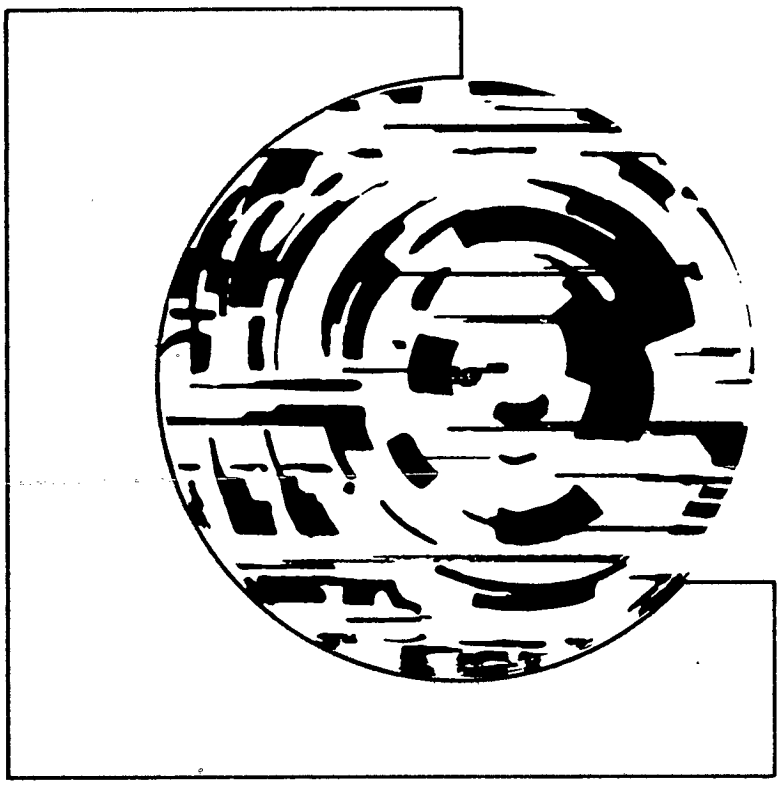
Urban Transport

Service Innovations

SPECIAL REPORT 184



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Urban Transport

Service Innovations

SPECIAL REPORT 184

This report contains the proceedings of a conference sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, in cooperation with the American Public Transport Association, the International Taxicab Association, the California Department of Transportation, San Diego Transit, and Airport Ground Transportation, and conducted by the Transportation Research Board, December 5-8, 1977, in San Diego, California. It also includes a group of papers presented at the 57th Annual Meeting of the board, January 16-20, 1978, that are relevant to the topics discussed at the conference.

Transportation Research Board
Commission on Sociotechnical Systems
National Research Council

NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C. 1979

Transportation Research Special Report 184
Price $7.80
Edited for TRB by Frances R. Zwanzig

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Library of Congress Cataloging in Publication Data
Conference on Urban Transport Service Innovations, San Diego, Calif., 1977.
Urban transport service innovations.

(Special report–Transportation Research Board, National Research Council; 184)
1. Urban transportation–United States–Congresses. 2. Urban transportation–Canada–Congresses. I. United States. Urban Mass Transportation Administration. II. National Research Council. Transportation Research Board. III. Title. IV. Series: National Research Council. Transportation Research Board. Special report–Transportation Research Board, National Research Council; 184.
HE305.C62 1977 388.4'0973 79-11336
ISBN 0-309-02817-5

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Preface

This Special Report includes the proceedings of a Conference on Urban Transport Service Innovations held December 5-8, 1977, at San Diego, California. The conference was conducted by the Transportation Research Board and sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, in cooperation with the American Public Transport Association, the International Taxicab Association, the California Department of Transportation, San Diego Transit, and Airport Ground Transportation. The report also includes a group of papers that were presented at the 57th Annual Meeting of the Transportation Research Board, January 16-20, 1978, in Washington, D.C., and are included because of their relevance to the topics discussed at the conference.

The board owes a special debt of gratitude to the Research and Development Center, Canada Department of Transport, and in particular to S. Ling Suen for her assistance on the steering committee and for the financial support that her agency gave to this effort.

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Introduction to the Conference Proceedings

David W. Jones, University of California, Berkeley

This volume amounts to a progress report on paratransit. The papers published here include some that were presented at the Transportation Research Board's Conference on Urban Transport Service Innovations in San Diego, December 5 to 8, 1977, and some that were presented at the Fifty-seventh Annual Meeting of the Transportation Research Board in January 1978. They review both American and Canadian experiences with shared-ride services such as car pools, van pools, shared-ride taxi services, subscription bus services, and dial-a-ride and demand-responsive services for special-need groups.

One common characteristic of these services is their ability to respond flexibly to the spatial patterns and temporal rhythms of travel demand. Another common characteristic is a recent record of increased interest and relatively rapid program expansion. The pace of recent developments argues that this is an appropriate time to review the performance of shared-ride programs and the direction of paratransit innovations.

The San Diego conference was not structured as a debate about the future of paratransit, but debate is what emerged in a subtle, muffled kind of way. That debate—or dialogue—focused on the appropriate next steps in the development of a national policy stance toward paratransit planning and financing.

Because this debate occurred in part off camera and was not structured by the frontal juxtaposition of rival proposals, the discussion of positions and points of view that follows necessarily involves some reportorial liberties in interpreting the positions of the conference participants. But, by taking those liberties, it is possible to identify three rival proposals for a national stance toward paratransit policy that were advocated, at least implicitly. These can be characterized as

1. Vertical and horizontal integration of transit and paratransit services,
2. Deregulation and entrepreneurship, and
3. Local flexibility in the context of full federal accreditation.

The argument for vertical and horizontal integration of transit and paratransit services rests on the merit of service coordination, integration, and consolidation that is imposed by the need for service connectivity, continuity, and reliability. It sees the conventional transit operator and unionized transit labor as the providers of community-level and social-service transportation that complements arterial and corridor transit. It envisions a system in which paratransit would operate as a feeder system to arterial services, van pools would be capitalized to extend service to peripheral suburbs that are difficult to serve with conventional transit because of extended route length and low labor and equipment productivities, and demand-responsive services would be provided for elderly and handicapped persons. Control of operating subsidies would be retained by the transit property and union job rights would be preserved, but in the context of negotiated special contracts adapted to paratransit operating regimes. This paratransit agenda posits that service innovation and delivery should be managed by the same agencies that provide conventional transit service.

The argument for deregulation and entrepreneurship begins with the proposition that many paratransit services have poor track records when cost and productivity are considered. It notes, in particular, that high cost and low productivity have characterized many paratransit ventures initiated in the organizational framework of public transit authorities with conventionally structured labor contracts. In contrast, many of the success stories of paratransit have occurred where service was procured from the private sector; where labor was provided by part-time or nonunion personnel; or where service was introduced by social-service agencies, employers, or employee cooperatives. In short, many cost-effective service innovations have originated outside conventional planning and programming channels. Institutionalizing shared-ride services in the monopoly setting of public transit runs the risk of encumbering paratransit with the baggage of conventional planning procedures and the cost structure of conventional transit. The encumbrances of federalization—the labor-protective provisions of the Urban Mass Transportation Act, the capital bias of grant-in-aid programs, and the red tape involved in documen-

tation and procurement—could increase the cost of paratransit operations and inhibit the grass-roots, market-responsive planning process that has fostered successful service innovations. The deregulation or brokering model emphasizes a larger role for employers, employee cooperatives, for-profit enterprises, social-service agencies, and civic organizations. This view places greater importance on part-time, unpaid, and volunteer drivers and the use of privately owned vehicles. Considering the hazards of federalization, it concludes that paratransit policy should emphasize deregulation and entrepreneurship in program development and service delivery.

The argument for local flexibility in the context of full federal accreditation is a middle-ground position between consolidation and deregulation. Its central thrust is that localities should be free to consider and implement unconventional services without extraordinary difficulty in establishing a claim to federal financial assistance. This is the position cautiously proposed in the Urban Mass Transportation Administration draft policy guidelines on paratransit. The heart of this approach is the proposition that paratransit can be considered as either a supplement or an alternative to service provided by a conventional transit operator.

To ensure that paratransit is not only fully credentialed and financially accredited, but also receives a bias-free evaluation, the draft guidelines endorse the concept of competitive procurement. Competitive procurement would enable taxi companies, community cooperatives, and other bidders to compete for operating contracts. The guidelines do not resolve the question of whether transit properties or a neutral third party should be responsible for this procurement and contracting, but several conference participants advocated placing the responsibilities for service delivery and service procurement in independent agencies.

The central dilemma in the local-flexibility argument is the resolution of job rights issues posed by both civic ethics and section 13c of the Urban Mass Transportation Act of 1964. A second dilemma is the financial barrier to supplementary or competitive services that is raised by the financial distress of much conventional transit. Some advocates of local flexibility maintain that it is precisely the financial distress and cost structure of conventional transit that argues for paratransit innovation in the traditional as well as the low-density and special-need markets.

The conference dialogue between proponents of these rival viewpoints carried over into the panel-by-panel discussions of strategic and tactical issues in paratransit labor relations, planning, management, and finance. In turn, this dialogue raised questions about

1. The role of part-time, volunteer, and unpaid drivers in shared-ride transportation;
2. The merit of competition as an alternative to the integration or consolidation of public transit services;
3. The merit of specialized services targeted at particular market segments as alternatives to standardized or universally accessible services;
4. The merit of userside subsidies as an alternative to direct operator subsidies;
5. The merit of placing the responsibilities for service operation and financial decision making in separate agencies;
6. The merits of competitive bidding and purchase-order procurement;
7. The role of areawide planning agencies in the implementation of community-level and special-need services;
8. The role of premium and discount pricing in service differentiation; and
9. The relation of paratransit to transportation system management, preferential treatment of high-occupancy vehicles, and air-quality maintenance planning.

In addition to focusing and sharpening the dialogues about paratransit finance, management, and cost containment, the conference papers and panel discussions offered an assessment of the performance of paratransit to date. Some of the more important assertions made by conference participants are summarized below:

1. The cost and cost per rider of paratransit have varied dramatically from operation to operation. Demand-responsive services operated within the wage and work-rules structures of the conventional transit industry have disappointing cost and productivity records.
2. Work rules, job security, and wage rates are the most critical factors affecting costs and operating deficits. Negotiations between transit labor and management can produce wage and work-rule agreements compatible with paratransit operating regimes, but such negotiations are delicate and, thus far, have focused on new, rather than replacement, services.
3. Employer-based van-pool programs have demonstrated the ability to operate on a self-financing basis (exclusive of contributed management services).
4. The fragmentation and earmarking of federal and social welfare funds have frustrated local service coordination and the realization of economies of scale and density in social-service transportation. However, scale thresholds are poorly understood.
5. The escalation of insurance costs could become an extremely problematic factor in all forms of ride sharing.

These conclusions—or assertions—about the promise and problems of paratransit present a mixed review. One conclusion in particular—the extreme variability of paratransit costs—argues for more definitive comparisons and analyses of operations and better understanding of scale and density thresholds.

The papers in this volume represent another step toward better appreciation of the factors that foster and frustrate cost-effective service innovations. More definitive research and more carefully structured demonstration projects are necessary if we are to unravel the merits of the rival arguments for deregulation and consolidation and the potential for finding a constructive middle ground between them.

Concepts

Relationship of Innovative Services to a Family of Urban Transportation Services

Daniel Roos, Center for Transportation Studies, Massachusetts Institute of Technology

A mixture of different transportation services and providers are required to serve the varied markets and needs in an urban area. Innovative services such as ride sharing and demand-responsive transportation provide new opportunities to serve markets that are currently not served by more traditional services. Communities such as Westport, Connecticut, have demonstrated that these services can be combined in a complementary fashion, so that the different services reinforce, rather than compete with, one another. By offering a range of services provided by different suppliers, a unique system has been created that has had a significant impact on the community. Westport shows what can be achieved by a single community, and the lessons of this and other communities with the family-of-services concept must be diffused on a much broader basis. To achieve this, changes are required on a local and federal level. These changes require an increased awareness of available options and approaches, incentives to adapt these options and approaches where appropriate, and new institutional arrangements to accommodate the changes. An increased emphasis on service implementation and coordination is required, and different relations between planning and operations are appropriate.

Every urban area has a unique mixture of activities, development patterns, local objectives, population densities, markets, and travel desires. To satisfy these varied characteristics and needs, a family of different transportation services is appropriate. No single service or provider can satisfy all the needs. Instead, a mixture of different services and service providers must be interfaced properly to produce an overall transportation system.

This paper discusses the family-of-services concept with particular emphasis on innovative urban transportation services. Three primary areas are addressed. The first is the evolution of specific innovative concepts into more general families of related services. The development of car pooling into a mixture of ride-sharing services is used to demonstrate this evolution. The second is how innovative service concepts can be interfaced with more traditional approaches to result in a coordinated system of different services. The case study of Westport, Connecticut, is used to illustrate this family-of-services approach. Third, a number of issues are raised that should be resolved to ensure that the family-of-services approach can be more easily implemented.

The discussion will be restricted to urban transportation innovations that are not dependent on fixed-guideway technology. Thus, automated guideways, personal rapid transit, and dual mode will not be directly considered although many of the issues raised are equally applicable to these services.

DIFFERENTIATION OF SERVICE CONCEPTS

Although most urban areas have many different transportation services, only recently have we reflected the family-of-services approach in the planning, implementation, and decision-making processes. A first step occurred during the 1960s when highway and transit options, which previously were independently considered, became more closely related. Next, the range of conventional transit alternatives was broadened from the narrow perspective of two modes, bus and rail, to the recognition that each consists of a family of different services. For example, bus systems vary with respect to the size and capacity of the vehicle (minibus, regular, articulated, and double-deck) and the nature of the service provided (local, express, priority lane, or exclusive lane), and rail service can be subdivided into light- and heavy-rail systems.

Traditionally, we have differentiated services by using supply characteristics such as vehicle technology, capacity, or speed. More recently, services have been differentiated on the basis of market segmentation. This is most evident for the specialized services developed to satisfy specific markets, such as ride-sharing options for the peak-hour commuter (car pooling, van pooling, and bus pooling), school bus and airport limousine services, and specialized services for the elderly and handicapped.

A family of service providers exists in most urban areas to operate the various services. These include public and private transit companies, nonprofit agencies, individual entrepreneurs, and companies that are not primarily in the transportation business but provide

transportation services in an incidental manner (e.g., many companies operate bus or ride-sharing services for their own employees).

Thus, the family-of-services concept is much more complex than transit versus highway or automobile versus bus versus rail. It reflects the rich mixture of services, markets, and providers present in an urban area and the need to select and properly interface these components in an appropriate overall system.

In addition to the many existing service alternatives, new innovative services should also be considered as parts of the family of services. What are the implications of these new concepts? First, the available options and the spectrum of choice are expanded. Second, the process of choosing and interfacing appropriate services is complicated. Obviously, the more choices one has, the more difficult it is to select among them. A further complication is the lack of experience with these new concepts and the uncertainties inherent in experimenting with something new. Third, and probably more critical, is that the implementation process can be quite complex. Here, again, uncertainty is a factor. However, the major difficulty is that the introduction of a new concept may cause changes in other institutions, and the process of institutional change can be quite complex.

EVOLUTION OF INNOVATIVE CONCEPTS

An innovative concept is often introduced in a specific (and sometimes narrow) context. As the concept develops, initial preconceptions change, and specific contexts evolve into more general approaches. Unfortunately, many new concepts become stereotyped at an embryonic stage, often in an inaccurate manner that does not reflect the changes in the concept as it evolves. We must guard against this, recognizing that most new concepts have numerous different configurations and variations.

The evolution of car pooling into a family of ride-sharing services illustrates how a specific new concept can evolve into a mix of services that are conceptually similar yet provide different service characteristics. Ride-sharing options (van pooling and bus pooling, as well as car pooling) are peak-hour subscription-type services in which each day the same people are picked up at their homes and brought to a common destination (generally an employment center). With respect to differences among the various ride-sharing services, van pools and bus pools with larger capacity vehicles are most useful for reasonably long commuter trips [e.g., 16 km (10 miles) or longer], whereas car pooling is more practical for shorter trips. Most bus pools use a paid professional driver, while car-pool and van-pool services use a nonprofessional driver who generally contributes in-kind services. As a result, the cost of bus-pool service is considerably higher than that of car-pool or van-pool services and generally requires a subsidy. A car-pool driver typically uses his or her or a passenger's vehicle, whereas a van-pool or bus-pool driver uses a vehicle provided by some organization. Thus, van-pooling and bus-pool service require some organizational involvement in their operations, whereas car pooling can rely on a much looser organizational structure.

There are many variations on a single ride-sharing concept, such as van pooling. The van-pooling concept first initiated at the 3M Corporation has now been replicated at over 100 other organizations. Obviously, there are limits to the number of companies that have a sufficiently large number of employees to support their own van-pool program or the motivation to initiate such a program. Therefore, to expand the applicability of the concept, multiemployer van-pool programs are being organized to serve several organizations in close proximity. The involvement of several different organizations broadens the market, but also complicates the implementation of the program. Whereas a company is often willing to perform certain functions (such as insurance protection and vehicle maintainance) for its own employees, it is reluctant to become involved with employees of other companies. Thus, some other organization must assume the coordinating role. For example, a multiemployer van-pooling project that has just begun in the Twin City area is being coordinated by the Metropolitan Transit Commission and will actively involve private enterprise in purchasing and leasing the vehicles. In the Knoxville, Tennessee, ride-sharing program, the city is the coordinating agency, while the vans are owned by the individuals providing service. The Tidewater Transit Commission will own all the vans in its van-pooling project. In the Baltimore VANGO van-pooling program, a private nonprofit corporation is the lead agency that acquires the vans. Different institutional arrangements have been developed to facilitate the deployment of a similar service concept.

All van-pooling programs to date have been structured on a break-even basis (an argument can be made that, in some cases, a company has provided various indirect subsidies to initiate and operate the program). However, many variants are possible—e.g., a profit-making operation, where the profits would serve as an incentive to private industry or as a cross subsidy for a public agency. Van pools could also be operated at a deficit, particularly if the deficit were less than those of other alternatives.

The various ride-sharing concepts are complementary, each serving different market needs. Organizations such as the 3M Corporation and the Tennessee Valley Authority use a mixture of car-pooling, van-pooling, and bus-pooling services, rather than relying on any single one. Many state and regional government agencies have initiated programs that reflect the family of ride-sharing services (the programs in California and Massachusetts are good examples of statewide ride-sharing programs).

A similar evolution has occurred as the original dial-a-ride concept has developed into a family of demand-responsive services. Numerous different service designs have been used in the more than 100 demand-responsive systsms that have been implemented in North America. Some of these systems are totally flexible, whereas others might be considered hybrid systems, combining both fixed and flexible characteristics. Different operating frameworks have been used, including public transit companies, taxi companies, and private nonprofit organizations.

As in the case of ride-sharing, demand-responsive services have been implemented on both regional and statewide bases. The most interesting statewide program is in Michigan where 41 new demand-responsive systems in small urban areas have been implemented in the past 3.5 years. The state will pay for the service the first year, but the locality must decide at the end of that year whether it wishes to continue the service and, if so, assume financial responsibility for approximately two-thirds of its cost (the state pays the remainder). Thus far, of the 32 communities making that decision, only 2 have decided to terminate service, whereas 30 have elected to continue. In 19 communities, the decision was put to the voters who passed the millage in 17 cases.

Percentage	No. of Systems	Percentage	No. of Systems
49	2	70 to 79	5
50 to 59	3	80 to 89	2
60 to 69	5		

At the same time that these communities were approving transit funding, some communities were defeating mileages for other public services such as schools and libraries by sizable margins. The conventional wisdom that public transportation in small urban areas is not a priority need has certainly been refuted in Michigan.

There are numerous examples of successful ride-sharing and demand-responsive services in many different settings, but many failures can also be cited. These failures have generally been caused by several factors. Initial perceptions of key issues and approaches are often incorrect. For example, many areawide carpooling programs that initially emphasized computer matching have been unsuccessful. The realization that the key initial contact is the employer (rather than the individual) and that the basic issue is marketing (not computer matching) results in more successful follow-on programs.

A second reason for failure is that a concept is misapplied or implemented in an inappropriate setting or manner. It is sometimes suggested that the inherent flexibility of demand-responsive service implies that no planning of service is required—just implement the service and see what happens. Often, not unexpectedly, an inappropriate service results.

In some cases, the implementation strategy for new services has been unrealistic. The best example is the demand-responsive service in Santa Clara County, where a new countywide service was instantaneously started. A myriad of operational problems developed, and the service was wisely discontinued.

Another reason for failure is changing goals, objectives, and constraints. Many urban areas that expanded their programs in urban transportation by using innovative concepts were forced to reappraise these programs and curtail service because of limited economic resources. Although the innovative services had satisfied their design objectives, they were not feasible under a changing evaluation framework.

