The Ann Arbor Transportation Authority has been practicing transportation system management since 1973. The most important program element is the incremental implementation of demand-responsive services that operate in close coordination with the line bus system. Ridership has tripled during the past 3 years. Management of such a system is difficult. Political leaders are not easily satisfied; some want a high-efficiency, high-capacity line bus system; others want a small, stable, unchanging system. Neither side can always accept that constant incremental change is the proper way to achieve the desired end state. The Ann Arbor Transportation Authority must also work with other transportation agencies to ensure coordination and within its own staff to maintain the momentum that has been responsible for its success.

This paper describes the Ann Arbor Transportation System and the planning philosophy behind that system as it relates to TSM.

Transportation systems management has been defined as a means of getting the most out of the existing transportation system. In the urbanized area served by the Ann Arbor Transportation Authority, TSM includes the usual traffic operation improvements in the street network plus a coordinated transit and paratransit (dial-a-ride) emphasis in the public bus system. The objective of the Ann Arbor public transit system is to incrementally increase the use of public transit and other high-occupancy vehicles. While dial-a-ride service is a possible supplemental project in some large urban systems, it is the transit system in Ann Arbor.

Ann Arbor has had a dial-a-ride system operating since 1971. Since passage of a special property tax for transit in 1973, dial-a-ride has expanded its role and ridership so that it is now totally integrated with line bus service within the Ann Arbor Transportation Authority operation. Weekday service provides for coordinated transfers between dial-a-ride collector-distributor vehicles and line buses at several points within the system.

Dial-a-ride as a marketing element in Ann Arbor’s program has helped the authority secure a dramatic increase in ridership during the past 2 years. Staged incremental implementation of small areas has allowed the introduction of dial-a-ride with a relatively high degree of reliability and minimum disruption. As a planning element, it has opened up a much broader range of service options, which are being applied selectively with changing demand patterns in the city.

Paratransit represents a range of service options, from adding a vehicle to the service with no visible changes to shifting to a different mode of operation. Thus, paratransit, if correctly applied, is TSM without an end point and without need for project definition beforehand. All of our transit improvements thus fit the TSM category. Paratransit is demand responsive in two senses: in the commonly accepted definition of a service mode that has a dynamically routed vehicle and also in a broader definition of a system that itself is dynamically planned to allow changes in service mode based on evolving demand patterns. By continually modifying our system to meet new demands, we are continually practicing TSM.

TSM also emphasizes efficiency in management and intermodal cooperation at a local level. As practiced by Ann Arbor Transportation Authority, this means keeping the professional staff alert to and responsive to new ridership opportunities and higher efficiencies. Externally, the authority must cope with a wide spectrum of local political opinion, must balance the public expectations for dramatic new services with demands for reduced public expenditures, and must work cooperatively with other public agencies to implement TSM projects. These activities and some of the underlying philosophy leading to these activities are described below.

BACKGROUND

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

The transit service that operated from 1969 through 1973 consisted of 6 fixed routes, radial to the Ann Arbor central business district, operating on 30-min peak and 60-min off-peak headways. Coverage was limited to the city of Ann Arbor, and weekday-only service operated from 6:30 a.m. to 6:15 p.m. Annual operating budgets during those years were typically $400 000 to $500 000; half of the budget was derived from fares and half from the city’s general fund on an annual appropriation basis.

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

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

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

Since 1973, the Ann Arbor Transportation Authority has hired a new management team, expanded from 30 employees to more than 200 employees, added 80 new vehicles to the existing fleet of 20, and embarked on a substantial facility construction program. Ridership has grown from 677,000 in the fiscal year 1972-73 (just before the election) to 1,814,000 in fiscal year 1975-76. Throughout this growth period, the transit system continues to operate within the budget.

DESCRIPTION OF PRESENT SERVICE

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

Dial-a-ride zones are operated with one, two, or three vehicles on a fixed-schedule tour dictated by the connection with the line bus at a transfer point. Seven such weekday dial-a-ride zones feed this loop route. The loop buses operate in both directions at 15-min peak and 30-min off-peak headways. Central business district routing serves the retail sectors, University of Michigan main campus, and the hospital area.

The weekday system also includes radial routes in Ann Arbor, each slightly different in nature. All operate at 15-min peak headways and 30-min off-peak headways. All serve the CBD activities mentioned above. All fixed-route vehicles travel a common route through the CBD and exit on a paired route from the opposite end.

On the radial routes, some dial-a-ride zones actually feed two transfer points. There are nine outlying zones, whose boundaries and connectivity patterns are based on local trip generators (schools, shopping centers) and geographic constraints.

