owned transportation carriers have raised their fares.

Bass:

Apparently, the appropriate number of potential transit users is known. These are people who have rejected transit on the basis of prior experience. The best evidence indicates that the way to deal with these people is to get them to have experience with

the improved public transportation product. In other words, have them sample the product again.

One possibility is to offer free transportation for a week. This is rather an obvious idea, but the public's experience is really what counts. If the consumer is satisfied with it, or likes it relative to the alternatives, then the consumer will choose to utilize the service. Another possible marketing device for public transportation is to try to identify potential consumers who do not have recent experience with public transportation and induce them in some way to try it.

Heathington:

Are transit companies currently using ideas such as the fare-free ride to induce patronage?

Bingham:

At the present time, we have arrangements with all the Welcome Wagons in our area. When a representative calls on new residents, he gives them literature on public transit including route maps and several free passes. Although we do not have a mechanism for determining the reactions of new residents to transit, many free passes are used. It is a good program, but we are unable to support this opinion with facts and figures.

In the past, we have worked on improving transit and then attempting to promote it through regular advertising channels. Our ridership has gained appreciably during this period, but there is still room for much improvement. We need to do more research on the transportation needs and desires of the public.

Hill:

We contact each residence or traffic generator that is located within a quarter of a mile on each side of the route of a new service extension. We provide the resident or generator with a map of the system, a schedule of fares, and 2 free tickets. Although this has had a good effect, more needs to be done in promoting the availability, attractiveness, and convenience of the service. We must also get cooperation from the various highway programs.

Morlok:

It seems to me that there have been a number of trends during the past 20 years that have influenced greatly the demand for transportation. One of these trends is the increasing decentralization of land uses in urban areas. The older centers of cities have essentially remained static or dropped in total population and in total level of activity. Most of the growth has occurred in rings around the center cities. Secondly, the amount of travel to and from central business districts in most cities along radial routes has remained virtually constant since World War II. In small cities this is no longer the case, but this holds true in the larger SMSA's. In a few, the total amount of travel to and from the central areas has actually declined.

Along with this central constancy in the number of trips to and from central areas, there has been a change in the time pattern of those trips. There are far fewer trips now spread throughout the day, and most of the trips are concentrated during the peak hours. However, the bulk of the travel increase has really been in a very diffuse pattern throughout urban areas, with people originating in a suburb and perhaps going to another suburb or going to a place not in the central business district. It is this type of trip that transit has not been able to accommodate or capture, especially in large cities.

It seems to me that, unless we try to provide public transit service for the diffused pattern of trips, we are faced with trying to capture a larger and larger fraction of essentially a static market that is declining in importance in urban areas.

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