We must be extremely careful in evaluating new service concepts and not incorrectly conclude that a concept has limited usefulness. A concept can be quite good, but improperly planned and implemented. Finally, we must acknowledge that many tests of new concepts are failures because the concept does not perform as anticipated. A high failure rate should be anticipated when anything new is attempted, but unfortunately, our political processes are not very compatible with failures in the public sector.

Ride-sharing and demand-responsive services represent two innovative areas where reasonable implementation experience has been gained. Several other innovative areas exist where little or no implementation has yet taken place. Examples include short-term automobile-rental schemes, transportation cooperatives for housing developments or neighborhoods, and organized hitchhiking schemes involving licensing regular drivers to pick up and charge passengers. Each of these schemes, and others, could play a potential role in the family of services, but far more must be learned before that role can be understood.

FAMILY-OF-SERVICES IMPLEMENTATION

A good way to illustrate how the family-of-services concept can be implemented is through examples. Many examples exist where various innovative concepts have been combined with more conventional approaches. Areawide programs combining fixed-route and demand-responsive services are under way or being initiated in Ann Arbor, Michigan; Orange County, California; Minneapolis and St. Paul; Detroit; Cleveland; and Chicago. Some transportation authorities are now playing an active role in ride-sharing, in addition to operating mass-transit, service. Knoxville, Tennessee, has established a new city agency to serve as a transportation broker and coordinator for bus, ride-sharing, and demand-responsive services and specialized transportation needs.

Rather than exploring a number of these examples in some detail, one specific example will be presented in considerably greater detail. Westport, Connecticut is an excellent example of how a family of services can be developed and have a significant community impact. Westport (population 28 000) was considered a community where public transportation would never succeed. It is extremely affluent (median family income $24 000), has low-density development [500 persons/km^2 (1300 persons/mile^2)], and high automobile ownership (2.2 automobiles/household). Three years ago, the newly created Westport Transit District introduced a pulsing fixed-route hail service where all routes converge at the town center approximately twice an hour (Figure 1). The seven routes are carefully laid out to serve major activity centers and provide coverage within 0.4 km (0.25 mile) of a route to 85 percent of the residents. During the peak hours, the routes are modified to serve the commuter railroad station [Westport is 80 km (50 miles) from New York City] (Figure 2). The system carries approximately 1800 regular riders and 500 commuters daily, and during the summer months, ridership increases significantly, sometimes exceeding 4000 riders/d. This ridership is significantly greater than ridership in other comparable areas. The cost per passenger for the service has varied between 50 and 60 cents, a remarkedly small amount for any urban area, particularly a small city.

The impact of the service on the community has been significant:

1. Twenty-six percent of the commuters have already reduced their automobile ownership, and an additional 24 percent plan to not replace an automobile (households with multiple automobile ownership).
2. The town real estate association, which initially opposed the system and claimed that it would destroy the community, presented the transit director with its first person-of-the-year award, stating that the transit service had done more to increase real estate values in the community than any other factor.
3. A poll of persons moving into the community indicated that the transit service was one of the three primary factors causing them to choose Westport.
4. More than 50 percent of the regular riders are 12- to 15-year-old children, and 50 percent of their trips represent travel that they were unable to make before the service was initiated. The transit service has provided a new mobility for young people, an often forgotten transportation-deprived group. Perhaps these young people will acquire a positive attitude toward public transportation that they will retain as adults.
5. A survey conducted 2 years after initiation of the service indicated that 40 percent of the population had ridden the bus during the previous year, 20 percent the previous week, and 10 percent the previous day.
6. As a direct result of the services, the town has canceled plans to build an additional 300 parking spaces that would have cost approximately $1 million.
7. The introduction of the service has resulted in a significant increase in the use of community services such as the libraries and summer schools.

There are many reasons for the Westport success, but three are of primary importance:

1. Service design: The service was carefully de-

signed to serve the travel needs of the community, with particular emphasis on two specific markets (commuters and young people), and to minimize peaking problems.

2. Pricing policy: An annual pass allowing unlimited use of the system was offered at extremely low cost [during the first year, the charge was $25/year for husband and wife and $7/year for each child (a 50¢/trip service is also available, but most passengers use the annual pass)]. More than 7000 persons (25 percent of the population) bought passes the first year, and once a person had a pass, the impetus to use it was present. Thus Westport was able to prefinance a large portion of the cost of a widely used service, rather than to use the traditional approach of obtaining most funding from taxes to support a service that is frequently used by only a relatively small number of people.

3. Marketing approach: During the first year, more than 7 percent of the annual budget was spent on marketing. The service was attractive, efficient, and reliable; it used eight Mercedes Benz minibuses. Great care was taken to interact with the community and make the service easy to understand and use.

Westport has successfully created a transit awareness in the community that is generally lacking in most urban areas. That degree of transit awareness is of critical size, allowing the city to build on an existing foundation. The overall objective of the transit district is to provide a range of complimentary transportation services that will further decrease reliance on the automobile and improve the quality of life in the community. Accordingly, a series of new services has been introduced as part of an Urban Mass Transportation Administration Service and Methods Demonstration Project. The first of these is a Maxytaxy shared-ride service to complement the existing Minnybus service. The initial plan was to form a new transportation cooperative and allow both taxi operators in the community to participate. One taxi operator declined to participate, so the new service was awarded by competitive bid. The same taxi operator who opposed the cooperative refused to bid and filed suit in Federal District Court. In an important decision, the judge ruled in favor of the Westport Transit District, which allowed the service to begin (the case has been appealed). The Westport Transit District pays the taxi operator on a cost-plus-fixed-fee basis with an incentive fee based on passengers carried, productivity, and safety performance.

Although the service has not been operating long, preliminary results are quite encouraging.

1. The ridership on the shared-ride service increased from 400 passengers/week at the beginning to more than 2500 passengers/week 9 months later.

2. The service is recovering 60 percent of its costs, with the recovery percentage increasing with increasing ridership. The goal of a near break-even operation appears feasible if ridership increases continue at the same weekly rate of increase.

3. Ridership on the regular Minnybus service increased in comparison with the previous year, with the increase appearing to be related to the Maxytaxy service.

4. Only 10 percent of the users of the shared-ride taxi service previously used the exclusive-ride taxi service. Thus, a new market has been developed, rather than an existing market being diverted.

5. There has been a 30 percent ridership decrease in exclusive-ride taxi service for the company supplying the shared-ride service. However, the operator's gross revenues and profitability for the exclusive-ride service

Figure 1. Off-peak service.

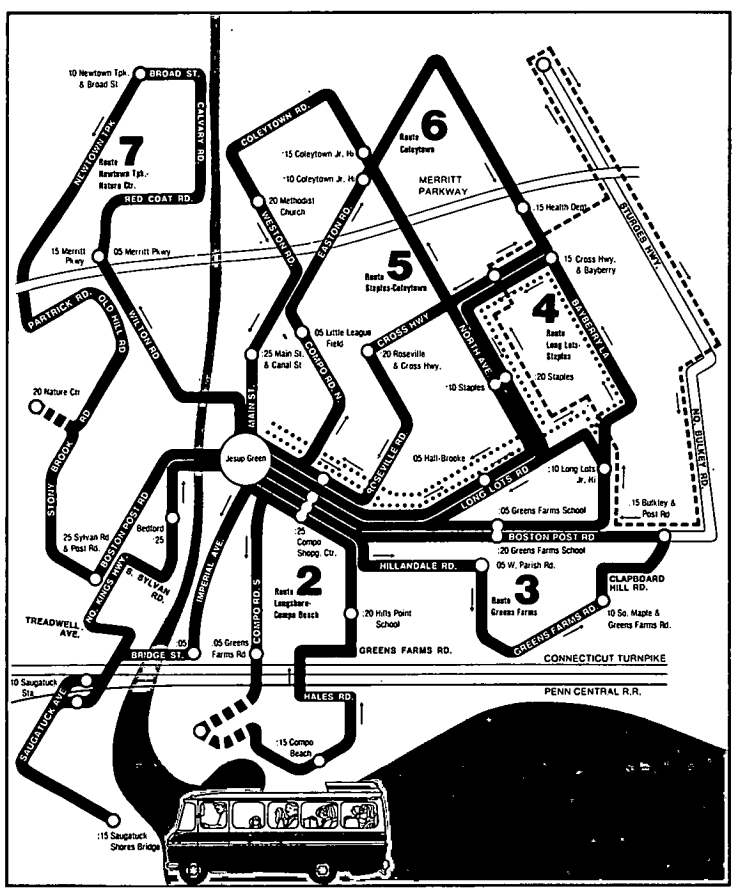
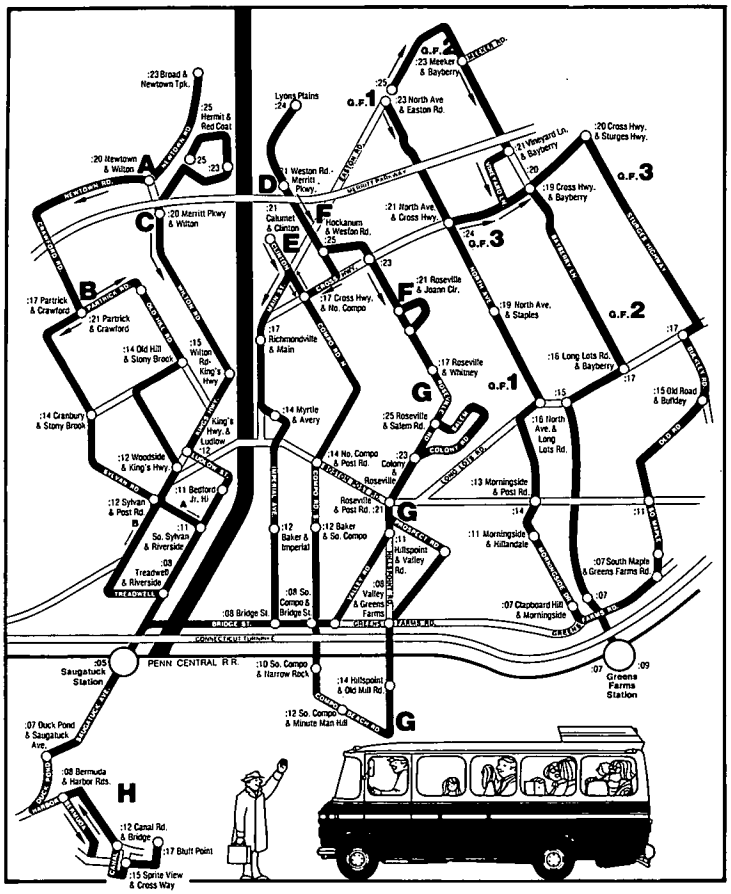


Figure 2. Peak-hour service.



Note:
To find the time Minny will be at your stop in the morning, "count down" or subtract the indicated number of minutes from train time. If evening trains are late — we'll wait at least til 8 p.m.

Commuter Minny timetable:

Saugatuck Trains	Greens Farms Trains
7:09 AM	7:04 AM
7:32	7:27
**7:51	*4:40 PM
**8:28	*5:20
*5:02 PM	*6:07
*5:20	
*6:07	

*Leaves Grand Central **Routes A, C, D, E, F, G only

have both increased; he now concentrates on using his exclusive-ride service for the more profitable long-haul service with the shared-ride service absorbing the less profitable short-haul trips.

Although the results are preliminary, they indicate several important conclusions:

1. Different services attract different markets. The shared-ride fare ($1 to 3/trip) is significantly more expensive than the Minnybus fare [50¢/trip (or less for passengers using passes)], but less expensive than the exclusive-ride taxi service.
2. The new service provides additional alternatives to the automobile, which increases the attractiveness and ridership of existing services.
3. The private provider benefits by having a more profitable overall operation. It was originally anticipated that the exclusive-ride service would be less profitable, but that the combination of the two would be more profitable. The increased profitability of exclusive-ride service is a surprise.

New services continue to be introduced. Several of the Maxytaxy vans are equipped with a wheelchair lift, so that areawide service to the physically handicapped is now available. A package-delivery service was recently begun as part of the Maxytaxy service. Small retail establishments that previously owned their own vehicles and used part-time drivers are now contracting with the Maxytaxy service to provide a similar service at lower costs.

The taxi company is also providing supplemental fixed-route service during the peak hours. The transit district is therefore able to avoid the peaking problems characteristic of most transit operations.

These car-pool and van-pool ride-sharing programs are being initiated in cooperation with the Connecticut Department of Transportation. The Westport Transit District is serving as an information coordinator and broker for all urban transportation needs. A computer system has been introduced to allow management to better evaluate performance and assist in a limited way with the operation of the services.

WESTPORT IMPLICATIONS

The Westport story is an impressive one, showing how a family of services can have a significant impact on a community. This city has successfully combined all

modes of travel from heavy rail at one extreme to taxi service at the other.

Success was not easy to achieve. The basic groundwork for initiation of the Westport Transit District started in 1968. It took 6 years before service was started, but the careful work that went into developing the various services has paid off.

Why has Westport succeeded, and can that success be replicated in other urban settings? Certainly the service design, pricing policy, marketing, and service-delivery approaches are essential components of the success. However, there are other more fundamental characteristics that include the following:

1. Leadership: The success is directly related to hard work, dedication, and the skill of Richard Bradley, executive director of the Westport Transit District. Bradley came to the transit district from a social service agency in the community. This past experience provided him with the necessary understanding of the community, its markets, and its needs. The lack of any past involvement in urban transportation allowed him to explore alternative approaches without preconceived biases. He attended professional meetings and talked with leading authorities to capitalize on new concepts and approaches.
2. Institutional setting: Because there was no community transit service before the formation of the transit district, Bradley was able to create a new entity without being constrained by existing institutions already providing service. The Westport system is on a small enough scale so that it can be reasonably managed. The employees feel that they are part of an exciting activity. As new activities and services are developed, each is provided with a separate organizational unit.

Consider these components of success in relation to other urban areas. There is an infusion of new leadership in urban transportation, as demonstrated by the number of young people heading major transportation authorities and transit operating companies, taxi companies, and ride-sharing programs. However, a much more extensive program in education and training will be required to ensure that top and middle managers can make maximum use of new concepts and approaches.

Institutional constraints in urban areas do, however, present formidable problems. Whereas we have recognized the concept of a family of services, we have not recognized the relation of those services to a family of providers. Many of the new concepts are not consistent with the traditional missions of existing institutions and do not fit neatly into existing organizational roles.

1. Car pooling is most closely associated with highway agencies whose traditional activities have been construction oriented, but the objective of car pooling is to increase automobile occupancy and reduce the need for new construction.
2. Metropolitan planning agencies have traditionally been concerned with long-range activities and the use of transportation to influence urban development. The new concepts largely reflect, rather than influence, development patterns, and traditional planning techniques are not applicable to their basic design questions. Issues of coordination and implementation become more central than traditional planning approaches.
3. Transportation authorities and transit operating companies preoccupied by escalating operating deficits are primarily concerned with providing adequate funding to support existing services and reluctant to allocate time or resources to different services.
4. The new services are not capital intensive and use existing equipment. Therefore, there is no major incentive for private industry to exert major interest.

The traditional advocates, both public and private, are not present to foster innovation and change. Given this situation, it is therefore not surprising that most of the major successes have been initiated by nontraditional groups. Ride-sharing programs have been initiated by radio stations, citizen's groups, and chambers of commerce, but not often by professional transportation agencies.

Why not allow this process to continue? There are several reasons. First, most of the programs initiated by nontraditional groups have been narrowly focused toward specific approaches. The group is often interested in promoting that specific technique, rather than in obtaining maximum benefit from interfacing the specific service with the family of other services. Second, whereas the initiating group serves the critical role of introducing the service, it is generally not well equipped to deal with the complex issues of service coordination. It is not surprising that the responsibility for second-generation ride-sharing programs, dealing with a variety of ride-sharing concepts and their relations with more conventional approaches, has shifted toward organizations having the capability to provide coordination and integration.

One must not confuse coordination and operation. The vitality, incentives, entrepreneurial initiatives, and private-sector involvement characteristic of the initial independent efforts can and must be preserved. A coordinating organization has much to provide, but it must be careful not to overstep its role.

The introduction of new service concepts has forced us to reexamine and rethink basic assumptions about organizational roles and responsibilities. These are not easy questions, but they are very important ones.

In most urban areas, there is no readily identifiable lead agency to provide overall direction and coordinate service delivery. Our funding programs, planning requirements, and institutional roles largely reflect a single provider of conventional services. A broadened perspective of multiple-service providers and the introduction of new service concepts raise new issues of resource allocation, regulatory reform, labor protection, and service delivery alternatives.

Issues of scale and impact are important. Many of the new concepts can play (and in some cases have already played) a major role. As such, they must be treated seriously and not simply remain on the periphery of the issues. Again, it must be emphasized that the issue is not simply introducing a new specific concept. Rather, it is a far broader concern—that of introducing a different process and conceptual framework for the planning and provision of urban transportation services.

FEDERAL ROLE

The federal government has a central role in these areas because of its function in providing funding and establishing guidelines and requirements. The U.S. Department of Transportation is to be commended for its recognition of the changes that have occurred as shown in its concern for transportation system management, short-range incremental planning involvement of the private provider, and consideration of a broader range of options. However, firm policies have not yet been issued. It has been more than a year since the draft policy statement on paratransit was released. Until that policy statement is finalized, urban areas will be reluctant to reflect the intent of the new policies. Second, existing funding pro-

grams and policies do not provide the necessary incentives or penalties to encourage change. Neither carrots nor sticks are present. It is unrealistic to expect most urban areas to allocate scarce resources for new service concepts. The use of Urban Mass Transportation Administration section 5 funds is a case in point. Although the program was intended to support both capital and operating costs, most funds have been expended for operating costs. New service concepts cannot compete in such an arena.

What, therefore, should be done? Several approaches seem appropriate. First is the issue of awareness. The federal government has stated that the determination of the appropriate service mixture is a local decision. That philosophy is sound and argues against any mandated program for a particular service concept. However, the federal government must ensure that local decision makers without professional transportation background are aware of the possible options and the implications of those options. How is awareness increased? More than better information dissemination is required. Existing planning procedures and requirements should be modified to better reflect changing needs and approaches. Less emphasis should be placed on traditional planning issues, and more emphasis should be directed toward operational planning, regulatory reform, resource allocation, implementation issues, institutional roles, service delivery, and service coordination. In how many urban areas are policy makers even aware of the inventory of existing service options and providers available to them? Very, very few.

A different emphasis on the planning process and increased information dissemination emphasizing new approaches should help. However, these alone are not sufficient. Additional earmarked funding will be appropriate to encourage urban areas to try new approaches. The most notable successes of new concepts have come from federal and state demonstration programs where additional funds were available to test new concepts. These programs have highlighted a few model approaches. They have not, however, served the role of diffusing a successful innovation on a broad scale. Such a program is needed to ensure that wide-scale implementation of well-tested successful concepts occurs.

Two fundamental, related problems exist at the federal level. First, because many innovative concepts involve numerous federal agencies, inconsistencies and conflicts have resulted. For example, there has been a proliferation of fragmented specialized services for the elderly and handicapped, but no federal agency has assumed an aggressive lead-agency role in ride sharing. Second, much of the enabling legislation and related programs were developed without consideration of various innovative services. Thus, existing legislation is being used in a far broader context than was originally intended. It is not surprising that numerous inconsistencies have developed. A challenge at the federal level will be to develop new legislative programs that reflect the broader view of urban transportation options, providers, and service delivery systems and ensure that the proper federal agencies can implement necessary programs in a consistent manner.

Social Service Transportation

Joseph S. Revis, Institute of Public Administration

The nature and scope of social service transportation systems are summarized, and the benefits and limitations of coordination among such services are explored. The potential for improvements in coordination and a series of considerations for future improvements are identified. The increased interest in coordinating social service transportation is explained by the increasing funding constraints of the late 1960s and the 1970s as projects became more concerned about using their resources as effectively as possible. The nature of coordination is examined and the findings of a national survey of state agencies on aging are presented. The barriers to coordination are identified and classified into two broad categories: statutory and legal and administrative, institutional, and perceptual. The statutory and legal barriers include eligibility and user restrictions and franchise and labor problems; the administrative, institutional, and perceptual barriers include regulatory and administrative constraints, accountability requirements, insufficient information on transportation costs, turf protection, preferential treatment of clients, discontinuity of funding, and public transit. The benefits of coordination include (a) reduced overlap and duplication, (b) increased service capacity, (c) improved vehicle productivity, and (d) cost reductions in purchases. Directions for improved coordination—in the areas of policy, planning, operations, and research—in the future among transportation services provided by social service agencies are identified.