For neighborhoods close to the CBD, there is dial-a-ride service directly to the major generators in the Ann Arbor CBD, including retail trade, the University of Michigan main campus, and the large medical complex. These same generators are served by the downtown routing of all lines. There are four such close-in zones. Thus, the total number of weekday dial-a-ride zones is 13. 7 on the loop route, 2 on radials, and 4 close in.

The resulting weekday system provides doorstep pickup by dial-a-ride, connections to line buses serving all parts of the community and major generators, and doorstep delivery in neighborhood areas if transfers are made off the line bus at a transfer point. It is thus possible on this system to reach any point inside the city limits.

On weekday evenings, most line route operations cease after 6:15 p.m. The city is then covered by citywide dial-a-ride operations on seven radial zones, all converging on the CBD. Crosstown trips are served by a single transfer at the CBD. Tours are 1 hour with two or more vehicles per zone, with effective mean headways of 30 min in each zone and doorstep pickup and delivery. Calls are accepted until 11 p.m. The last trips are dispatched at midnight.

Weekend service is also provided by citywide dial-a-ride operations similar to those on weekdays, except that Saturday line bus service connects the CBD with two major shopping centers on the edge of town. Hours are 8 a.m. to 11 p.m.

The Ann Arbor system also includes specialized service to handicapped passengers in vans equipped with wheelchair lifts. These are dispatched as citywide, many-to-many dial-a-ride vehicles.

TRANSPORTATION SYSTEM MANAGEMENT AND INCREMENTAL IMPLEMENTATION

The past emphasis on long-term (15 to 20-year) planning has been helpful in giving information and cost estimates to decision makers, but has been of little help in responding to short-term (2 to 5-year) changes in demand on the system and has even had some negative results. For example, in transit planning, technology and high-capacity systems have received much emphasis, but they often make the improving of existing systems appear undramatic. TSM is now emphasizing these changes in transportation systems. Ann Arbor was an ideal place to launch an incremental program in 1972-73. Significant public opposition to new street thoroughfares had solidified. The Ann Arbor Transportation Authority had formed a far-reaching, ambitious statement of goals that called for a public transit system capable of competing with the private automobile in cost and convenience. And dial-a-ride had, through a small demonstration in one part of the city, captured the imagination of many.

After the 1973 millage vote, the Ann Arbor Transportation Authority's implementation of services was deliberately slow. The implementation plan might best be described as programming to meet objectives rather than implementation in the sense of a single major capital project. Each new dial-a-ride zone has been phased in according to a plan originally adopted in 1973. Although the coverage has only been slightly modified, the dates have been continually pushed back to allow for adjustment based on experience so that the full plan described at the time of the April 1973 millage election was not in place until almost 3 years later.

The point of such painstakingly slow implementation is the ability to adjust, correct, and modify each area before proceeding to the next. New staff can only be hired and trained at the rate of three to four persons per week. Equipment deliveries (vehicles, radios, and telephones) have often governed implementation dates, particularly long delays between March 1974 and January 1975. Even at this slow rate, there is criticism from within the organization that we are often not "polished" enough before proceeding to a new area. The operating staff and the union are usually interested in delaying each implementation step as long as possible in the interest of quality control.

Disadvantages of staged implementation include inequitable service delivery (all citizens pay taxes from the outset but do not receive service at the same time) and loss of enthusiasm and momentum. However, we believe that the benefits of staged incremental implementation outweigh the costs. Certainly Ann Arbor services, while not perfect, are operating at a better level of quality than some of the more dramatic "all-at-once" implementations.

INTERNAL MANAGEMENT AND POLITICAL RELATIONS

Technically, incremental changes with a dial-a-ride
The goal of personnel management has been to establish and maintain within the organization a creative and innovative atmosphere in order to continually change, adjust, and add to our basic services. Management is aware that, if the system stops changing at the end point previously described, then capacity constraints will cause ridership growth to stagnate and policy goals will not be met. Dial-a-ride must, in this case, be viewed as a marketing tool used to encourage patronage sufficient to justify the addition of incrementally higher capacity components of the system.

With the growth of the organization, however, has come bureaucratization and growing resistance to change internally. This resistance is increasing as the original dial-a-ride plan nears full implementation and is especially evident with attempts to initiate small service changes which they may lead to more significant changes in the long run.

A recent example is the initiation of a daily chartered service for employees of a company that relocated just beyond the Ann Arbor city limits in a corridor that is experiencing greater urbanization pressures. Regular fixed-route service was programmed to begin in 3 years in that area, and work subscription service is a para-transit option that is also programmed for the near future. The opportunity was thus taken by the Ann Arbor Transportation Authority management to explore both services with this relatively minor (8 to 10 passengers/day) operation. An added benefit was that the employer covered the marginal operating costs. The operation staff, however, was reluctant to undertake what it saw as a tangential, dead-end project, and much of the planning time was spent convincing operation staff that the project had some value.

The point of this story is that the nature of the organization must parallel the nature of the transit system. In the case of the Ann Arbor Transportation Authority, the desired nature of the transit system is one that will nurture and develop higher and higher demand and then dynamically respond with higher and higher capacity modes. If the organization becomes complacent, the system will stop growing. Ann Arbor Transportation Authority management is, therefore, constantly working to maintain a steady state of change within the organization.

An important part of TSM is a focus on intermodal cooperation at the local level. In the case of the Ann Arbor Transportation Authority, this is accomplished through the local transportation planning agency, the Ann Arbor-Ypsilanti Urban Area Transportation Committee (UATC). This agency is essentially a small metropolitan planning organization, in which representatives of two cities, eight townships, the Ann Arbor Transportation Authority, the county road commission, and the county planning department meet to formulate local transportation plans. In the recently approved 1990 plan for the area, transit is given a major role.

Evidence of local intermodal cooperation is the participation of the Ann Arbor Department of Streets, Traffic, and Parking (STP) in the authority's traffic-signal priority system (STP is installing all on-street equipment and is responsible for setting signal phases) and the new downtown "transit spine" (STP is handling all parking meter removal, signs, and painting). Each of these projects is listed by both the city of Ann Arbor and the Ann Arbor Transportation authority as a current TSM activity. The cooperation is possible only as long as both parties take care to see that traditional roles are preserved, credit is awarded fairly, and no serious disbenefits to either result from implementation.

Two related problems of public opinion have become evident in this community: Having had policies clearly established that heavily emphasize public transit, the public tends to be impatient. The 1990 plan suggests a high-capacity facility, and the people clearly want the benefits to be derived from it. Yet, the system operating today does not seem close to having the capacity or efficiency to achieve the goals, and the ridership growth, although dramatic in relation to previous transit ridership, still has not made the modal-split gains desired. Conservatives see small buses as inefficient and wasteful; liberals want a highly visible, high-capacity system; and neither fully accepts that we must speak in terms of communitywide behavioral change, a slow process, to achieve both efficiency and societal benefit.

The second problem is that many feel that continual change, even though it may be in the right direction, means that the system is never really definable and never really becomes stable. People want change but prefer to experience change from one stable system to another stable system, which then becomes a part of a predictable world. Thus, despite statistical evidence to the contrary, there are those in this politically aware community who feel that the system has failed because it continues to change. From the standpoint of management, maintaining the ability to change is a mark of success since the goal is ever-increasing demand that creates a need for higher capacity transit system elements.

**PROCEEDING INTO THE FUTURE**

Dial-a-ride service has a definite ongoing role in the program of the Ann Arbor Transportation Authority. Our 1990 plan, completed in 1976, calls for an extension of the coordinated dial-a-ride and line bus concept to all parts of the urbanized area. This, of course, will require additional sources of local funding, either similar to the city of Ann Arbor property tax or perhaps a regionwide replacement of that tax. There is a feeling among those responsible for formulating the 1990 plan, including elected officials, that the doorstep service provided by dial-a-ride is an important part of an increasing emphasis on public transit (and away from private vehicles). There is also a role envisioned for dial-a-ride in providing rural transportation to mobility-deprived persons in the Ann Arbor Transportation Authority's service area. We also intend to add other paratransit programs such as van pooling and "transportation brokering" for specialized transportation needs.

In the matter of relative emphasis, Ann Arbor follows the thesis that, with increased demand density, new fixed-route services are justified and the relative importance of dial-a-ride, in terms of number of riders and number of dollars allocated, decreases compared with line service. There are now plans for adding fixed-route service in established dial-a-ride areas and to add five major regional fixed routes during the next 5 years.