The provision of transportation services to their clients by social service agencies has long been an integral part of their programs. Recently, these agencies have become more concerned and involved with the issue of coordinating their transportation services because of

1. The substantial and relatively sudden increase in the number of projects providing such services (due to the inadequacy of public transportation and the lack of private transportation among certain social groups),
2. The scarcity of funds for social service programs in the 1960s and 1970s, and
3. The concomitant recognition of the importance of coordination in the face of the need for and scarcity of funds.

This paper reviews the background of social-service transportation projects; describes the nature of coordination and the barriers and limitations to coordination efforts; and presents an overview of some of the solutions and possibilities for improving transportation coordination among social service agencies and between social service agencies and public transportation (1, 2).

PROJECT GROWTH AND FUNDING

Project Growth

The Institute of Public Administration's (IPA's) state-of-the-art report on the transportation problems of the elderly, which was based on a survey of projects throughout the country, estimated that in 1974 there were between 1000 and 1500 projects providing transportation services to the elderly and other disadvantaged groups (1, pp. 71 ff). Most of these projects were of comparatively recent

vintage—few of them predated the late 1960s. Based on more recent data collected from state agencies on aging for FY 1975, approximately 2000 transportation projects were being funded under titles III and VII of the Older Americans Act of 1965. If projects funded under sections 16b2 of the Urban Mass Transportation Assistance Act of 1974 and 147 of the Federal-Aid Highway Act of 1973 are included, there were an estimated 2500 transportation projects providing services to the elderly alone (2, pp. 6 ff).

Although the available data do not permit an accurate estimate of the number of transportation projects being funded by other programs such as those under the social security, vocational rehabilitation, and public health services acts, the community action program, private agencies, and other programs, a conservative estimate indicates that, if the projects funded by these programs were added to the total, the number of transportation projects serving the elderly and handicapped in FY 1975 would be more than 3000—well above the 1974 estimate of about 1000. These estimates are summarized below (2).

Item	Number of Projects	Estimated Number Serving the Elderly
Projects under titles III and VII of the Older Americans Act	2000	2000
Projects under section 16b2 of the Urban Mass Transportation Act	1031	520
Projects under section 147 of the Federal-Aid Highway Act	45	25
Total	2076	2545

(Because projects under sections 16b2 and 147 may be funded by other sources including one another and titles III and VII, these numbers do not represent unduplicated totals. It is assumed here that at least half of the projects shown for sections 16b2 and 147 were for the elderly and did not duplicate projects under titles III and VII.)

Many of these projects are not for the elderly only and include a variety of other service recipients. There are also other social service programs that provide transportation services to the nonelderly population, although there are no data available at present that permit estimation of the extent of these services. However, given the scope of the programs sponsoring these services, it would not be surprising to find that the number of transportation projects operated by social service agency programs was three to five times the 3000 estimated above.

Project Funding

The maze of federal, state, and local programs has made it difficult to estimate the scope of funding for transportation services by social service agencies. The IPA study attempted to survey programs through state agencies on aging, but for a variety of reasons, these agencies were unable to provide all the information necessary for a detailed view of the pooling and use of transportation funds. The agencies frequently found that they simply did not have the information available or could not make it available in time to be of value to the study. Many state agencies reported that they were not required to keep detailed information, especially on matching sources of funds.

With these limitations in mind, an attempt was made to provide a best estimate of the pooling and use of transportation funds under the major programs of titles III and VII, sections 16b2 and 147, and titles XIX and XX of the Social Security Act of 1974 (there were no data available that would permit estimates of title XIX of the Social Security Act, and no data were developed on title XVIII).

Despite problems with the data provided by the state agencies on aging, estimates of the total funding from major federal sources for the provision of transportation to the elderly were developed for FY 1975; these estimates are summarized in Table 1 (2).

As can be seen in Table 1, total expenditures on transportation for the elderly in FY 1975 from major federal sources (titles III, VII, and XX and sections 16b2 and 147) were probably in the range of $60 to 70 million. This is exclusive of a wide variety of other major programs, public and private, that offer transportation services to older Americans (e.g., the public health services act, section 5 of the Urban Mass Transportation Act of 1974, and ACTION).

Funding for mobility of the elderly under sections 16b2 and 147 for FY 1975 was estimated at about $20 million (the midpoint of items 3 and 4 of Table 1). In addition, an estimated $25 million was spent on transportation services for the elderly under title XX of the Social Security Act. [If it is assumed that an estimated 2 percent of the title XX program of $2.5 billion was allocated to transportation, approximately $50 million appears to have been used for this purpose in FY 1975. Although the share of the elderly in the use of these transportation services is not known, it has been assumed that their share is approximately proportional to their share of the number of persons receiving supplemental security income payments (i.e., about half of the $50 million).] Unfortunately, data were not available to permit even rough estimates of the funding share for transportation services under the $12.1 billion spent in FY 1975 for the title XX program.

Finally, state agencies on aging were asked to identify the funding sources that contributed to titles III and VII and sections 16b2 and 147 programs. Although the data would not allow quantified estimates of the scope of these contributions, there was considerable evidence of pooling of funds among various programs. Transportation programs were being supported not only through shared funding arrangements drawing on the federal programs listed in Table 1, but also with funds from such sources as vocational rehabilitation resources, the economic opportunity act, public transit, local and state allocations, and private contributions.

Similar estimates for other social service programs covering the nonelderly population are not available. Some estimates have indicated that over $1 billion is being spent on special transportation services by the Department of Health, Education, and Welfare (HEW) alone. The validity of such an estimate largely depends on the definition used for transportation and by and large is not well documented. However, there can be little doubt that substantial funds are being expended for such services by social service agencies and that the increases in these efforts are relatively recent—probably within the last 5 years.

Coordination Funding

At the same time that the recognition of the need for transportation was expanding, there was a general decline in the availability of funds for social service and human development programs. This was especially true during the latter part of the 1960s and into the 1970s when agencies became more and more concerned about using their resources as effectively as possible. That concern reflected itself in a growing desire to pool resources with other agencies.

By 1973, the problem had become sufficiently acute that the Administration on Aging (AoA) commissioned IPA to undertake a state-of-the-art study of transportation problems; the 1975 report of this study identified

Table 1. Funding for transportation services to the elderly: fiscal year 1975.

Act and Title or Section	Program Amount ($ millions)	Estimated Transportation Share (percentage)	Estimated Funding for Transportation ($ millions)	Estimated Transportation Funding for Older Americans ($ millions)
Older Americans Act: title III	97.0[a]	15.0	15.0	15.0
Older Americans Act: title VII	124.5	6.0	8.0	8.0
Urban Mass Transportation Act: section 16b2	20.8	100.0	20.8	12.5 to 16.6[b]
Federal-Aid Highway Act: section 147	9.4	100.0	9.4	4.7 to 6.1[b]
Subtotal	251.7	–	52.3	39.3 to 44.8
Social Security Act:[c] title XX	2506.0	2.0[d]	50.0	25.0[e]
Total	–	–	–	64.3 to 69.8

[a] Excludes Model Projects funds.
[b] Program is not exclusively for the elderly, but the elderly represent a substantial share: the lower limit assumes that 60 and 50 percent of sections 16b2 and 147 respectively are serving the elderly; the upper limit assumes these shares to be 80 and 65 percent respectively.
[c] Detailed transportation data were not available.
[d] This percentage is based on 1.7 percent for transportation as reported by the Subcommittee on Federal, State, and Community Services of the Select Committee on Aging of the House of Representatives in its report (3).
[e] Assumes the share of the elderly to be proportional to their share of the number of persons receiving supplemental security income (about 50 percent) (4).

four factors that tended to inhibit coordination:

1. User restrictions,
2. Franchise conflicts and other institutional restrictions,
3. The lack of participation by social service agencies in the public transit planning and operating process, and
4. Institutional mismatches.

Since the publication of that report and with growing recognition of the savings possible from coordinated efforts, the interest in and involvement with coordination has increased at an incredible pace. Although the barriers remain, other inhibiting factors have been identified, as well as some potential directions for improving the levels of coordination. Perspectives have changed. For example, until very recently, conflicting federal requirements were considered to be a major barrier to the development of coordinated transportation systems; this was the underlying theme of almost every study and report on the issue. However, one view suggests that federal constraints may not be as great a barrier as was originally thought. One observer has noted that a review of the statutory authorities and regulations concerned with the Office of Human Development in HEW found that although each of the respective programs had statutory eligibility requirements based on age, health, income, and geographic location, none of these requirements, in and of themselves, constituted an unbreakable barrier to the pooling of resources toward the development of a coordinated transportation system that would serve all groups (rather than discrete, categorical services to meet the needs of each group separately) (5).

This does not mean that conflicting statutory and regulatory requirements do not act as inhibitions to coordinating transportation resources. Unquestionably, these conflicting requirements make the job of coordination much more difficult than it need be. However, these barriers can be and have been overcome. In a study of 20 special service transportation projects by IPA, a wide range of coordinating efforts were identified, confirming the real possibilities of achieving coordination. However, it was not an easy task (2).

WHY COORDINATION?

Before proceeding to a discussion of the barriers to coordination and how they might be eliminated, it might be useful to explore the meaning and value of coordination. Before project operators or agencies can be persuaded to participate in a coordinated transportation effort, they must feel that there is some real benefit in it. A better understanding of what coordination means and what it can and cannot do will, by itself, help encourage coordination.

Meaning of Coordination

The term coordination from a project-operation viewpoint has often been used interchangeably with the concepts of cooperation and consolidation when, in fact, they have different meanings and imply different levels of working together. If the three concepts are related to differences in freedom of action with respect to providing transportation, then consolidation implies the greatest degree of joint action and cooperation the least. These differences are reflected in the definitions that follow:

1. Cooperation: The active working together in some loose association or cooperative way, with the individuals or the individual agencies retaining their separate identification.
2. Coordination: The bringing together of individuals or individual agencies for common action, or to act together in a concerted way, to provide for a smooth interaction of separate units of a program or system. In coordination, the primary concern is in expanding the benefits of the entire system through joint action as a group. Coordination may come in the form of common funds, equipment, facilities, or operations, but the members or agencies preserve their identity.
3. Consolidation: The joining together or merging for mutual advantage. In the case of transportation services and in the context of this report, we will use consolidation when referring to a fully integrated transportation system in which all individual units or individuals have been combined or consolidated into one system and individual agency identity for the purpose of transportation is no longer maintained.

Confusion in the use of these terms is widespread and often obscures important policy and operating issues. At the present level of the state of the art, the term coordination is most frequently used in this paper because it best covers the range of current activity. However, the extent to which any of these three levels of joint effort is successfully achieved will depend to a considerable extent on a variety of statutory, regulatory, and adminis-

trative practices and on the perceptions of participants at all levels of government and in the private sector. The difficulties are further compounded by the fact that coordination can (and must) occur at a number of different levels.

The matrix of potential levels of joint action to provide transportation services shown below illustrates the complexity of achieving coordinated transportation.

Agency or Group	Federal	State	Local	Private
Federal	Intralevel	Level 1: federal and state	Level 2: local and federal	Level 3: private and federal
State	Level 1: federal and state	Intralevel	Level 4: local and state	Level 5: private and state
Local	Level 2: local and federal	Level 4: local and state	Intralevel	Level 6: private and local
Private	Level 3: private and federal	Level 5: private and state	Level 6: local and private	Intralevel

As can be seen, joint action to provide transportation services is possible at many different points ranging from intragovernmental levels (within federal, state, and local levels and the private sector) to joint efforts between levels of government and the private sector (levels 1 through 6 above). This obviously does not include the potential need for joint action within a single agency or group or among three levels: federal, state, and local. Furthermore, the concept of coordination is by no means new. In terms of transportation and social services, the present federal statutes and regulations underlying programs all generally contain specific requirements for coordination, and these requirements have recently been summarized for major federal programs providing transportation or social services or both (6). A review of that summary clearly illustrates the range and variation of these coordinating requirements and, in itself, identifies the nature of the difficulty in providing for more effective coordination among federal agencies. The multitude of requirements among federal agencies illustrates the complexity of coordinating the various statutory requirements, not to mention regulations and administrative practices.

Interagency coordination and cooperation has usually been required by most federal agencies, and informal cooperation at the staff level has always existed—typically by sharing information. Interagency task forces and work groups are used to encourage information exchange and consideration of joint policy implementation, and recent efforts along these lines among AoA, the Office of Human Development (both HEW agencies) and the U.S. Department of Transportation (DOT) reflect the growing concern among federal agencies about the issue of coordination of transportation for the disadvantaged.

Value of Coordination

In the face of the many problems and complexities, the value of coordination would have to be substantial to be justified. Experience with the AoA and Urban Mass Transportation Administration (UMTA) studies as well as the results of the state-of-the-art study in 1975 indicated that most transportation services were operating side by side with little attempt among the providers to avoid duplication or fragmentation of service potential and resources. Each agency typically designed its own project to serve its own clients—with separate vehicles, staffs, facilities, and budgets. In an inventory of transportation services in Pinellas County, Florida, for example, it was found that there were 26 different projects, using over 40 vehicles, and 26 separate staffs, budgets, and operating requirements. In the case of Pinellas County, the potential for savings through some form of coordinated effort hardly needs much substantiation. There were 26 project directors (26 assistant project directors?); 26 office staffs; 26 different garages; and repairmen, supply sources, an unknown number of drivers, dispatchers, and other support staff that could easily be combined and simplified. One project operating in a consolidated manner might not have been possible (or even sensible), but fewer than 26 was clearly possible.

The advantages of cooperative transportation projects can be identified (and measured) in terms of (a) more or better quality transportation for the same costs, (b) the same transportation at lower costs, or (c) more and better transportation at lower costs. If one or more of the latter does not result from coordination, no one is going to be persuaded to coordinate. Furthermore, the extent to which cost reductions or service improvements occur as a result of coordination will depend on a variety of factors reflected in the costs of operation (although noncost factors can also play an important part—e.g., work practices and agency policy on social service objectives). In this context, it might be helpful to discuss the nature of transportation costs and illustrate some of the targets of opportunity for potential savings through coordination.

Data from the IPA state-of-the-art study summarized below show the relative distribution between operating and fixed costs for nine transportation programs serving the elderly and other transportation-disadvantaged persons (1, technical annex B).

	Category of Expense (percentage)		
Project	Operating Costs (labor, fuel, oil, tires, maintenance, insurance, and depreciation)	Fixed Costs (supervision, contract and administration, rent, and taxes)	Total
Senior Citizens Transport, Rhode Island	86	14	100
Human Services Transport, Chattanooga, Tennessee	89	11	100
Lift Line, Palm Beach County, Florida	87	13	100
YMCA Seniors on the Move, Chicago	52	48	100
Valley Transit District, Naugatuck Valley, Connecticut	66	34	100
Supplemental Transport, San Diego	81	19	100
Whistlestop Wheels, Marin County, California	70	30	100
Older Adults Transportation, Missouri	65	35	100
Rural Transportation Project, Pennsylvania	76	24	100

To the extent that the data permitted, differences in operating characteristics and cost definitions among projects were reconciled in the table. As can be seen, transportation costs can be segregated into two broad categories: (a) operating (variable) costs that change with the level of operations (e.g., number of passengers, vehicle distances traveled, or vehicle hours) and (b) fixed costs that are (relatively) insensitive to variations in operating level.

Operating costs include cost elements such as fuel, oil, drivers' wages, tires and maintenance, insurance, and depreciation. In the nine projects listed, operating

costs ranged from 52 to almost 90 percent of total costs, and efficiencies in operation through the elimination of duplication and overlapping services, centralized dispatching, and more effective use of capacity could be significant. Some of the possible operating cost reductions (such as quantity purchases and discounts) are relatively easy to achieve. More efficient use of capacity through centralized dispatching may be somewhat more difficult, especially if the systems attempting to coordinate have similar periods of peak demand. However, even where peak demands are similar, there are typical gains to be realized through centralized dispatching. Coordinated transportation projects can also result in cost savings associated with more efficient purchasing of parts and supplies through quantity discounts or centralized maintenance.

Fixed costs include administration, garages and other facilities, rent, telephone, and similar overhead items. The potential for reduction of fixed costs through coordination is associated with the elimination of duplicated physical facilities (such as garages and dispatching sites) and equipment and reduced management and administrative costs. From the table above, we can see that fixed costs ranged from 11 to 48 percent of total costs in the nine projects, which indicates that elimination of duplication and greater rationalization of the fixed-cost factors through coordination could result in substantial savings.

As to the specific magnitudes of potential economies, unfortunately, no projects have developed hard analytical data. It is hoped that the five demonstration projects sponsored by the Office of Human Development and recent social-service transportation-coordination efforts in Portland, Oregon, and other locations sponsored by the Urban Mass Transportation Administration (UMTA) will yield more data. There is considerable need for such data and, undoubtedly, it will be necessary to evaluate a number of projects before real information is developed on this issue. However, on an a priori basis and given that cooperative efforts may be easier with regard to such items as administration, joint maintenance, purchasing, garaging, and perhaps even fuel, the potentials for savings are likely to be significant.

Coordination Experience

Project operators surveyed by IPA did perceive coordination as desirable, and identified reduced overlap and duplication, more service capacity, greater productivity and operating efficiency, and reduction in cost of supplies and materials as some of the major benefits to be derived, corresponding to the cost benefits described above. Table 2 (2, appendix B) summarizes the specific coordination experiences of 20 projects. The findings of a detailed review of these projects and a survey of the experiences of state agencies on aging with transportation services for the elderly are reflected in the following discussion of coordination barriers and benefits.

Table 2. Coordination activities of 20 social-service transportation projects.

Name of Project	Coordination Activities		
	Public Transit	Other Special Transportation Projects	Social Service Agencies
Appalachian Ohio Region Transit Association (Ohio counties)	None	Backup vehicles for a few projects	Shared office and garage, information sharing
Belknap-Merrimack Community Action (New Hampshire counties)	None	Backup vehicle	Coordinated planning
Broward County Social Service (Florida)	Transit authority on advisory board	None	Vehicle maintenance, office space, information exchange
Cape May County Free-Fare System (New Jersey)	None	Incorporated into Cape May system	Office space in county offices garage facilities
City Wide Senior Transportation Service (Chicago)	Transit authority estimated costs, did financial analysis, and selected equipment	None formally	Planning survey participation
Community Action Transportation (Akron and Summit counties, Ohio)	None	Backup emergency vehicle	Preliminary coordination planning
Consolidated Agencies Transportation System (Brevard County, Florida)	Route planning, vehicle maintenance, emergency service, taxi, and garage	Backup emergency service	Liaison
Cranston Transvan (Rhode Island)	Rhode Island transit authority provides driver and maintenance at cost	None	Information sharing, client referral, participation on steering committee
Easter Seal Service (37 counties in Tennessee)	None	Information exchange, client referral, share maintenance and garage	None
Help on Wheels (El Paso and 5 counties in western Texas)	Assistance with 16b2 grant	Passenger referral	Advisory committee, routing and scheduling, project promotion
Human Services Transportation (Chattanooga)	None	Fully integrated	Fully integrated
Lift Line (Palm Beach County, Florida)	Fully integrated	None	Participation in planning
Maricopa County Motor Service (Phoenix and Maricopa counties, Arizona)	Limited	Scattered service supplied	None
Older Adults Transportation Service (Missouri)	Taxi service, contract with transit company	Joint use of equipment, information exchange	Information sharing, planning, shared office space, equipment leasing
Roanoke Agency Dial-a-Ride (RADAR) (Roanoke Valley, Virginia)	City sponsors both transit and RADAR	Limited, shared office space	Participation in planning, client referral
Senior Citizens Transportation, Inc. (Rhode Island)	Limited planning coordination	None	Client referral
Senior Handi-bus (Lincoln and Lancaster counties, Nebraska)	Transit authority operates project	Tries to avoid duplication	Client referral
Ten-County Rural Transportation (Southern Iowa)	Very little transit available	Unknown	Planning, information sharing
Valley Transit District (four cities in Connecticut)	Little to poor public transit	None	Planning and public relations
Whistlestop Wheels (Marin County, California)	Transit provides funding, evaluation, accounting, and taxi discounts	None	Information sharing, client referral, some sharing of drivers and vehicles

As can be seen in Table 2, there is a wide range of activities, ranging from fully integrated activities (Chattanooga) and transit funding (Marin County, California), to client referral and equipment and office sharing.

The experiences of the state agencies on aging are also relevant. Successful efforts of 41 agencies in 25 jurisdictions in FY 1975 in coordinating transportation funds under titles III and VII and the types of agencies participating are summarized below (2).

Type of Agency	Number of Times Identified	Percentage of Times Identified
Local social service	31	35.6
State, metropolitan, or local unit of government	21	24.1
State department of transportation	12	13.8
Nonprofit private	8	9.2
Area agency on aging	6	6.9
Regional or local transit	5	5.8
Private transportation	4	4.6
Total	87	100.0

(Because area agencies on aging are not generally permitted to directly operate transportation projects, they were only infrequently listed as coordinating transportation.) The types of activity by which coordination was achieved are summarized below.

Type of Coordination Activity	Number of Times Reported	Percentage of Times Reported
Improved working relations or communication (cooperation)	19	46.3
Improved communications	6	–
Improved working relations	4	–
Use of task force committees	5	–
Interagency agreements	3	–
Designation of a coordinator	1	–
Joint funding or use of equipment	11	26.8
Coordination of transportation services	9	22.0
Coordination of routes or schedules or both	5	–
Subcontract purchase of services	2	–
Joint promotion of program	2	–
Other	2	4.9
Total	41	100.0

The reasons why coordination efforts were successful are given below.

Reason for Success	Number of Times Given	Percentage of Times Given
Strengthened interagency relations made coordination possible	23	57.5
Expectation of reductions in duplication or fragmentation of transportation services	8	20.0
Expectation of improvement in mobility for the elderly and handicapped	4	10.0
Expectation of reduced overhead costs	3	7.5
Quality of coordination leadership	2	5.0
Total	40	100.0

In terms of types of agencies, the private and public local social service agencies were most frequently cited as successfully coordinating transportation services under titles III and VII (35 percent of the time). State, metropolitan, and local governmental units (other than social service agencies) were also important, but less so, being cited only 24 percent of the time. State departments of transportation were reported as participants in coordination activities 14 percent of the time and other agencies much less frequently.

In terms of types of coordination activities, greater levels of cooperation (improved working relations or communications) accounted for 46 percent of the coordination activity reported. Joint funding or equipment or both accounted for 27 percent and coordination of services for an additional 22 percent. Taken together, the latter two activities accounted for more than half of the coordination activity reported, suggesting that coordination in many cases had moved beyond improved working relationships.

Finally, strengthened interagency relations were most frequently cited as the reason for successful coordination (57.5 percent of the responses). The remaining responses attributed successful coordination to both the recognition of the desire to obtain the benefits associated with coordination—reduced duplication and overlap of projects, lower overhead costs, and more transportation services available for the elderly and handicapped.

Benefits

The specific benefits from coordination identified bear repetition.

Reduced Duplication and Overlap

Reduced duplication of management and administrative tasks is one of the potential benefits of transportation project coordination most often emphasized by the operations surveyed. Anywhere from 10 to 50 percent of total project expenditures are spent for the fixed-cost items of general supervision, administration, and overhead. Much of this must be expended to a fixed minimum level for even the smallest uncoordinated project for such items as grant application and monitoring, public relations, clerical record keeping, bookkeeping, payroll and cost accounting, and renewal of licenses and contracts. The marginal cost of these items for project expansion is small, and the potential savings by eliminating duplication through coordination is considerable.

Increased Service Capacity

Increased service capacity was identified as another benefit of coordination. The transportation providers surveyed defined coordination as expansion of service to more clients, agencies, trip purposes, and larger areas of operation, and expansion of capacity was seen as a prerequisite for rather than a result of coordination; i.e., many believed that additional available capacity must be already in operation to draw in other agencies and sponsors.

Improved Vehicle Productivity and Operating Efficiency

Increased operating efficiency in terms of vehicle use in scheduling is another potential benefit of coordination that was generally identified by project operators and state agencies on aging. Project operators were aware of many small and uncoordinated transportation projects in their areas that used their vehicles for only a few hours per day or week and that coordination could improve the level of vehicle use by distributing the use of a vehicle over many programs.

Of interest, in this context, is that almost all the projects surveyed noted that they had empty seats on demand-responsive trips—especially medical trips. However, they also observed that this unused capacity did not necessarily constitute potential excess capacity for project expansion. It was their view that unused ca-

Table 3. Barriers to coordination of social-service transportation projects.

Type of Barrier	Number of Times Reported	Percentage of Times Reported[a]
Funding and associated problems		
Lack of continuity	10	12.4
Restrictions on use	7	8.6
Insufficient available (federal and state) funds	6	7.4
Lack of matching funds	4	4.9
Subtotal	27	33.3
System-operation problems		
Conflicting schedule or route requirements	6	7.4
Conflicts with franchised transportation operations (e.g., taxis and handi-cabs)	5	6.2
Difficulty in obtaining insurance coverage	3	3.7
Conflicting vehicle requirements	2	2.5
Conflicts in funding cycles or accounting requirements and phasing	2	2.5
Subtotal	18	22.3
User or client restrictions		
User eligibility restrictions	11	13.6
Incompatibility of clients	3	3.7
Difficulty of mixing subsidized and nonsubsidized riders by public transit	1	1.2
Subtotal	15	18.5
Planning and organizational problems		
Lack of third-party coordinating structures or operators	6	7.4
Lack of technical information and expertise	4	4.9
Problems of turf	3	3.7
No program to coordinate	1	1.2
Subtotal	14	17.3
Conflicting state or federal interpretations and guidelines	7	8.6
Total	81	100.0

[a]May not add due to rounding.

pacity is a natural consequence of the inherent inefficiency of demand-responsive transportation. However, whether increased vehicle use can be translated into increased load factors (average vehicle occupancy) depends to a considerable extent on the pattern of peak loads, the time distribution of trip demands, and the trip purposes allowed by the project. In general, coordination usually permits a broader market of trip demands and provides for greater vehicle use and higher vehicle occupancies. Where projects have the same peak demands and similar trip ends, major increases in vehicle use and occupancy levels may not be possible, but if only one or a few vehicles can be used to serve the combined clients of a number of projects in a single area, wasteful overlap may be avoided.

Insofar as productivity, in terms of ridership, is concerned (i.e., riders per vehicle hour), recent data on on-call or real-time dial-a-ride systems suggest a range of 5 to 10 riders/vehicle·h (7, 8). The overall average ridership productivity for all the projects surveyed was about 3 to 5 riders/vehicle·h (i.e., generally lower than on-call dial-a-ride service). Since most of the projects surveyed used some form of advance reservation and scheduling system, they should have been more productive than on-call dial-a-ride systems, which further suggests that the potential for improved productivity and more efficient vehicle use through coordination is probably substantial. However, it should be kept in mind that many of the projects were probably operating at close to capacity during peak periods and that the overall average is for all the systems and therefore should be interpreted with considerable caution.

Cost Reductions in Purchases

Finally, cost reductions in the purchases of supplies, materials, or equipment is another potential benefit of coordinated transportation services. Cost reductions in the purchase of supplies and materials result from discounted prices for large-quantity purchases of gasoline, oil, and tires; centralized maintenance, repairs, and purchase of replacement parts are particularly susceptible to this cost-saving advantage. Many projects achieve this benefit at present by combining their demands for supplies and materials (typically gasoline and mechanical maintenance) and purchasing them from a central supplier (often a municipal or county garage or a commercial service station). Insurance discounts were identified as available for large-volume coverage, but some project operators express doubt of this benefit. Insurance rate setting for social-service transportation projects is not universally established at this time, and some operators report insurance increases for combinations of clients with multiple disabilities. Projects that transport elderly, handicapped, and exceptional clients (mentally retarded and epileptic persons, for example), sometimes have excessive insurance premiums.

The capital cost of vehicles can also be reduced by consolidated purchases of equipment, particularly from commercial dealers of vehicles.

BARRIERS TO COORDINATION

Although the benefits of coordinated transportation services are substantial, there are a number of important barriers. These have been identified and cited above. Again, experience is invaluable as a source of documentation of the problems actually encountered at the project planning, implementation, and operating levels. Some of the barriers reported are summarized in Table 3.

Of 32 state agencies on aging responding to the question of whether they had encountered any stumbling blocks to the coordination of transportation services, 28 (80 percent) reported experiencing a variety of problems. There is little reason to doubt that the difficulties reported by the 28 reflect the experience of all.

The 81 answers identified problems experienced or anticipated in five major categories: funding, system-operation problems, client restrictions, organizational problems, and conflicting state and federal interpretations and guidelines.

According to the reports, funding is the primary barrier to coordination; indeed, one-third of all barriers were related to funding. Of particular importance within that category are the lack of funding continuity and restrictions on the use of funds.

A second major category of barriers was related to system operations. Twenty-two percent of all the responses were in this category. Specifically identified were conflicting schedule and route requirements (the need for service at similar peak periods) and conflicting vehicle requirements (special equipment). Other constraints (immediate or potential) are those caused by conflicts with existing franchised operators (such as taxi services) and difficulty in obtaining insurance coverage.

User or client restrictions were perceived as barriers by almost 20 percent of the state agencies responding. Specifically, eligibility restrictions were identified as a primary problem, but the difficulties of mixing the clients of different agencies (incompatibility) and subsidized and nonsubsidized riders were also perceived as impediments to coordinating services.

Planning and organizational problems were cited in 17 percent of the responses as barriers to coordination. The most significant finding in this category was that coordination was impeded by the absence of a third-party or neutral organization (outside the social service agency structure) that could serve as a project developer or op-

erator. (If a third-party role could be developed for public transit, it could be expected to serve as an important mechanism for coordinating special transportation service operations. Taxis, for example, represent an important potential with considerable experience in operating special services on a demand-responsive and door-to-door basis.) This response suggests a need for organizational mechanisms to help bring together the present range of social service agencies.

Finally, conflicting state and federal interpretations of regulations and guidelines were reported as barriers in 9 percent of the responses. This suggests that perceptions of the regulations and guidelines may be more of a barrier to coordination than are the regulations themselves.

The most striking observation to be made about the barriers to coordination identified is that so few are directly linked to some type of statutory or legal inhibition (user eligibility and franchise conflicts). The remaining barriers (almost 80 percent) are primarily associated with regulations, rules, administration, funding, operating problems, and the perceptions of coordination. Most of these barriers are susceptible to change providing there is appropriate leadership and assistance—especially at the federal level.

Forty-seven agencies or individuals were interviewed by telephone and their comments recorded. These witnesses were project operators; representatives of public transit systems, private social-service transportation agencies, and state-level transportation and human resources departments; area agencies on aging; advisory groups on aging; owners of charter bus operations; and specialists in the aging and transportation fields. By and large, their comments corroborated the findings from the state agencies on aging.

Thus in reviewing the barriers identified by project operators, state agencies on aging, and witnesses, it becomes apparent that these barriers fall into two broad categories:

1. Statutory and regulatory barriers and
2. Administrative, institutional, and perceptual barriers.

Statutory and Legal Barriers

The category of statutory and regulatory barriers includes the inhibiting effects of user or eligibility restrictions and of franchise and labor problems.

User or Eligibility Restrictions

Efforts to combine social programs or pool transportation facilities are frequently frustrated by user or eligibility restrictions. Many social agency programs cannot serve all groups and legislation is frequently designed to serve only special groups, so that merging the transportation demands of a number of agencies and programs is difficult. Differences in age, income, or location requirements may make agencies resistant to any combination of effort with other agencies because of the difficulty of allocating costs and designing an operational system. Although no statutory prohibitions may exist, the categorical nature of the programs, coupled with the regulations, certainly inhibits coordination.

There have been a number of complaints about the paperwork (and the eligibility) requirements of title XX. The new rules on group eligibility probably will help, but unfortunately, it appears that the Joint Simplification Act does not apply to direct payments and may, therefore, not be significant for the paperwork requirements of title XX nor to titles III and VII of the Older Americans Act.

Franchise and Labor Problems

If transportation projects are run by public transit companies, their costs will be higher than if they are run by social service agencies independently—primarily because of wage-level differences. In addition, in many cases, operation of a transportation service for older Americans or other transportation-disadvantaged persons by using public transit facilities and networks may require franchise modifications or face legal conflicts with taxi operators—especially if demand-responsive services are included. These difficulties become more important when fares are being considered, because fare approval and franchise authority for specific services and routes may be required from a public utility commission or equivalent body.

For social service agencies (who are mainly concerned with providing the social services themselves), the roadblocks may seem insurmountable and not worth the effort. The difficulties include obtaining a new franchise and negotiating a labor agreement (perhaps for changes in wages, or even more critically, operating practices that would permit hands-on personalized service).

Administrative, Institutional, and Perceptual Barriers

In addition to the statutory and legal barriers, a number of administrative, institutional, and perceptual barriers were identified. These are discussed below.

Regulations (Administrative and Otherwise)

Federal and state grant restrictions and regulations were targeted as additional barriers to coordination by project operators and others. However, administrative rulings appear to have had more actual impact on potential coordination than the federal statutes or regulations—especially when the rulings were restrictive or inconsistent. In general, the major complaints about regulations were that they were being interpreted in a variety of ways, especially by the states. More specifically, comments on the regulations included the following: (a) the regulations were being interpreted narrowly, thereby providing a limited scope for coordination activity; (b) there was fear of bending the rules, especially at the local level, which also tended to inhibit coordination activity; and (c) state and federal interpretations were often inconsistent.

Perceptions of program eligibility restrictions seem to inhibit coordination primarily at the development stage; problems of conflicting restrictions seem to be reconciled or outmaneuvered after a system has begun and there is a commitment to its survival and success.

Accountability

One of the most frequently identified problems in coordination—sometimes experienced as a barrier to initiating a coordinated system and sometimes to extending coordination—is the accounting problem of servicing programs with differing eligibility restrictions. All sorts of complex juggling maneuvers are used—separate books, separate bank accounts, and daily posting of charges on estimated ridership under different programs. (For example, one Louisiana system had eight different funds in eight banks.)

Concern was expressed about the problems of varying auditing interpretations and the need to keep elaborate records for accountability requirements. In fact, two programs that had coordinated funding were in the courts

settling differing auditing interpretations from the two different agencies.

Lack of Knowledge of Transportation Costs

Many social service agencies have little idea of their total costs for transportation, so that there is little impetus to participate in a coordinated system where the charges are enumerated and may seem higher than independent provision of service. There are two elements to this barrier: (a) agencies underestimate the real cost of transportation—if they understood what those costs were, they would be more willing to cooperate to lower them or buy taxi or public transit services and (b) in most agencies the costs of transportation are merged with those of other activities, making it difficult to develop cost-sharing agreements or arrangements with other groups.

Turf Protection

Concern about the protection of turf was frequently identified as a barrier to coordination. Most persons are concerned with the preservation of their agency's identity and do not like losing control over their vehicles. Private agencies are particularly reluctant to pool because of concern about loss of their identity.

One of the more relevant comments on turfism was the observation that, in some respects, it is a good thing. It is appropriate that agencies be concerned about their clients and that they receive adequate transportation services. Agencies should be concerned about giving over the transportation responsibilities to someone else who might not provide service in a form appropriate to their client needs, and this is even more true if the third party is new and untried.

Preferential Treatment to Clients

Many project operators were not enthusiastic about coordination. However, their support for the concept seemed to be related to their size. Small social service agencies were often willing and enthusiastic to coordinate—especially if they had little or no service of their own. Large operators, on the other hand, expressed fear that they would lose control of their project or that service would be unreliable.

There was considerable concern that the prime or lead coordinating agency might give preferential transportation treatment to its own clients. Thus, the social service agencies themselves may not be the best institutions to assume the lead-agency role in providing coordinated transportation. Operators and state agencies felt that third-party providers would be more impartial in operation and thus were less skeptical about possible lost prerogatives with such arrangements. The survey responses suggest, therefore, that coordinated-transportation project operators should not be directly involved with the delivery of social services also, but rather that independent authorities—particularly city, county, or council-of-government organizations—function as the third-party operators. Although public transit was mentioned, operators and agencies had a number of concerns about this.

Public Transit

There was general concern that public transit is not terribly interested in serving as a third party for either planning or operation. There was also opposition to public transit serving as the third-party provider of service because of the perceived problems of reduction in the social service nature of special transportation and increased costs for service. Small cities often do not want to absorb the subsidy costs that such projects entail. The survey respondents also noted that sometimes transit authorities are confined to specific city boundaries and, therefore, cannot serve many clients who live beyond the authorized operating boundaries. In addition, many agencies felt that if transit became an operator or a participant in such projects, they would be subject to section 13c (the labor clause) of the Urban Mass Transportation Act. That would sharply increase the project costs. Concern was also expressed that public transit operators cannot take advantage of section 16b2 funds because these funds are restricted to private, nonprofit agencies.

Mixing Clients

Some concern was expressed about mixing clients. Coordination was not considered to be universally applicable. A number of programs have clients that cannot readily be mixed. There are also programs in which transportation plays a special role in the primary service (e.g., employment training in drug rehabilitation programs) and other significant reasons for projects to remain exclusive. It was observed that the elderly are unwilling to mix, but it was not possible from the comments to determine whether it is the elderly or the elderly's advocates who are concerned. There was a consensus that, though sensitivity training might ease the problem, a barrier would remain.

Discontinuity of Funding

Through all of the work, there were repetitive complaints about the amount of available funds and the lack of continuity of funding. Of particular importance to the question of continuity of funding is the problem that, in coordinating, a whole system could be jeopardized by the loss of a single funding source. The question of project funding continuity often expresses itself as a need for either more operating or capital funds. In fact, both are needed.

SOME DIRECTIONS FOR IMPROVED COORDINATION

Within the framework of this paper, it is not possible to explore in any detail the solutions and approaches being used or that might be used to increase transportation coordination efforts throughout the country. However, I would be remiss if I did not at least mention a few. In that spirit, and without trying to inventory every possible alternative, some of the major solutions that have been used or could be experimented with—particularly at the project level—are described.

Policy and Planning

Legislative Review

1. Congress could set aside transportation funds for major categorical social programs that could be offered as an incentive available only to local communities and regions showing coordination of transportation services among agencies.
2. In view of the recognized importance of volunteers in providing transportation services to the elderly, there is a distinct need for noncash incentives to reward and encourage volunteer participation. Specifically, these should include (a) revisions in the U.S. tax codes to permit travel deductions for volunteer activities corresponding to those permitted for business travel and (b) state

and local legislation to make available tax-free fuel and low-cost automobile parts and services to volunteers.

3. Because state agencies on aging and other agencies concerned with coordinating transportation have indicated that actual or potential franchise conflicts frequently limit coordination, state legislatures might review the statutes and regulations of their utility commissions to eliminate or reduce conflicts between social service transportation and franchised operators.

Organizational Needs

1. Social service agencies have expressed the need for a neutral third party to plan and operate coordinated transportation services, and despite the expressed apprehension of some agencies, public transit has the skills and neutral status to fill this role. DOT and HEW should jointly explore ways in which public transit can be encouraged to serve as such a third party.
2. Many agencies need guidance in organizing and planning coordinated transportation services. HEW and DOT could jointly develop organizational models for use by local service providers.

Strengthened Interagency Relations

Improved interagency working relations and communications were frequently cited by state agencies on aging and witnesses as one of the most important factors leading to successful coordination of transportation services. To further improve both relations and communications, it is suggested that

1. Interagency coordination be accelerated by encouraging more federal and state interagency working agreements;
2. A more intensive program of information sharing that includes transportation planners and operators as well as social service agencies be undertaken at the state and local levels with federal support and participation; and
3. States must make fuller use of interagency coordinating committees or task forces to provide better policy direction and review of transportation needs, and greater use should be made of federal executive boards and regional councils.

Improved Regulations and Administrative Procedures

1. In view of the many complaints about administrative and accounting problems (e.g., mismatches in budget phasing, billing cycles, and cost definitions), a study should be made of the basis for rationalizing such matters. For example, there should be agreement on a set of auditing rules to be used by all federal and state agencies.
2. The use of waivers and integrated grants for coordinating funds for the delivery of transportation services should be extended and made easier.
3. The problems associated with funding transportation projects that were reported to be inhibiting coordination (e.g., treatment of depreciation and disposal of vehicles that makes coordinated vehicle use difficult, the use of multiple sources of funding that may mean multiple justifications each year for renewed funding, the 1-year life span of agency agreements and funding cycles that adds uncertainty to operations, and that reduction or cuts in the funds of one coordinating agency may jeopardize the entire project) should be reviewed and a program undertaken to eliminate or reduce their impact on coordination.

Long-Range Planning Improvements

1. In the long run, effective coordination requires that social-service transportation needs be integrated into the transportation planning process. Examples of such integration are (a) a sign-off role for social service agencies in transportation planning grants; (b) requiring that the transportation needs of the elderly be considered in the location decisions for social services, housing, and other aspects of urban planning; (c) a more formalized role for area agencies on aging in regional transportation planning activities; and (d) the location of multipurpose social service centers near good shopping centers and other services. These can provide a number of economies and improve the potential for coordinating the operations of transportation services (it is recommended that the use and development of such centers be encouraged by HEW and HUD).
2. Coordination should be pursued more actively at the local level. Given that some of the administrative and regulatory blocks are largely perceptional, strong local efforts and support could help change these perceptions. The commitment and leadership of local government is essential to coordination.
3. The greater use of multipurpose social service agency centers located near activity centers such as shopping and offices would help in planning and operating coordination services—especially in rural areas.