The difficulty in making such a shift in emphasis toward fixed-route operation is primarily one of timing for implementation of a particular route. There is no clear signal for the addition of either fixed-route service in a dial-a-ride area or new service in an urbanized corridor. The first small increment in serving an urbanizing corridor was discussed in the preceding section of this paper. Similarly, the analysis that led to the inclusion of a "flyer" service suggested the need for a small incremental change. That analysis showed a short-term peak of demand density high enough (in theory) to justify a fixed-route addition to the southwest
area. The options were to add more capacity to the area with an additional dial-a-ride vehicle in the peak hour or to add a fixed route with higher incremental capacity but also with the risk of not being able to attract the passengers to fill that capacity. A single fixed run fitted to the demand patterns (established through dispatching records) was added in the morning peak. This decision was shown to be justified by a resultant voluntary diversion of approximately 25 passengers, allowing a reduction in dial-a-ride service hours in the area with no reduction in service quality. Dial-a-ride demand is being watched closely in the southwest area to determine appropriate timing for expansion of the fixed-route service.

PROBLEMS OF PACKAGING TSM ACTIVITIES: DIFFERING OBJECTIVES, CONFLICTS BETWEEN ACTIVITIES, AND INSTITUTIONAL PROBLEMS

Roberta Remak
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This paper addresses the problems of selecting effective combinations of TSM activities in light of the broad and sometimes conflicting transportation goals to be achieved and considers some of the institutional implications of programs calling for the cooperation and approval of several public agencies and private organizations. Various federal and state programs and special local concerns represent a number of different social, environmental, and energy-conservation objectives that can be affected by a TSM program. No TSM activity can meet all of these objectives equally well, and local planners must evaluate the proposed program in terms of one objective and then another to select the combination of activities that offers the best compromise. Both the feasibility and impact of individual TSM activities can be radically changed by being implemented at the same time. Some function more effectively in combination, and others work against each other. The TSM program must be evaluated as a whole to ensure that necessary supportive activities are included and that incompatible combinations are avoided. It is necessary to establish an institutional framework for incorporating all of the concerned agencies and organizations into the TSM planning process and to coordinate the action programs of participating public and private institutions.

In a study of peak-period traffic congestion performed under the National Cooperative Highway Research Program, a number of techniques were identified that could be effective in reducing peak-period congestion, particularly those representing alternatives to capital-intensive solutions such as new rail rapid transit facilities or expansion of urban freeway systems. Techniques operating on both the supply and demand aspects of the congestion problem were included: those that increased the carrying capacity of the existing road system and those that reduced the number of vehicles on that system at peak commuting times. These ranged from technical approaches to improve transit operations and traffic control; social approaches to modify commuting times by staggered and flexible work hours; socioeconomic approaches of road pricing, parking controls, restricting vehicle access, car pooling, and modifying land use patterns; to a sociotechnical approach of substituting communications for travel to work.

During the course of the study, it became apparent that none of the 17 individual techniques had the potential for solving the peak-period congestion problem or for making more than a modest improvement to traffic flow. But it was found that their effectiveness could be improved, substantially in some cases, by implementing them in combination with one another. In fact, some techniques proved to be useless unless accompanied by another. As an example, peripheral parking lots will not attract many users unless some transit shuttle and CBD circulation service is provided.

Out of this recognition of the interdependence of congestion-reducing techniques developed the concept of "packaging" groups of compatible techniques to be implemented within a coordinated program. Although the objectives of the transportation system management (TSM) program are broader than reducing peak-period traffic congestion, many of the optional TSM activities and the congestion-reducing techniques are identical and both types of programs present similar problems of carrying out joint efforts involving a number of different agencies and organizations.

Our current research is focused on the institutional problems of implementing these packages. The project is still in its beginning phase, but we have identified some common types of institutional barriers and have developed some tentative approaches to dealing with them. This paper primarily addresses the problem of selecting effective combinations of TSM activities in light of the broad and sometimes conflicting goals to be achieved, but it concludes with a consideration of some of the institutional implications of programs involving several agencies and organizations.

DIFFERING GOALS

Only within recent years have we come to recognize not only that the several components of an urban transportation system—roads, transit, parking, bikeways, and pedestrian facilities—are interdependent but that transportation resources themselves affect and are affected by local economic and social conditions, land use patterns, physical environment, and national energy resources. Increasing responsibility has been placed on those who provide local transportation facilities and services to consider not only the internal efficiency of their particular operation but its impact on the rest of the transportation system and the community at large.

Various federal and state programs as well as special local concerns represent a number of differing goals to be achieved through improvements to urban transportation. These goals are not always compatible. A goal of mobility for those without access to private automobiles because of age, health, or financial circumstances may be in conflict with a goal of minimizing needs for public subsidy of transit services. Measures that improve traffic flow may encourage people to drive their automobiles to work and thus increase fuel consumption. Localized air pollution problems may be relieved by an automobile-restricted zone but add to traffic congestion on adjacent streets.

No TSM activity or combination of activities can meet all goals equally well. The task facing local designers