Operational Alternatives

1. Because there is at present no vehicle that can be used interchangeably for a wide range of transportation needs (e.g., for work trips, for the elderly, the disabled, and the young), the coordination of transportation services among agencies and with public transit is made more difficult. DOT, jointly with the states, should develop specifications for equipment that is better suited to special transportation needs, particularly vehicles for fewer than 15 passengers.
2. Because difficulty in obtaining insurance coverage for coordinated transportation is a frequent problem, state departments of human resources in cooperation with state insurance commissions should explore the feasibility of state-guaranteed insurance programs for coordinated transportation projects.
3. Because many agencies find that variations in the definitions used for transportation costs make coordination difficult, DOT should prepare a reasonably simple set of common cost definitions that could be used by social service agencies attempting to pool transportation funds.
4. The expansion of paratransit options—including more use of taxis and shared rides, userside payments, and broader based transit agencies—should be explored.
5. Sensitivity training of drivers, agency staff, and clients could reduce the problem of mixing clients on transportation systems.
6. Transportation clearinghouses where trip needs and vehicle capacity (seats) might be available to all agencies so that they could exchange capacity without being formally integrated should be established.

Research

Better data on the cost advantages of coordination should be developed.

ACKNOWLEDGMENT

The information given in this paper comes from four basic studies in which IPA has been involved:

1. A recent updating of the AoA state-of-the-art report;
2. A transportation coordination study for the Urban Mass Transportation Administration;
3. A special study of the transportation problems of the disabled for the Office of the Assistant Secretary of Planning and Evaluation of HEW; and
4. A series of three workshops on service and funding coordination sponsored by HEW and DOT.

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Coordination of Human Service Agency Transportation: Evaluation Method

V. Clayton Weaver, Northeastern Illinois Regional Transportation Authority, Chicago

The topic of the coordination of transportation services among human service agencies has become very popular in the past few years. The involvement of these agencies, whose initial mandates probably did not include transportation, creates the potential for such problems as duplication of services, higher than necessary costs, and equipment maintenance difficulties. While transportation service coordination is desirable, it is a difficult task. One of the major problems is the lack of experience in analyzing agency transportation programs. This paper presents an analytical methodology that should assist in service evaluation and, therefore, the development of coordination plans. Two fundamental questions that must be considered before any coordination plan is developed are addressed. First, how much coordination is good for any particular agency? Criteria were developed to assist in the determination of which agencies would benefit from service coordination and which would not. Agencies were found to vary greatly in the degree of coordination that is useful to them. Second, just what is meant by service coordination? Is it a motor pool of vehicles? Is it a centralized maintenance facility? Or is it a coordinated transportation service with especially designed vehicles and professional drivers? A method is presented for matching the needs of the agencies with the services provided through the concept of a transportation support center that can be developed in phases and offer a range of services to be purchased by agencies according to their need.

If Mr. Smith were to open a rail line between Chicago and Detroit and a month later Mr. Jones were to open a parallel line, most people would probably agree that the resulting competition would be a good thing. But what if Mr. Smith and Mr. Jones had both used federal funds to build their rail lines? Instead of the praise for competition, there might be an outcry against the duplication of services and the waste of taxpayers' dollars. To some extent, such an outcry is now being heard with respect to social service transportation programs. But are such programs really duplicating services and wasting taxpayers' dollars?

BACKGROUND

In recent years, most major cities have invested significant resources in the provision of public transportation services. These investments have largely emphasized programs useful for the average citizen, that is, for the greatest number of people.

However, because the specific needs of individuals can be so varied, this approach does not fulfill all transportation needs. In response to this situation, agencies such as those associated with human services have also entered the transportation service field. Moreover, this response has been partly stimulated by the availability of funds through state and federal programs that allow these agencies to purchase vehicles and provide services.

The result is that many of these agencies are now in the transportation business to serve persons who, because of physical and mental conditions, cannot make use of general public transportation. The involvement of these agencies, whose initial mandate probably did not include transportation, creates the potential for such problems as higher than necessary service costs and duplication of services.

Because of these potential problems, many funding agencies are now asking, "How well are you spending our money?" and "Are you duplicating your neighbors' transportation programs?" and as a result, many regions are beginning to undertake the coordination of transportation services offered by human service agencies. This was the case in Rochester, New York, where the Rochester-Genesee Regional Transportation Authority and the United Community Chest of Greater Rochester jointly commissioned a study to formulate a plan for service coordination.

HISTORY OF ROCHESTER STUDY

While the initial emphasis of the Rochester study was to develop a program for coordinating the transportation services of the many human service agencies, it soon

Table 1. Example of service evaluation.

Type of Agency	Transportation Services Provided	Major Problems	Coordination Opportunities	Service Expansion
Neighborhood centers and settlement houses	Wide variety of program transportation; little transportation to and from centers; emergency transportation very important; heavy reliance on staff as drivers; much service on individual basis for social services and medical purposes	Lack of equipment; vehicle maintenance; need for large vehicles during summer months; emergency or unplanned travel that frequently ties up staff members for extended periods	Some centers would be able to share equipment; a maintenance pool would benefit all; true service coordination opportunities appear rather limited, although senior programs offer some potential; costs are fairly low (due to use of staff) and, therefore, cost reductions will be difficult	Nutrition programs and day-care transportation only areas cited for much expansion
Physically handicapped clients	Daily commuting (8:00 a.m. to 4:00 p.m.) to and from facility; vehicle with wheelchair lift needed; attendant usually required; service must be door-to-door; same clients every day; some program transportation between 10:00 a.m. and 2:00 p.m.	Sharp peaks in demand caused by commuting needs of clients; high cost of vehicle maintenance; lack of vehicle reliability due to maintenance problems; some clients required to spend long periods of time in vehicle (up to 2 h); vehicle replacement	Service coordination appears feasible and desirable for commuting trips; use of taxi service to supplement agency transportation appears possible; maintenance and motor pool appears desirable; cost-effectiveness may be improved (because of use of paid drivers)	Demand fairly stable
Day-care centers	All transportation is for programs; little, at present time, to move children to and from centers; buses needed because of group size; staff members used as bus drivers; expanded services in summer months	Vehicle replacement	Little potential for service coordination; little opportunity to improve cost-effectiveness (because staff used for drivers)	Little growth in demand; few additional programs anticipated

became clear that this was a complicated problem that was significantly more than one of simply coordinating routes and schedules. One of the major problems was a lack of experience in assessing agency transportation activities. This required that a great deal of effort be spent in developing a methodology for carrying out the study.

Two basic issues seemed to be ever present as the methodology was developed. First, "What really is service coordination?" and second, "How much coordination is good for any particular agency?" Service coordination can mean anything from a motor pool of vehicles to a special service with professional drivers or a simple information-and-referral system. Developing ideas for coordination was the easy part of the study. What was difficult was deciding how much, or what level of service coordination, would be useful for a particular agency.

STUDY METHODOLOGY

The methodology used had two basic parts. The first part was an inventory of the agency services available. This inventory was broadly defined to include not only transportation, but also other agency services, client needs, and overall agency objectives. This broad understanding of the agencies was essential if the transportation improvements were to meet agency needs.

The second part was a more detailed analysis of service efficiency and effectiveness. During this detailed analysis, several evaluation criteria were developed to assist in determining the proper levels of service coordination for individual agencies. The use of these criteria provided a quick way to assess the needs of a particular agency and to match those needs with transportation improvements.

Inventory

The 25 study agencies represented a broad spectrum of human service activities. They provided services to clients in the areas of physical and mental rehabilitation; family counseling; day care; youth programs; job training; senior citizen programs; and emergency needs such as food, shelter, and clothing.

The transportation programs offered by the agencies varied as widely as did the agencies themselves. Of the 25 agencies, 19 provided transportation with their own equipment and personnel, while the remainder contracted for services. The 19 agencies had a combined total of 104 vehicles and a 1975/1976 fiscal year expenditure for transportation of about $620 000 (although many hidden costs, such as overhead and management were not included).

In-depth interviews conducted with the agencies proved to be an essential element of the study. Only by spending considerable time and effort could one become familiar enough with the agencies, their programs, and their transportation needs to identify ways in which their services could be coordinated.

The interviews were helpful in identifying the types of services the agencies were providing, what their problems were, the areas in which they felt service coordination could be useful, and the additional services they felt needed to be provided. Table 1 presents an example of this evaluation.

On the basis of the interviews, seven recurring problems were identified.

1. Information dissemination: There was no effective way to disseminate information among the various agencies. Therefore, many agencies were duplicating services without even knowing it.
2. Record keeping: The existing record keeping systems of the agencies were not adequate. This presented a major problem for the evaluation of operations.
3. Program: Transportation is often a vital part of the agency programs being offered. The separation of transportation and program may not be possible for some agencies.
4. Vehicles: Maintenance and the purchase of equipment was both expensive and a problem for most agencies.
5. Drivers: There was a need to retain the use of volunteer and staff drivers whenever possible. Driver training was almost nonexistent.
6. Demand peaks: Sharp peaks in demand caused by the need to move clients from their homes to agencies caused a problem that is similar to the transit industry's peak-to-base problem.
7. Funding: Financial resources were limited and frequently restricted. There was a need to develop a more permanent funding source for special services.

Table 2. Productivity measures.

Type of Agency	Vehicle Fleet	Annual One-Way Person Trips	Daily Productivity
Neighborhood centers and settlement houses			
Action for a Better Community	8 automobiles and 8 vans or buses	14 000	3.4
Baden Street Settlement	2 automobiles and 2 vans or buses	7 200	6.9
Lewis Street Center	1 van	7 500	28.8
Total	10 automobiles and 11 vans or buses	28 700	5.3
Physically handicapped clients			
Rochester Area Multiple Sclerosis	1 automobile and 1 van	4 936	9.5
Association for the Blind	2 vans or buses	24 424	47.0
United Cerebral Palsy	2 buses	14 946	28.7
Total	1 automobile and 5 vans or buses	44 306	28.4
Mentally handicapped clients			
Association for Retarded Citizens	1 automobile and 3 vans	14 560	14.0
Monroe Development Service	7 automobiles and 23 vans	46 800	8.7[a]
Total	8 automobiles and 26 vans	61 360	9.3
General assistance: Salvation Army	2 automobiles and 3 vans or buses	56 000	43.1
Senior citizens: Jewish Family Services	1 van	3 500	13.5
Other medical services: Medical Motors			
General	5 automobiles	16 406	12.6
Radiation	2 automobiles	6 025	11.6
Vans	5 vans	25 826	19.9
Total	7 automobiles and 5 vans	48 257	15.5

[a]Based on 180 d of operation.

In a more positive sense, the inventory of agency activities helped to identify coordination opportunities. Although the agencies could have benefited from a wide range of improvements, the areas with the most potential for multiagency applicability were (a) the vehicle fleet, (b) coordination of routes and schedules, and (c) the sharing of support facilities.

Several opportunities for coordination were identified that dealt with the vehicle fleet. One such opportunity was a systemwide maintenance program. Most servicing could be conducted at contract maintenance facilities; such centralization should lead to a better maintained and, therefore, more reliable vehicle fleet. Another opportunity was a leasing pool from which individual agencies could lease vehicles. The pool would be responsible for purchase and maintenance of vehicles, including spares, and insurance. The use of a spare vehicle from the pool would allow the individual agencies to have constant service that was not interrupted by the need for maintenance.

Another significant area for coordination was that of actual routes and schedules. Several of the agencies had surges in service demand between 7:00 and 9:00 a.m. and between 2:00 and 4:30 p.m. These surges or peaking effects were caused by the need to transport clients from their homes to the service centers. Once at the service center, there was a need for midday transportation related to agency programs, but this was normally at a lower level of demand in terms of vehicle requirements. In contrast, there were other agencies with higher midday travel demands—such as the senior programs at the settlement houses and the nutrition programs. Because of these time differentials, it appears that there is a realistic opportunity to coordinate the services provided by these two types of agencies (high morning and evening peak movements and high midday demand). The key benefits of such coordination are improved vehicle productivity (passengers per day per vehicle) and more effective use of salaried drivers.

A third coordination opportunity may exist for those agencies that can share support facilities, such as administration, scheduling, dispatching, accounting, and purchasing. This would be compatible with both maintenance pooling and vehicle sharing.

Service Efficiency and Effectiveness

The second step in the methodology was a review of the efficiency and effectiveness of existing agency transportation programs. Several measures of system efficiency were defined. These measures were grouped into two categories: vehicle productivity and cost of service. The first category attempts to define how much and what type of service is provided, and the second defines the cost of providing that service.

Vehicle Productivity

The study agencies had a fleet of more than 100 assorted vehicles. The use of these vehicles varied widely among the agencies. Table 2 summarizes the vehicle productivities of the 11 agencies that operated their own vehicles and had adequate ridership records. Vehicle productivity varied from 3.4 to 47 one-way person trips/vehicle/d.

To a large extent, vehicle productivity was directly related to the nature of agency activities. Agencies that provided a variety of programs for a variety of clients (such as the neighborhood centers) had a lower productivity than those (such as the Salvation Army) that focused on large group activities. The Association for the Blind had a high vehicle productivity due in large part to the fact that they provided transportation to nutrition sites.

Thus, this analysis seemed to indicate that gains in vehicle productivity were likely to result from service coordination. However, there is a group of agencies for whom service coordination may not produce productivity gains because of the nature of the agency activities. Efforts toward productivity improvements should be focused on those agencies with clients who make repetitive trips (such as home-to-agency trips for rehabilitation) or that have groups traveling together. Finally, significant gains may be produced by matching agencies that have travel demands at different hours of the day.

Cost of Service

The next major factor reviewed was the cost of service. Table 3 presents a summary of the base costs (defined as direct operating expenses plus insurance, but not including wages, administration, or general overhead) and total costs. Examination of the base costs showed a

Table 3. Transportation operating statistics.

Type of Agency	Annual One-Way Person Trips	Base Cost (operating + insurance) ($)			Total Cost ($)		
		Annual	Annual/ Vehicle	Per Person Trip	Annual	Annual/ Vehicle	Per Person Trip
Neighborhood centers and settlement houses							
Action for a Better Community	14 000	18 000	1125	1.29	48 000	3 000	3.43
Baden Street Settlement	7 200	5 978	1495	0.83	16 460	4 115	2.29
Lewis Street Center	7 500	2 365	2365	0.32	3 565	3 565	0.48
Total	28 700	26 343	1254	0.92	68 025	3 239	2.37
Physically handicapped clients							
Rochester Area Multiple Sclerosis	4 936	3 692	1846	0.75	27 629	13 815	5.60
Association for the Blind	24 424	8 180	4090	0.33	71 830	35 915	2.94
United Cerebral Palsy	14 946	14 205	7103	0.95	24 662	12 331	1.65
Total	44 306	26 077	4346	0.59	124 121	20 687	2.80
Mentally handicapped clients							
Association for Retarded Citizens	14 560	12 023	3006	0.83	46 688	11 672	3.21
Monroe Development Services	46 800	26 500	883	0.57	100 500	3 350	2.15
Total	61 360	38 523	1133	0.63	147 188	4 329	2.40
General assistance: Salvation Army	56 000	11 837	2368	0.21	12 605	2 521	0.23
Senior Citizens: Jewish Family Services	3 500	1 612	1612	0.46	17 764	17 624	5.08
Other medical services: Medical Motors							
General	16 406	11 742	2348	0.72	89 771	17 954	5.47
Radiation	6 025	4 697	2348	0.78	35 911	17 956	5.96
Vans	25 826	11 393	2279	0.44	90 827	18 165	3.52
Total	48 257	27 832	2319	0.58	216 509	18 042	4.49
Grand total	242 123	132 224	1674	0.55	586 212	7 420	2.42

surprising unanimity in unit costs. Generally, it costs about $1500 to $2000/year to operate each vehicle (although this varied from $883 to $7103).

Higher than average base costs usually indicated one of two things—either a high cost for maintenance or an extensively used vehicle (which results in larger direct costs for items such as fuel). For example, the Association for the Blind had a base cost of $4090/vehicle. While this was about twice the norm, their vehicle productivity of 47 trips/d was the highest of any. On the other hand, United Cerebral Palsy had a base cost of $7103/vehicle that could not be attributed to high vehicle use, but rather reflected an unusually high cost of maintenance.

The average total cost per one-way person trip was about $2.50, and the range varied from $0.23 (Salvation Army) to $5.96 (Medical Motors). Although it is not always the case, improvements in cost-effectiveness may be easier to achieve for agencies with high unit costs.

To assess the general characteristics of the study agencies, productivity and unit-cost analyses were also carried out for the functional categories of agencies (Table 3). Some rather interesting differences were apparent among the types of agencies. For example, three types of agencies—neighborhood centers and settlement houses, those with physically handicapped clients, and those with mentally handicapped clients—all had unit costs of about $2.50/passenger, but different factors were involved. The neighborhood centers tended to have rather low vehicle productivities, but also rather low expenditures for drivers' wages and overhead. The agencies with physically handicapped clients had high annual costs per vehicle (both base and total), but also high vehicle productivities that kept their unit costs per passenger about the same as those of the neighborhood centers. The agencies with mentally handicapped clients had a combination of rather low costs of operation and also low rates of productivity.

One group of agencies—the general assistance group—had a very low unit cost per trip. This was because of a combination of high productivity, few costs other than those of gasoline, oil, and maintenance (of course, some labor and administrative costs were hidden), and high vehicle productivity that resulted from group trips. This review of operations provided a great deal of insight into agency activities, their needs, and opportunities for service improvements. It indicated the importance of improved vehicle productivity, the continued use of staff and volunteer drivers, and the desirability of avoiding the establishment of another formal structure and its subsequent administrative and overhead expenses.

EVALUATION CRITERIA

To assist in the development of a program that would match the needs of the agencies with the services provided by a coordinated system, several criteria were developed. These criteria provided a simple way to quickly examine a group of agencies to see what type of coordination might be needed. Remember that the real question to be addressed was how much service coordination is good for a particular agency.

The end product of this analysis, a summary of evaluation criteria, is given in Table 4. The first criterion is the ratio of base cost to total cost. This is an index of the salary, administrative, and overhead costs. An index of 1.0 indicates that all costs are base costs (direct operation and insurance). It may be difficult to lower the expenditures of agencies with a very high ratio of base cost to total cost (such as Hillside Children's Center, St. Joseph's Early Childhood Program, the Salvation Army, and Children's Nursery). Therefore, those agencies may benefit most not from coordinated routings and scheduling with professional drivers, but rather from support services such as purchasing, maintenance, and record keeping.

The second criterion is the use of paid drivers. If volunteers or staff members are now used as vehicle drivers, change to paid drivers may increase costs (although it may also improve service reliability and quality). Agencies with unpaid drivers are likely candidates for support services and possibly vehicle pooling.

A third criterion is the unit cost per person trip. It is only logical to expect that improvements in operating efficiencies may be easier for those with large unit costs of operation. However, care must be taken to analyze high operating costs and determine the underlying reasons for them and then to develop service improvements

Table 4. Evaluation criteria.

Agency	Base Cost/ Total Cost	Paid Drivers	Cost per Trip ($)	Time Compatibility			Total Cost ($)
				Commuting Peaks	Midday Program	Nutrition Program	
Action for a Better Community	0.38	X	3.43	–	X	–	48 000
Baden Street Settlement	0.36	X	2.29	–	X	X	16 460
Eastside Community Center	0.31	–	–	–	X	X	4 572
Lewis Street Center	0.66	–	0.48	–	X	–	3 565
Montgomery Day Care Nursery	0.65	–	–	–	X	X	3 237
Charles Settlement House	0.40	–	–	–	X	X	2 003
Hillside Children's Center	0.95	–	–	–	X	–	6 958
St. Joseph's Early Childhood Program	1.00	–	0.22	–	X	–	2 673
Rochester Area Multiple Sclerosis	0.13	X	5.60	X	X	–	27 629
Association for the Blind	0.11	X	2.94	X	X	–	71 830
United Cerebral Palsy	0.58	X	1.65	X	–	–	24 662
Monroe Development Service	0.26	X	2.15	X	X	–	100 500
Association for Retarded Citizens	0.26	X	3.21	X	X	–	46 688
Convalescent Hospital	0.24	–	–	–	X	–	31 418
Salvation Army	0.94	–	0.23	–	X	–	12 605
Children's Nursery	1.00	–	–	–	X	–	3 563
Jewish Family Service	0.09	X	5.08	–	X	–	17 764
Medical Motors Services							
General	0.13	X	5.47	X	–	–	89 771
Radiation	0.13	X	5.96	X	–	–	35 911
Vans	0.13	X	3.52	X	–	–	90 827

that match the problems.

The commuting peaks, midday programs, and nutrition programs indicate the time compatibilities of the various agencies. By fitting together peak and midday programs, an overall increase in vehicle productivity may be developed. This, then, was the fourth criterion.

Finally, the total cost was important. To be effective in achieving better overall financial performance or an increase in service quality, one must address those agencies that contribute most to the overall financial requirements.

COORDINATION PROGRAM

As a result of application of the methodology presented here, a coordination program is being developed by the boards of directors of the Rochester-Genesee Regional Transportation Authority and the United Community Chest of Greater Rochester. The program recognizes the need for several levels of coordination and has the following components that can be developed in phases:

1. Establish a transportation support center (TSC) for human service agencies: The TSC will function as the major focal point for agency transportation in Rochester. It will not initially own or operate vehicles, but will carry out other important functions from a centralized facility—including serving as a clearinghouse for transportation information, centralizing purchases of equipment and supplies, developing a driver training program, and implementing and monitoring a transportation service information system. These support services will be useful to nearly all of the study agencies.

The TSC will develop a user and agency information clearinghouse. What this really means is that the center will maintain a file on "who is doing what." An inventory of community transportation resources that will include data on not only member human service agencies, but a also on day-care centers, churches, schools, taxis, charter buses, and public transportation services will be a key element of the clearinghouse. The TSC will assist agencies in meeting their short-term vehicle needs through borrowing or leasing.

The coordination and centralization of purchasing will be another major TSC activity. The use of centralized purchasing can assist individual agencies to take advantage of the economies associated with large-volume purchases. Because the purchase of vehicles is particularly important, the TSC should seek their standardization through the development of vehicle specifications. The centralized purchasing of parts, tires, and even office equipment should also result in savings for member agencies. The TSC will act as a broker or middleman in the purchasing activities, acting on requests for capital purchases by member agencies by aggregating like requests and asking for bids from vendors.

A third major area in which the TSC will provide assistance will be driver training. In conjunction with the transportation authority, the TSC will conduct driver training programs for agency drivers.

The fourth major group of activities of the TSC will be the development of an information system that should satisfy the following objectives: (a) collect, store, manipulate, and report data on the operations of the organization; (b) meet legal requirements for record keeping and reporting; and (c) account for all assets and prevent loss by error or fraud.

2. Develop a vehicle-leasing program: A program to own, insure, maintain, and lease vehicles will be developed. The lease program will offer agencies more flexibility in the size of their vehicle fleet and will allow agencies to provide any type of driver they wish—staff, volunteer, or paid. This flexibility in type of driver is critical because many of the agencies have staff or volunteers available.

This second level of coordination will benefit many of the agencies, but will be most beneficial to those with high maintenance costs (as identified by the cost analysis) and those with small fleets. At present, many routine maintenance items are ignored because the vehicle is too busy to be serviced. The development of a vehicle leasing program will allow the agencies to obtain well-maintained vehicles while routine maintenance is conducted.

3. Form a small transportation operating group within the TSC: The analysis of existing conditions indicated that the need for actual provision of transportation operations by the TSC was rather limited as the majority of the agencies were providing service in a reasonably cost-effective manner. Any attempt at widespread use of a specialized transit service by these agencies would probably result in higher costs. On the other hand, there were some agencies that would benefit from the availability of a special agency-related service. Initially, the need appears to be the greatest for two types of service: (a) commuter services for those agencies that

need to move their clients to and from their agency center on a daily basis and (b) midday nutrition programs. Therefore, it is recommended that the TSC initiate this type of service on a trial basis (probably by purchase from an existing operator).

Without the analysis of efficiency and effectiveness, it is probable that a much more ambitious program of actual transportation operations would have been attempted. This could have resulted in a substantial increase in the total costs of services provided.

SUMMARY

The approach outlined in this paper should help to establish a framework for coordination of agency transportation. The underlying philosophy is the need to identify how much coordination is good for a given agency. If the available financial resources are to be used in the most efficient manner, care must be taken not to overcoordinate. The analytical tools presented here will provide decision makers with at least some factual data with which to answer the questions of "How much coordination?" and "For which agencies?"

ACKNOWLEDGMENT

This paper is based on a study (1) that was jointly sponsored by the Rochester-Genesee Regional Transportation Authority and the United Community Chest of Greater Rochester.

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Paratransit and the Journey to Work: Status Report

James P. Womack, Center for Transportation Studies, Massachusetts Institute of Technology

Work-trip paratransit will flourish if the time and money costs of competing modes increase, whether due to price increases or taxation policies. It will also prosper if its time, money, and flexibility costs decrease as a result of operational economies or subsidies. In the short run, it appears that the competing modes will suffer only modest price inflation and largely escape the effects of energy taxation. It also appears that paratransit will receive little subsidization; it has only a weak institutional base and public officials are currently reluctant to embark on new spending programs. It follows that the growth of work-trip paratransit in the near term depends on the development of suitable, low-cost provider arrangements and on price reductions deriving from decreased insurance costs and improved vehicle operating efficiency for van pools. If successful adoption of these techniques produces significant market penetration at present price levels, public officials may find additional ride-sharing initiatives, in the form of price incentives or subsidies, both cost-effective and politically feasible as means of conserving energy, reducing emissions, and alleviating congestion.

None of the modes grouped under the rubric of commuter paratransit is exactly new. In fact, the shared use of automobiles was much more common in the early days of the motor age, and the various shared-ride-taxi and commuter-jitney options discussed in the past few years were well-known by the 1920s. However, in the period between the end of World War II and mid-1973, neither the commuting public nor the American government at any level showed much interest in these modes, and they were for the most part forgotten. Commuters were busily switching from transit and shared automobiles to driving alone, and governments were attempting to ensure adequate road space for the burgeoning drive-alone commuter force.

Suddenly, at the end of 1973, two circumstances—the energy crisis and the approaching deadlines of the Clean Air Act Amendments of 1970 (set for 1975)—created the widespread expectation that this was all about to change. Under the twin spurs of the energy embargo and court orders to develop transportation control plans (TCPs) for air-quality improvements, public officials busily sought alternatives to drive-alone commuting. Ride sharing in particular attracted interest because of all the options available, including rationing, fuel taxes, and expansion of mass transit, it alone combined immediate availability, low public and user costs, and expansion rather than constriction of commuter options. Within a short period, four federal agencies—the Federal Highway Administration (FHWA), the Federal Energy Administration (FEA), the Environmental Protection Agency (EPA), and the Urban Mass Transportation Administration (UMTA)—were actively promoting ride sharing, and parallel efforts were under way in many states and localities and among many major employers. In addition, a new and promising variant of ride sharing, the van pool, had just been invented and initially tested. To many observers of the urban transportation scene, it appeared that a major transformation in commuting habits might be just ahead.

In reexamining the scene 4 years later, it seems fair to say that events have not evolved as many expected. After increasing 40.2 percent between September 1973 and July 1974, gasoline prices have increased only 13.8 percent in the following 3 years. (Price data are from various issues of the Consumer Price Index: Detailed Report of the U.S. Department of Labor, Bureau of Labor Statistics.) By contrast, the general price level in the 1974 to 1977 interval rose 23.4 percent. At the same time, the perceived threat of an oil embargo has receded, the price demands have moderated, world supplies have increased with the opening of new fields in Alaska, the North Sea, and Mexico, and the U.S. Congress has proved reluctant to deregulate gasoline prices or impose energy conservation taxes. As a result, energy prices will probably remain roughly constant (in real dollars) into the 1980s.

Paradoxically for work-trip paratransit, the specter of energy shortages and additional price increases has

motivated the automobile manufacturers to improve fuel economy dramatically (about 40 percent between the 1974 and 1978 model years), with the result that the gasoline price increases (59 percent over this same period) have been largely offset. This, combined with only modest inflation in the cost of automobile operation as a whole [46.2 percent versus 37.6 percent for all prices between July 1973 and July 1977 [a trend largely explained by the modest increase in new automobile prices (27.7 percent between July 1973 and July 1977) that has offset the much larger increases in insurance, repairs, and gasoline]] and increased consumer income [a 5.5 percent increase in real purchasing power during this 4-year interval (this figure is derived from the per capita disposable personal income adjusted for inflation given in various monthly issues of the Survey of Current Business of the U.S. Department of Commerce, Bureau of Economic Analysis)], means that drive-alone automobile commuting is hardly more of a luxury in late 1977 than it was in early 1973. Since the prime attraction of paratransit for the consumer is its potential for cost savings, it is hardly surprising that the market for these new products has proved rather soft, even where they have been vigorously promoted by government officials and corporate leaders.

Nor are there likely to be any new inducements to commuter paratransit from the environmental movement. The 1977 amendments to the clean air act will have the effect of delaying TCPs with stringent enforcement requirements until at least 1982, while the new emphasis on vehicle inspection-and-maintenance programs as the preferred technique makes it unlikely that restraints on commuter vehicle movements will be seriously considered as part of future TCPs.

Finally, if commuter paratransit has not benefited from any sticks in the form of higher gasoline prices, energy taxes, or environmental sanctions, neither have its proponents succeeded in developing any significant carrots in the form of government subsidies or internal operating economies.

These trends do not necessarily presage the end of commuter paratransit, but do make clear that its widespread acceptance and transition from a minor, enthusiast's mode to a mass mode will require much more promotion and nurturing than might have been the case if the potential cost savings and the environmental imperatives were greater. The aims of this paper will be to survey the present institutional environment of commuter paratransit and to determine what new initiatives might make these modes attractive to the widest possible cross section of the commuting public.

INSTITUTIONAL CONTEXT OF COMMUTER PARATRANSIT: FALL 1977

Federal-Level Programs

EPA was the first federal agency to begin paratransit promotion by virtue of several court cases in 1973 whereby EPA was directed to promulgate TCPs for air-quality control regions (AQCRs) in probable violation of ambient air quality standards by 1975. (The most important of these was the Natural Resources Defense Council decision in early 1973, whereby the D.C. Court of Appeals disallowed an EPA request to grant a blanket extension from 1975 to 1977 for AQCRs unable to meet the standards.) Of the 38 TCPs developed, 17 contained some sort of ride-sharing element. The strongest of these by far was in the Boston AQCR. But even this TCP was quite mild, simply calling for all employers with 50 or more full-time, daytime employees at a site to develop car-pool matching programs, for those with 250 or more employees to develop and continually update car-pool matching programs, and for those with 1000 or more at a site to continually support car pooling and make van pooling available if requested by the employees. Each employer was to make a good faith effort by use of these techniques to reduce by 25 percent the number of drive-alone automobiles brought to the site (details are given in 40 Code of Federal Regulations section 52).

These TCPs provided no funds for program development, administration, or enforcement and thus have been implemented with minimal enthusiasm by local governments and employers. In Boston, the most ambitious of these programs (funded with FHWA car-pool demonstration money) reduced work-trip vehicle travel by only about 1 percent. Also, only 4 of the approximately 50 employers with 1000 or more employees at a site actually established van-pool programs. The others cited lack of employee interest in vans. While an evaluation consultant recently found the program highly cost-effective in terms of benefits to commuters (ride-sharing promotions generally have very favorable cost-benefit ratios, although the ratios commonly cited by proponents are clearly gross overestimates because they fail to subtract the value of extra travel time from the saving in operating costs), it is also apparent that the program has had a trivial air-quality benefit.

As EPA looks ahead, the potential benefits of hardware solutions such as inspection-and-maintenance programs appear very large as compared with programs such as ride sharing that aim at altering commuter behavior. While the 17 TCPs with ride-sharing components will remain in effect pending filing of new plans by January 1, 1979, the feeling among those concerned with these matters at EPA is that ride sharing will have a very minor role in new TCPs.

FHWA entered the ride-sharing area in a major way in early 1974 via the car-pool demonstration program authorized under the Emergency Energy Conservation Act of 1974. Car-pool matching programs on an area-wide basis and through employers were initiated in 86 of the nation's 283 urbanized areas using these funds, and van pools were soon added to the program through a provision of the Federal-Aid Highway Act of 1974 permitting use of car-pool demonstration funds for van-abort costs, interest-free van loans, and the administrative costs of car- and van-pool programs borne by either local governments or employers. A recent consultant's report on these programs concludes that the best of these produced work-trip vehicle travel reductions of 1 to 3 percent [or 0.3 to 1 percent reductions in overall vehicle travel (1)]. The programs were highly cost-effective compared with most other highway programs, but trivial contributors to energy saving, air-quality improvement, or congestion relief.

This program was placed on a permanent basis when the Federal-Aid Highway Act of 1976 authorized unlimited use of federal-aid urban systems (FAUS) and federal-aid primary (FAP) funds for car-pool matching, van-abort costs, interest-free van loans, and car- and van-pool administrative costs. At first, this seems a remarkably generous level of support; FAUS-FAP funds in FY 1977 totaled $2.04 billion. However, in practice, these funds are divided on the local level without any national directives on their use. Since ride-sharing proponents have no lobbying assistance from road builders or construction unions or any other substantial interest, it is not surprising that only about 40 metropolitan areas will use any FAUS-FAP funds for ride sharing and that even in these the amounts will be modest, in no case exceeding $300 000/year. The key factor in a local decision to use FAUS-FAP funds seems to be the presence

of an innovative individual or group who can point to past results and articulate a good case for additional funding.

FEA, itself a creation of the energy crisis, identified van pooling in 1974 as one of the most promising energy-conservation techniques. A series of workshops for more than 1000 major employers were conducted in 1975 and 1976 in about 150 metropolitan areas. As a result, most employers large enough for economical in-house van-pool programs are probably at least aware of the concept.

Now that the active van-pool promotion is ended and FEA authority for such activities has been transferred to the U.S. Department of Transportation (DOT) as a result of an amendment to the Department of Energy Organization Act of 1975, the agency's one continuing paratransit activity involves funding for the state energy plans (SEPs). These plans are to be prepared by each state with the object of reducing energy consumption through conservation to 5 percent below the probable 1980 level in absence of the plans. The Energy Policy and Conservation and the Energy Conservation and Production acts of 1975 together authorize about $35 million/year to develop and implement these plans in the 50 states. Although the purchase of vans or other paratransit vehicles with these funds is not permitted, they may be used for the administrative costs of ride-sharing promotion. However, because the funding level is low (an annual average of $700 000/state) and because a wide range of projects compete for these funds, paratransit has received only small assistance to date. Officials report that only in California—where the third-party van-pool promotion in San Francisco is receiving $115 000—and in Massachusetts—where about $100 000 will go to MASSPOOL in calendar year 1978—are substantial FEA funds being used for the direct support of paratransit.

The present confusion over the shape of energy legislation makes it difficult to discern the future role of FEA and the U.S. Department of Energy in paratransit, but it appears that barring major amendment of the present bills before the Congress, its contribution will be minor.

The role of UMTA in paratransit promotion is of long standing, but until recently has been very low-key. Because of restrictions on the use of funding under sections 3 and 5 of the Urban Mass Transportation Act of 1964, the main evidence of UMTA interest has been in the service and methods demonstration program funded through section 6. The demand-responsive transit demonstration projects in Haddonfield and Rochester included subscription work-trip services to determine whether costs could be reduced to an economical level and whether automobile commuters could be coaxed from their automobiles, but the findings were not promising. Recently, UMTA has funded third-party van-pool promotional programs in Knoxville, Tennessee; Norfolk, Virginia; Minneapolis, and San Francisco. These attempts to develop satisfactory provider arrangements independent of employers are the most interesting and important federal initiatives in progress at present.

Because section 6 funding is limited (about $20 million/year) and is spread over the entire range of innovations in both conventional transit and paratransit, and because, in any case, the new ride-sharing provider arrangements cannot be continued as demonstrations indefinitely, it is apparent that other funding sources will soon be needed. UMTA's forthcoming Paratransit Services: A Statement of Policy would seem on the surface to open the way to a timely new source of funding for work-trip paratransit promotion. It reportedly permits the use of section 3 (capital) and section 5 (operating) funds for van and bus pools provided they are publicly available. However, on a moment's reflection, it is apparent that two major obstacles effectively block the path: the transit fiscal crisis and section 13c of the Urban Mass Transportation Act (this is being interpreted at UMTA to mean that employer-organized van or bus pools would not be eligible, but that third-party-organized pools would be, even if organized at an employer's work site—provided, of course, that nonemployees were not specifically excluded).

The extent of the transit fiscal crisis in most communities is such that every nickel for vans taken from the UMTA bus-rail subsidy will mean bus-rail runs cut or new equipment not purchased. Since paratransit for the moment has no effective allies to counter the powerful transit unions, operator associations, and supplier groups, it seems unlikely that substantial sections 3 or 5 funding will be made available in the short run.

Even if funds are allocated, section 13c will present additional problems. Because paratransit does pose a threat to some conventional services (despite tactical protestations to the contrary by paratransit proponents), transit unions have fought for and received elaborate guarantees in each of the van-pool demonstrations. These have included not only agreements that transit employees will not be adversely affected regarding their condition of employment, but also promises to maintain the size of the bargaining unit, to perform nonwarranty van maintenance with transit mechanics, to refuse van service to present bus users, and to run vans only over routes where bus service is not available even if the vans would pick up only former automobile commuters. When one considers that these van pools are only demonstrations funded from section 6 and that union negotiators are likely to push even harder for protections when the funds come from the common source of sections 3 and 5, it seems probable that paratransit will need to find other funding sources for the short term.

Provider-Level Programs

Turning from the consideration of funding sources to the actual paratransit provider arrangements currently in operation, we find an enormous range of experiments. Employer-sponsored programs will be considered first.

Although the trend in employer-based car-pool programs is unclear, it is quite apparent that the number of firms with van- and car-pool programs continues to grow. The National Association of Vanpool Operators (NAVPO) estimates their present number at about 100, with about 2000 vans on the road (but this is just a guess; only 29 employers have joined NAVPO). This is an impressive growth rate for only 4 years, but still represents only a tiny fraction of the 13 000 employment sites with 500 or more employees that may be capable of supporting van pools at reasonable overhead costs per van. It is also clear that the majority of larger employers will not be initiating van pooling. The available evidence indicates that employers who implement van programs do so in response to one or more of the following: (a) a parking shortage, (b) capacity limitations on routes to the job site that public agencies either cannot or will not remedy, (c) a poor image for corporate citizenship (this applies mostly to energy companies), or (d) an employee recruitment or retention problem (usually because of opening a remotely located plant or moving to a far suburban site). It seems reasonable that only a small proportion (perhaps 5 to 10 percent) of large employers face these problems and that the others will find van- and car-pool programs unpromising for two reasons. First, they are difficult to run on a self-costing basis (i.e., without employer subsidy) because full costing discourages many riders (the effect is to increase the commuting distance at which the vans become a bargain) and reduces participation. This further increases the fares because the overhead is spread over fewer vehicles and may reduce

participation to a point where the program hardly seems worth the trouble. Second, even in cases where full costing is possible, the program requires diversion of management energy and capable staff to tasks unrelated to the primary goals of the organization.

Although it is possible that a higher proportion of large employers will find it in their interest to promote van pools at some future date, particularly if there is an energy disaster or if vans come to be viewed as a relatively routine fringe benefit, ride-sharing proponents have for some time searched for third-party provider arrangements to serve large employers who are not interested and the two-thirds of the work force employed at work sites too small to support single-employer programs. The ideal provider, of course, would be a for-profit operator able to make money on such programs while aggressively promoting them on a wide scale. To date, however, no major private providers have emerged, although a number of automobile-leasing companies have shown some interest in the concept.

In the absence of for-profit operations, most of the current interest in van-pool experiments lies with the third-party programs now operating in Los Angeles and Knoxville, those just getting under way in Norfolk and the Golden Gate Bridge district in San Francisco, and those in final planning in Baltimore, Minneapolis, San Francisco, and Honolulu. These programs are quite similar in general concept, but differ in their particulars.

Commuter Computer in Los Angeles is a nonprofit corporation operated with both private (from Atlantic Richfield Company) and public (from the California Department of Transportation and FHWA) contributions that has concentrated to date on van pools for those commuting to downtown Los Angeles from far suburban areas. The vans are specially modified to seat 10 in maximum comfort on the long hauls, but at resulting high fares—the highest of any van-pool operation. Despite a very considerable contribution to overhead from Commuter Computer, it was necessary to raise fares substantially in mid-1977, with rather serious consequences for ridership.

In Knoxville, the vans have been owned by the city department of transportation and operated by drivers recruited in campaigns at various employment complexes. The present thrust of the demonstration is to sell the vans to the drivers and form a van-pool association consisting of the approximately 50 former city vans and the approximately 200 private free-lance van pools thought to be operating in the area. The association would attempt to find ways to economize through group purchase of new vans, repairs, and perhaps insurance. It would maintain a file of interested poolers to replace those dropping out and conduct new recruitment campaigns as necessary.

In Norfolk, the vans are owned by the local transit authority and will be leased to drivers and riders working at the various naval bases. Special efforts are being made to fit the vans into gaps between the existing transit system and the long-established, third-party, for-profit bus-pool system.

In the Golden Gate Bridge district north of San Francisco, section 6 funds are being used to purchase 35 vans. The program will attempt to initiate the largest possible number of van pools by requiring that the poolers purchase their own van after 6 months use of the UMTA-funded van. The UMTA van will then be given to another group for a 6-month trial. It is hoped that the 35 vans will spawn 140 van pools during the 2 years of the demonstration. A second object of the demonstration is to test consumer preferences for types of vans, seating, and fares. Half the vans seat 12 in standard bench seats. The other half seat 10 in aircraft-type reclining seats of the kind used by Commuter Computer. The fares for the deluxe vans will be about 35 percent higher.

In Baltimore, the vans will be leased from an automobile-leasing company with FHWA abort funds used to ensure the lease agreements. A nonprofit corporation (VANGO) with a small staff has been organized to match drivers and riders with vans. This project is funded by FHWA through the Maryland DOT.

In Minneapolis and San Francisco, the third-party providers (nonprofit corporations in both cases) will lease the vans from an automobile-leasing company with the loans guaranteed by funding from UMTA in the former case and FEA in the latter.

These experiments do not exhaust the list of programs under way or planned. In several states and metropolitan areas, for example, FHWA funds will be used in the next year by state departments of transportation or transit agencies to assist employers in starting programs and purchasing vans. These examples do, however, illustrate the wide range of operating arrangements feasible within the broad concept of van pooling.

Experience with these programs to date points up the following:

1. Van poolers are quite fare-sensitive, particularly since commuters tend to compare the van fare with their out-of-pocket automobile-commuting expenses. (Staff members of the third-party provider in Norfolk report that their most effective sales device is a balance-sheet flyer that totals all of the costs of automobile commuting and compares it with the van fare. Those taking the time to read it are immediately more receptive to van pooling.)
2. Local regulatory conditions, while often an annoyance, are not a major barrier if van pool promoters address them forcefully. In 17 states, regulations have been amended in the past 4 years to ease restrictions on ride sharing, and there is no known case where state or local regulations have permanently thwarted persistent ride-sharing promoters.
3. Insurance costs for third-party van pools, despite the new insurance services office (ISO) van-pool classification, continue to be very high (usually at least $1000/van annually) and far in excess of what actual claim experience would warrant.

Major questions about provider arrangements that should be answered in the next few years include the following:

1. What kinds of provider organizations—nonprofit corporations, transit agencies, other government agencies such as departments of transportation or metropolitan planning organizations, or private employers using public funding—are most effective in finding riders and fostering long-term van- and car-pool arrangements?
2. What specific details of the provider arrangements—such as leasing versus purchase of the vans, recruitment at a few major employment complexes versus areawide matching, and fancy vans versus plain vans—are important for the success of programs?
3. Most important of all, to what extent can third-party vans at present fares penetrate the drive-alone commuter market?

CONTINUING PROBLEMS AND NEW INITIATIVES IN WORK-TRIP PARATRANSIT

As paratransit proponents look ahead, the most immediate challenges lie in reducing van-pool costs and fares, particularly for third-party operators, and in providing the full range of car-, van-, and bus-pool services for

the majority of urban automobile commuters.

One cost-reduction technique is to develop a more fuel-efficient van. Present vans get only about 3.8 km/L (9 miles/gal), and fuel costs may be as much as one-fourth of total operating costs, so there is clearly room for improvement. The most probable methods would be substitution of weight-saving materials in van bodies and development of a lightweight diesel engine. Chrysler has already announced that a redesigned van for the 1979 model year will have room in the engine compartment for a diesel, although they have not announced that a diesel will actually be offered.

Another technique is to add passengers to the van pool or to divide the costs among more riders. Fifteen-passenger vans are now available and would permit a 20 percent reduction in fares compared with 12-passenger vans, but it is questionable whether the increase in collection time would offset the direct cost savings. Bus pools, which from the passenger's standpoint are only super van pools, have not found new markets in recent years, apparently because there are few concentrations of origin-destination pairs that permit their operation within tolerable collection times. (From the driver's standpoint, of course, the difference is much greater; few commuters are likely to want a bus in their driveway at night or need such a large vehicle for family outings. Consequently, drivers tend to be treated as part-time employees rather than as commuters. This added organizational complexity may be as significant as increased collection time in explaining the relative lack of interest in this mode.) However, experience at the 3M Company in St. Paul and elsewhere has shown that some van poolers are much more sensitive to fares than to collection time, so that any van-pool program may have a place for at least a few larger pools. Rather than stretching the van, providers might also consider reducing fares by dividing the costs of present eight-fare van pools over all 11 passengers. There may be a problem in finding enough drivers when the only compensation is a free trip to work and use of the vehicle nights and weekends, but several of the provider experiments under way are reporting success with 11-fare vans. The greatest fare reduction not surprisingly comes from combining these two techniques. Fares for a 14-passenger, 14-fare van, for example, are nearly 40 percent below those for an 11-passenger, 8-fare van for any given trip length.

Yet another path to reducing costs and fares is cheaper insurance. Even with the ISO rating, third-party operators are finding it very difficult to obtain insurance with adequate limits (generally $100 000/person, $300 000/accident or $300 000/person, $500 000/accident) for less than $1000/van annually. When one considers that 3M's monthly van-pool fixed costs are only $142 (of which $40 goes to a self-insurance plan), while many third-party operators are paying $80/month for insurance and some are paying as much as $150, the extent of the problem is apparent. One approach being explored in Knoxville and already in use at the Social Security Administration in Baltimore is to lease or sell the van to the driver and have him or her insure it as a personal vehicle. In this circumstance, it appears that insurance with $300 000/person, $500 000/accident limits and additional uninsured-underinsured-motorist coverage can be obtained in some states for less than $300. The problem lies in finding drivers either willing to risk personal exposure in the unlikely event that an accident produces claims in excess of the insurance limits or able to obtain catastrophe coverage under homeowners policies or other personal insurance.

The problem of providing car-, van-, and bus-pool options for most members of the work force with commuting distances long enough to make the arrangements attractive is rather more difficult. At present, it appears that car-pool matching either at major employment complexes or areawide will be available on a continuing basis in about 50 of the nation's 283 urbanized areas. Van pooling on a third-party basis will be offered in only about 10 areas in 1978. Employer-sponsored programs will probably be confined to 10 percent or fewer of the largest employers and will be impractical at the smaller employment sites that account for the largest part of the work force. Other shared-ride incentives such as preferential lanes and reserved parking for high-occupancy vehicles will be limited to a handful of corridors and employment complexes. The remedy for this relative lack of progress clearly lies in establishing effective car- and van-pool provider organizations on an areawide basis in most urbanized areas and in offering attractive incentives to employers to run their own programs. There seems to be little agreement, however, on how best to do this or at what scale the effort is most cost-effective.

One approach, proposed by Representative Robert Edgar of Pennsylvania, would create a separate ride-sharing modal agency within DOT. The first step in this process, involving the transfer of FEA's ride-sharing promotions to DOT, has already been accomplished, and Representative Edgar is now pushing a much more ambitious program. It would provide nearly $100 million/year from the highway trust fund for the new agency to fund ride-sharing development plans on a 90/10 matching basis in each state. The overhead costs of ride-sharing promotion as well as the vehicle-purchase costs incurred by any designated recipient, public or private, would be eligible for reimbursement. An additional $100 million would be placed in a revolving fund to permit interest-free vehicle loans to local provider groups, public or private.

A similar proposal by Representative Edgar was approved in the House last year as part of the Federal-Aid Highway Amendments of 1976. The Senate version did not include the measure, however, and it was deleted in conference committee. Representative Edgar reportedly plans to reintroduce the measure in 1978, but its prospects are uncertain. The established modal agencies and their beneficiaries are reluctant to see a competitor program established. FHWA and UMTA, in fact, have recently been directed by Secretary of Transportation Brock Adams to form a task force and develop, by February 1978, a program for ride-sharing promotion within the present modal framework. The established agencies also criticize the Edgar proposal by pointing out that it is another categorical grant program being introduced just as the department is moving toward block grants via some sort of surface transportation trust fund.

Many paratransit innovators at the local level are also skeptical that an additional federal program, with its inevitable bureaucratic rigidities, can do more than throw money at the problem. They argue that, unlike conventional transit, ride sharing must be sold to potential users, not merely offered. In their view, a traditional federal grant program based on needs rather than on demonstrated ability to produce results will be little more successful in the long run than the majority of the FHWA-funded ride-sharing programs that produced very little measurable benefit. More appropriate incentives, they suggest, might be patterned after other sales organizations. Providers (whether public, private, or employer) and even individuals within provider organizations might be placed on commission and given bonuses for forming exceptional numbers of van pools or eliminating large amounts of drive-alone automobile travel. Groups showing significant results would be given additional funding while the also-rans would be phased out.

Unfortunately, there is little precedent in federal experience for these types of incentives, and there is substantial question whether they could be offered without engendering major abuses. For these reasons, local innovators tend to support incentives aimed directly at the drive-alone automobile commuter via increased energy taxes for private automobiles or at employers by means of additional investment tax credits for those providing paratransit options for their employees. They also suggest that the federal government as the nation's largest employer is ideally suited to lead the way by developing effective in-house paratransit options for its employees.

At present, the prospects for these alternatives are uniformly dim:

1. The Carter energy pricing program, including gasoline price deregulation and the well-head tax, will have a very modest effect [1.8¢/L (7¢/gal) or less] even if fully enacted. Indeed, one recent analysis (2) argues that the oil industry has already found ways to defeat price controls and is presently charging the international price. If this is the case, deregulation and the well-head tax will have no effect on gasoline prices. As for taxation to raise domestic energy costs above the international level, no national political figure is presently even proposing this.
2. A proposal to allow a 20 percent investment tax credit after 3 years to employers purchasing vans for pooling has been approved by the congressional energy conference committee but is caught in the larger impasse over the energy bill. (The usual investment tax credit allows corporations to subtract 10 percent of the value of an investment from corporate income tax payments spread over a period of 10 years: The proposed credit would permit corporations purchasing vans for pooling to subtract a full 20 percent from their next tax payment provided they certified in the succeeding 3 years that the van was still in use for pooling.) Even if the credit is eventually enacted, however, there is serious question about its power to generate employer programs. Assuming a $7500 purchase price for a new van, the employer will receive only about $500/year in operating assistance via the tax credit compared with an overhead cost for many employer programs of $1000/year or more.
3. The House has voted down a proposal to purchase 6000 vans for federal employee van pooling, apparently in the belief that the program represents a new fringe benefit for federal employees rather than a significant energy conservation measure.
4. The Senate in July 1977 overwhelmingly (56 to 25) rejected Senator Charles Percy's proposal to charge federal employees the true cost of parking at federal facilities.

SOME LONGER RANGE PROSPECTS

This review of institutional initiatives suggests that commuter paratransit will proceed in the near term without benefit of significant carrots or sticks. Over the next few years, however, the external environment of paratransit may change in several ways. On the one hand, there will almost certainly be substantial energy price increases sometime in the future, in response to either balance of payments problems or actual shortages. These will negatively impact the drive-alone automobile commuter and increase the attractiveness of paratransit. On the other hand, the transit fiscal crisis may become so serious that receptivity will increase at the local level to paratransit alternatives that skim the deficits caused by the work-trip commuting peak. However, the situation will indeed have to be serious for this to occur, since public officials must first be convinced that the gratitude of those voters spared tax increases to cover the deficits will more than offset the protests of those (including transit employees) whose circumstances are worsened by curtailment of conventional services. However, it just may happen in at least a few localities.

If local officials do choose paratransit alternatives, there are several in addition to car, van, and bus pools available. One is the institutionalized hitch-hiking concept that consists of an association of drivers checked for driving and criminal records and adequate insurance and riders checked for criminal records. The drivers would use established corridors en route to work and pick up members displaying association identification. The riders would pay a small cash fare set by the association. More elaborate versions of this concept would blend into car and van pooling through use of telephone matching in place of street hailing and prepayment rather than cash fares. A large number of combinations are obviously possible.

UMTA has considered this idea several times in recent years, and consultants have analyzed it from just about every possible angle, but no demonstration has been undertaken. In part, this is because no corridor with sufficient demand has been identified that does not already have conventional service and UMTA has not been anxious to prove a new concept at the expense of transit. Perhaps more important, there are strong doubts about public acceptance because of fears for personal safety and questions about reliability, even if conventional buses at long headways are available as back-up transportation.

A variant of this concept that addresses both the security and reliability problems might be termed share-a-van. Commuters willing to purchase a van and affix a share-a-van logo would be licensed to pick up association members along certain corridors or in response to phone hails. The more substantial van vehicle with its larger average loads would provide security of numbers and bright interior lighting in the early morning and late evening hours and so might assuage passenger fears. Drivers might be spared the risk of handling cash, as well as the unpleasantness of cash transactions with neighbors, through use of a coupon system administered by the association. The reliability problem could be solved by paying part-time workers, housewives, retirees, or even commuters themselves to drive along certain corridors each day at specified times.

Subvariants within this concept can also be imagined. For example, a share-a-van with four or five regular riders might pick up four or five additional riders from the street corner or in response to telephone requests the previous evening. This amalgam of long-term and ad hoc ride sharing might be stronger than either option alone.

Moving a bit further in this direction, one can imagine the revival of the old-fashioned jitney, using vans and full-time drivers. A natural off-peak use for the vehicles and drivers would be in shared-ride taxi service.

At least a few of these concepts may be more cost-effective in certain applications than conventional transit services. Whether they receive a trial in the near term seems more a political and institutional, than a technical or economical, question.

SOME CONCLUDING PROGNOSTICATIONS

The theme of this paper has been that work-trip paratransit will flourish to the extent that the time and money costs of competing modes increase (whether because of price increases or taxation policies) and to the extent that the time, money, and flexibility costs of paratransit

modes decrease (whether because of operational economies or subsidies). For the moment, it appears that the competing modes will suffer only modest price inflation and largely escape the effects of energy taxation and that paratransit will receive little subsidization. It follows that the growth of work-trip paratransit in the near term depends on the development of suitable provider arrangements as well as price reductions from decreased insurance and fuel costs. As these goals are achieved and experience accumulates on probable market penetration at present price levels, additional price incentives or subsidies may become very attractive to public policy makers as cost-effective and politically feasible ways of conserving energy, reducing emissions, alleviating congestion, and stabilizing transit deficits.

ACKNOWLEDGMENT

The preparation of this paper was supported by the U.S. Department of Transportation.

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Effects

Reductions in Vehicle Travel by Use of Car and Van Pools in Major Metropolitan Areas

C. C. Miesse, Environmental Protection Agency, Philadelphia

Techniques are developed for determining the car- and van-pool potential of major employment centers as functions of employee residential distribution and income level. The techniques are based on an automobile-occupancy model previously developed for the national capital area and an empirical van-pool model derived from the highly successful van-pool program by the 3M Company in St. Paul. Application of the techniques to private and government employment centers in the national capital area indicates a potential 10 percent reduction in peak-hour traffic and a potential saving of 3.5 percent of total gasoline consumption.

The Clean Air Act of 1970 required each state to submit a state implementation plan that would include pollution control measures designed to effect a reduction in pollutant emissions to the extent necessary to attain and maintain the national ambient air-quality standards for particulates, sulfur dioxide, carbon monoxide, photochemical oxidants, and oxides of nitrogen. Since transportation sources are responsible for substantial portions of the emissions of carbon monoxide, hydrocarbons, and oxides of nitrogen (and the latter two react chemically to produce photochemical oxidants), transportation control plans (TCPs) were required in 41 metropolitan regions. Key elements of the TCPs were measures designed to reduce total automobile travel (VT). These included improvements in mass transit, exclusive traffic lanes reserved for car pools and buses, car-pool programs, parking restrictions, and employers' mass-transit incentive programs.

However, lack of increased patronage (demand elasticity) minimized the benefits from the mass transit improvements. The Environmental Protection Agency was prohibited by Congress from the implementation of parking regulations. And subsequent analysis (1) showed that the traffic congestion that would result from reservation of exclusive bus lanes would create additional pollution unless 10 to 30 percent of the automobile drivers became bus passengers.

Hence, the only remaining VT control measures that promise to effect a significant reduction in emissions (and in gasoline consumption) are the car pool and employer-incentive programs. The continuing and growing success of the commute-a-van program (2) at the 3M Company in St. Paul has shown the attractive potential of van pools. This analysis was undertaken to determine the potential reductions in VT that would result from car- and van-pool programs in a metropolitan area that includes a significant number of major employment centers.

CAR-POOL ANALYSIS

The potential reduction in VT that should result from a vigorous car-pool incentive program by an employer is given by Equation 1.

$$(CP)_j = \sum_{i=1}^{n_j} (EVT)_{ij} (TL)_{ij} \{1 - [(CO)_o/(CO)_p]\}_{ij} \quad (1)$$

where

$(CP)_j$ = potential VT reduction from car pools to employer j,
$(EVT)_{ij}$ = existing number of employee vehicle trips from residential district i to employer j,
$(TL)_{ij}$ = trip length from residential district i to employer j,
$(CO)_o$ = existing automobile occupancy from district i to employer j,
$(CO)_p$ = potential automobile occupancy from district i to employer j, and
n_j = number of employee residential districts considered for employer j.

$(CO)_o$ is determined from the calibrated automobile-occupancy model developed by R. H. Pratt Associates (3) that relates automobile occupancy to a density function (DF) that for median income levels and destination parking charges is defined by Table 1 and Equation 2.

$$DF = 100 \log_{10}(WTD) + 1000 \quad (2)$$

Table 1. District-level modal-choice model calibrated automobile-occupancy curve for home-to-work trips.

DF	CO	DF	CO	DF	CO
350	1.206	700	1.263	830	1.390
500	1.208	710	1.272	840	1.400
550	1.210	720	1.281	850	1.411
600	1.212	730	1.290	860	1.422
610	1.214	740	1.298	870	1.440
620	1.216	750	1.307	880	1.458
630	1.218	760	1.316	890	1.476
640	1.220	770	1.325	900	1.493
650	1.227	780	1.333	910	1.529
660	1.234	790	1.344	920	1.564
670	1.241	800	1.356	930	1.599
680	1.248	810	1.368	940	1.634
690	1.255	820	1.380	950	1.667

where WTD = work-trip density and is defined by Equation 3.

$$\text{WTD} = \text{work trips from A to B/area of A} \times \text{area of B} \tag{3}$$

$(CO)_p$ is determined in the same manner, except that Equation 3 is replaced by Equation 4, in which the destination area (B) is replaced by the area of the employment center (E).

$$(\text{WTD})_e = \text{employee trips from A to E/area of A} \times \text{area of E} \tag{4}$$

VAN-POOL ANALYSIS

The potential reduction in VT that should result from an employer-instituted van-pool program $[(VP)_j]$ is determined by Equation 5, which has been shown to provide a conservative estimate of car-pool potential for the 3M Company in St. Paul (4).

$$(VP)_j = \sum_{i=1}^{n_j} 3(EVT)_{ij} F_i (TL)_{ij}/4(t/T)_{ij} \tag{5}$$

where

$(VP)_j$ = potential VT reduction from van pools to employer j,
F_i = average income factor for residential district i as shown below:

Income	F_i
Low	0.3
Medium	0.2
High	0.1

t_{ij} = pickup time for eight employees of employer j in residential district i, and
T_{ij} = line-haul time from residential district i to employer j.

The derivation of Equation 5 assumes that one-fourth of the employees will be unable to car pool. The application of Equation 5 assumes that the minimum number of passengers is eight, so that the potential number of van pools to employer j $[(NVP)_j]$ is given by Equation 6.

$$(NVP)_j = \sum_{i=1}^{n_j} 3(EVT)_{ij} F_i/32(t/T)_{ij} \tag{6}$$

T_{ij} is estimated by using Equation 7.

$$T_{ij} = (TL)_{ij}/V_{ij} \tag{7}$$

where V_{ij} = average line-haul speed. The following approximate speed versus distance relation is assumed:

$(TL)_{ij}$ (miles)	V_{ij} (mph)
2	15
5	25
10	35

(Because these equations were derived for U. S. customary units only, SI units are not given.) This relation can be approximated by Equation 8.

$$V_{ij} = 10[(TL)_{ij}]^{1/2} \tag{8}$$

so that Equation 7 can be rewritten as

$$T_{ij} = [(TL)_{ij}]^{1/2}/10\,(\text{h}) = 6[(TL)_{ij}]^{1/2}\,(\text{min}) \tag{9}$$

t_{ij} can be determined by assuming that each pickup will require 1 min and that the time between pickups equals the average house-to-house distance in residential district i for employees of employer j (d_{ij}) divided by an average speed of 30 mph.

$$\begin{aligned} t_{ij} &= 8[1 + (d_{ij}/v_{ij})] \\ &= 8\left(1 + \{[A_i/640(EVT)_{ij}]^{1/2} \times (60\text{ min}/30\text{ mph})\}\right) \\ &= 8\{1 + 0.25[A_i/10(EVT)_{ij}]^{1/2}\} \end{aligned} \tag{10}$$

where A_i = area of residential district i (acres) and v_{ij} = average speed of van during pickup mode.

The substitution of Equations 9 and 10 into Equations 6 and 7 respectively gives Equations 11 and 12.

$$(NVP)_j = \sum_{i=1}^{n_j} 9(EVT)_{ij} F_i [(TL)_{ij}]^{1/2}/128\{1 + 0.25[A_i/10(EVT)_{ij}]^{1/2}\} \tag{11}$$

and

$$(VP)_j = \sum_{i=1}^{n_j} 9(EVT)_{ij} F_i (TL)_{ij}^{3/2}/16\{1 + 0.25[A_i/10(EVT)_{ij}]^{1/2}\} \tag{12}$$

APPLICATION TO NATIONAL CAPITAL AREA

To demonstrate the applicability of the above analyses to a typical metropolitan area, the equations were applied to the major private and federal government employment centers in the Washington, D. C., metropolitan area.

The location and number of employees of 120 major private employers (representing 124 000 employees) were obtained from a survey of 680 major employers in the Washington metropolitan area, as listed by the Metropolitan Washington Board of Trade (5). Of the 230 responses received, 110 indicated fewer than 100 employees/facility or provided insufficient information for analysis. Similar data for the 233 major federal facilities in the area were obtained from a listing provided by the General Services Administration (6).

So that the available data on existing trip distribution, interdistrict distances, and average income could be used, the locations of employment centers were designated in terms of the transportation planning districts defined by the Transportation Planning Board (TPB) of the Metropolitan Washington Council of Governments (COG) (7). A map of the planning districts is shown in Figure 1.

The COG zone areas (8) were summed to determine the total areas of the pertinent TPB districts, and the calibrated interdistrict highway impedances (9) were

Figure 1. Washington metropolitan area policy-analysis districts.

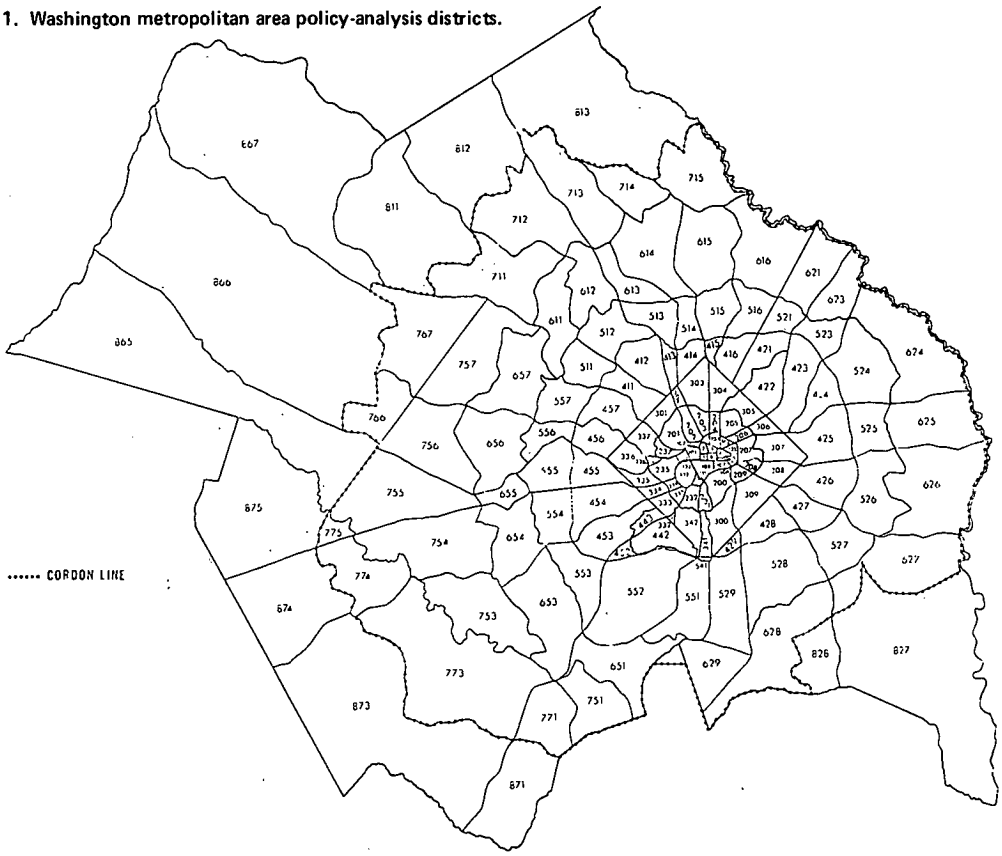
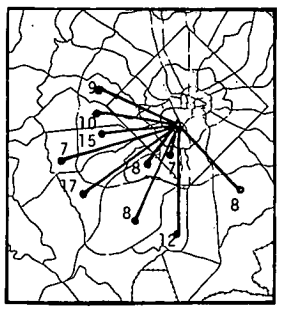


Figure 2. Work-trip distribution to Pentagon (by percentage).



used to determine average interdistrict distances via the existing system of transportation links and nodes. Average district income factors, tabulated by R. H. Pratt Associates for COG (10), were used to assess income factors.

Since the actual distribution of employee residential locations for each employer was not available, the trip distribution was assumed to be proportional to the 10 highest trip numbers of origin-destination pairs terminating in the employer's district, as obtained from the validated home-to-work trip distribution (11):

$$(EMP)_{ij} = (VWT)_{ij}(EMP)_j \Big/ \sum_{i=1}^{10} (VWT)_{ij} \qquad (13)$$

where

$(VWT)_{i,j}$ = number of vehicle home-to-work trips from residential district i to employer's district j and
$(EMP)_j$ = total number of employees for employer j.

A typical trip distribution, determined by Equation 13 for the Pentagon, is shown in Figure 2.

A similar simplification was introduced into Equation 4. Since the actual area of each employment center was not always available, the area E was arbitrarily set at the uniform value of 1 acre.

A representative tabulation of the pertinent car-pool variables for an employer with 1500 employees, located in TPB district 68 (Alexandria, Virginia), is shown in Table 2.

The percentage variation in $(CP)_j$ with number of employees is plotted in Figure 3. A least-squares analysis of these data indicates that they can be projected by Equation 14

$$\%VT = 8.64(EMP)^{0.306} \qquad (14)$$

with a correlation coefficient of 0.715.

Figure 3 shows that $(CP)_j$ can be expected to vary from 35 for an employer with 100 employees to 700 for 1000 employees to 1500 for a large facility with 10 000 employees.

The pertinent van-pool parameters for the district 68 employer with 1500 employees are given in Table 3.

The variation of NVP with the number of employees is plotted in Figure 4, which indicates a mean variation of the form:

$$NVP = 0.003\,16(EMP)^{3/4} \qquad (15)$$

or a lower bound (safety-factor) variation of

$$NVP = 0.0025(EMP)^{3/4} \qquad (16)$$

Figure 4 shows that $(VP)_j$ varies from 1 for an employer with 200 employees to 13 for 1000 employees to 250 for 10 000 employees.

Table 2. Matrix of employee vehicle trips and travel resulting from car-pool program.

Variable	Residential District 68	92	52	91	71	51	73	131	72	69	Total
Area, km^2	17.98	93.18	10.64	32.83	43.77	4.76	24.65	30.21	28.22	4.99	–
$(VWT)_i$,	2650	1636	1629	1286	930	782	701	601	578	481	11 269
$(TL)_i$, km	1.6	10.0	5.3	5.1	9.0	3.9	14.3	27.8	9.5	5.1	–
$(CO)_o$	1.215	1.209	1.215	1.210	1.208	1.216	1.210	1.209	1.209	1.212	–
$(EMP)_i$,	352	217	216	171	123	105	93	79.5	76.5	64.5	1 487.5
$(CO)_p$	1.476	1.352	1.479	1.393	1.362	1.484	1.379	1.359	1.360	1.442	–
Potential trip reduction	62.2	23.0	38.4	22.4	13.9	18.4	11.4	8.8	8.5	10.3	217.2
$(CP)_i$, km	99.5	230.0	203.5	114.2	125.1	71.8	163.0	244.6	80.8	52.5	1 385.0

Note: 1 km = 0.6 mile and 1 km^2 = 247.1 acres.

Table 3. Matrix of van-pool potential and vehicle travel reduction.

Variable	Residential District 68	92	52	91	71	51	73	131	72	69	Total
Area, km^2	17.98	93.18	10.64	32.83	43.77	4.76	24.65	30.21	28.22	4.99	–
F	0.3	0.2	0.2	0.1	0.1	0.3	0.2	0.2	0.2	0.2	–
$(TL)_i$, km	1.6	10.0	5.3	5.1	9.0	3.9	14.3	27.8	9.5	5.1	–
T_i, min	6.0	15.0	10.8	10.8	14.4	9.3	18.0	25.0	14.6	10.8	–
$(EMP)_i$	352	217	216	171	123	105	93	80	77	65	–
t_i, min	10.3	14.5	10.2	12.3	13.9	10.1	13.1	14.1	14.0	10.7	–
$(t/T)_i$	1.72	0.97	0.94	1.14	0.97	1.09	0.73	0.56	0.96	0.99	–
$(NVT)_i$	6	4	4	1	1	3	2	3	1	1	26
$(VP)_i$	76.8	320.0	169.6	40.8	72.0	93.6	228.8	667.2	76.0	40.8	1786

Note: 1 km = 0.6 mile and 1 km^2 = 247.1 acres.

Table 4. Car- and van-pool potential in the national capital region.

Type of Employer	District of Columbia CP	NVP	VP	Maryland CP	NVP	VP	Virginia CP	NVP	VP
Private	47 941	931	54 602	47 074	366	31 269	27 783	323	39 730
Federal	237 093	3336	368 900	40 971	535	60 592	232 130	1987	204 801
Adjusted total[a]	380 921	6249	532 706	182 192	1633	154 398	315 479	2956	340 085

[a]Total = three times private + federal because private-employer data are based on 33 percent returns.

Figure 3. Vehicle travel reduction from car pools.

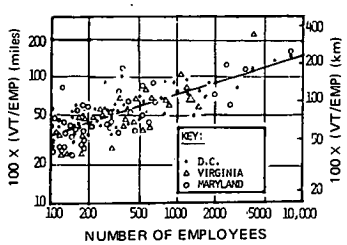
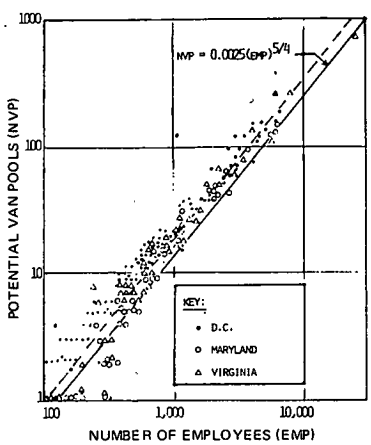


Figure 4. Number of potential van pools in Washington metropolitan area.



The calculated potential for VT reductions by vigorous car- and van-pool programs in the Washington Metropolitan area is summarized in Table 4, which shows a potential need for 4860 vans for the private sector and 5858 vans for federal employees. This would be accompanied by a potential VT reduction of 638 283 vehicle miles during the peak hours, which on a daily basis is 1 280 000 miles or 4 percent of total VT by light-duty vehicles.

CONCLUSIONS

The following conclusions can be drawn from the above analyses and application.

1. Vigorous car- and van-pool programs by major employers can reduce peak hour VT by 10 percent.
2. Potential VT reductions from van-pool programs are approximately equal to the number of employees.
3. Van-pool programs for companies with more than 500 employees are more effective than are car-pool programs.
4. The results provide a guideline for variation of car- and van-pool potential with number of employees.

ACKNOWLEDGMENT

I thank Nancy Goldman and Colin Hart, work-study students from the University of Pennsylvania, for their assistance in performing the calculations discussed in this paper. The views expressed are mine and are not

necessarily endorsed by the Environmental Protection Agency.

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Van Pooling—New Dimension in Urban Transportation: Results From Two Operational Programs

Douglas W. Wiersig, Transportation Center, University of Tennessee
Frederick J. Wegmann, Department of Civil Engineering, University of Tennessee

The results are described of two experimental, commuter van-pool programs—the Tennessee Valley Authority employer-based program and the Knoxville commuter pool areawide program. The two are compared with each other and with other van-pool programs in an attempt to assess the effectiveness of van pooling on employer and community levels. Van riders and drivers for both programs were surveyed to obtain user profiles and identify the factors felt to underlie the success of the programs. The survey found van pooling to be acceptable to a wide range of individuals, both male and female, representing a broad spectrum of income and occupation. The Knoxville commuter pool vans were found to be operating at various employment centers and successfully mixing employees of different companies in the same van. The survey also found that the two programs have had different success rates in reducing the number of commuter vehicles: Each Tennessee Valley Authority van was replacing 6.1 vehicles, and each Knoxville commuter pool van was replacing 4.5 vehicles. These results are extremely important for the estimation of the reduction in energy and vehicle travel that can be achieved from van pooling and suggest that local assessment must be made with care.

Traditionally, transportation planners have been concerned with providing a supply of transportation facilities to accommodate future levels of travel demand. However, recent events such as the energy crisis, the limitations being imposed on public agencies to finance capital improvements, and the costs of labor-intensive transportation services are leading to a reevaluation of these established transportation concepts. Today, greater consideration is being given to short-range actions that respond to immediate travel needs. Ride sharing is such a strategy as it attempts to increase occupancies through bus, van, and car pooling.

Knoxville, Tennessee, is the site of two experimental commuter ride-sharing programs. At the Tennessee Valley Authority (TVA), the largest employer in downtown Knoxville, an employer-based, commuter ride-sharing program stressing regular and express buses and van and car pools has been active since late 1973.

At present, efforts are being undertaken by the Knoxville transportation brokerage demonstration project to extend ride sharing to the community as a whole by creating a transportation brokerage service. The brokerage concept is somewhat unusual in public transportation in that the broker attempts to match individual mobility needs with the available supply of transportation, thereby altering riding habits and achieving more productive use of vehicles and facilities. The service is being operated by the Office of Public Transportation Services of the city of Knoxville and is funded by a 20-month Urban Mass Transportation Administration methods and services demonstration grant. The commuting function of this program is called the Knoxville commuter pool (KCP).

OBJECT

The object of this paper is to highlight the relative success and impact of the KCP and TVA commuter van-pooling demonstration programs, describe comparative ride-sharing user profiles, and identify the factors felt to underlie the success of these programs. Comparisons are also made with other van-pooling programs to identify the effects of various market segments on van pooling.

TVA COMMUTER POOLING DEMONSTRATION PROGRAM

In 1974, when TVA combined its offices into a new twin tower complex, 1300 downtown parking spaces were lost. In response, TVA management elected to use a ride-sharing solution, oriented around an earlier success of express buses, rather than initiate a massive downtown-parking construction program. Effective January 1975, TVA employees were reimbursed for travel by bus (express or regular fixed route) or van and car pools. For example, the commuter pooling program reimbursed bus

Table 1. Mode to work of TVA work force.

Date	Work Force	Mode to Work (percentage of work force)			
		Drive Alone	Ride Bus	Car Pool	Van Pool, Bicycle or Walk
November 1973	2950	65	3.5	30	1.5
December 1974	3000	42	14	40	4
January 1975[a]	3100	30	23	42	5
January 1977	3400	18	31[b]	41	10[c]

[a] First month of commuter pooling demonstration.
[b] Approximately 3 percent on express buses and 28 percent on regular buses.
[c] Approximately 7 percent van pooling.

riders for one-third the cost of the commuter bus ticket. Car poolers (defined as three or more riders) were issued a $5/month municipal parking ticket and van poolers were credited in the amount of $3 to $11/month for each employee participating in the TVA credit union van-pool program (1).

Another part of the program was the establishment of the position of a transportation coordinator to assist employees in forming van and car pools and in negotiating services with public and private transit operators, and to administer the reimbursement program through the credit union.

The TVA van-pool program is operated through the credit union, which owns the vans and in turn leases them to the drivers. Leases are set up so that drivers receive a free ride to work for driving the van. Lease rates are established based on round-trip travel distance and the number of riders in the van. Vans are discontinued when the number of riders drops below 6 and an additional monthly charge of $4/passenger is charged when the number of riders falls below 10.

Drivers are responsible for driving the van to and from work, collecting fares from riders, maintaining a minimum number of riders, and seeing that the van is maintained and kept clean. Maintenance, gasoline, and oil costs are charged directly to the credit union and when necessary a backup van is provided.

In this program, the van drivers receive no monetary incentive to drive. They do not have the opportunity to retain any fares over a minimum ridership and thus receive only a free ride to and from work. They are encouraged not to use the vans for personal use, but are given a 320-km (200-mile) monthly allowance for taking the van in for maintenance and cleaning. This allowance provides some indirect incentive to drivers, but in the case that they exceed the limit, they are charged a rate of 6¢/km (10¢/mile).

The impact of the commuter pooling program was immediate and dramatic. As shown in Table 1, during the 3 years since initiation of the first express bus, the use of bus transportation has increased from 3.5 to 31 percent of TVA's downtown work force, and the proportion of single-occupancy vehicles has decreased from 65 to 18 percent. The incentive program has been continued and expanded to include 18 vans and 24 express buses.

KNOXVILLE TRANSPORTATION BROKERAGE SERVICES

There are many reasons for the success of the TVA program, but among the key factors is the transportation brokerage service provided by the transportation coordinator. Since many firms are too small to support a full-time brokerage operation and many employers and employees have not yet recognized the benefits to be derived from ride sharing, the Knoxville Transportation Brokerage Service (KTBS) was initiated in January 1976. The KTBS broker works on a communitywide basis and deals with a range of travel needs.

Brokerage services are different from traditional transit planning because they identify transportation demand on an individual-traveler basis rather than through aggregate statistics. Demand is identified through a general public market analysis and by working with employers to survey individuals within organizations having specific travel needs. The broker also identifies specific transportation suppliers who can fill these needs. A unique aspect of the KTBS program is that 51 seed vans are available to the broker to introduce a new commuter mode—van pooling—to the public. These vans are provided to demonstrate that individuals can operate their own successful van pools with assistance from the broker. Thus, the broker is absorbing the risk involved in permitting commuters to test a new transportation concept.

One of the most important aspects of the Knoxville van-pool program is that the vans are being introduced on a communitywide basis rather than on the more common basis of a single employer. Through this approach, planners will be able to investigate how successfully van pooling is received by the entire community and discover the segments of the commuter market that respond more favorably (2).

Initially, the broker has concentrated efforts in the areas of

1. Overcoming the institutional barriers that hinder implementation of a communitywide ride-sharing program,
2. Increasing the awareness of employees and commuters for ride-sharing opportunities by developing a comprehensive commuter data base, and
3. Organizing the 51 seed vans.

Institutional Barriers

Two areas that initially hindered the KTBS were those of regulation and insurance. Before the broker could implement the seed-van program, permission had to be received from the Tennessee Public Service Commission to exempt vehicles carrying 15 or fewer passengers and used for commuting purposes from all regulations except those pertaining to insurance and safety. Also, satisfactory insurance rates had to be negotiated to make van pooling competitive (3). Only recently have insurance rates been established for multiple use of the vans, so that social service agencies can use the vans during noncommuting hours. Although the effects of the broker's efforts in overcoming the institutional barriers to ride sharing cannot be assessed quantitatively, they were vital to the foundation of the program. Without regulatory exemption and the elimination of excessive insurance rates, an environment in which ride sharing can occur cannot be created.

Data Base Development

In the KCP survey program, the benefits of ride sharing were outlined to 520 firms in the Knoxville area. Approximately 300 firms allowed KCP to survey their employees' travel patterns. Each employee was asked his or her home origin of the regular commuter trip, regular work hours, and degree of interest in ride sharing as (a) driver only, (b) shared driver, and (c) rider only. The surveys enabled the broker to determine the commuting potentials of the work force for various ride-sharing modes. The survey forms were then coded and computer matched to identify possible ride-sharing arrangements among groups of employees

within a firm and among nearby firms. A data file containing more than 18 000 travel records was accumulated. Each individual participating in the survey received a computer-matched list identifying other individuals living within a 1.6- by 1.6-km (1- by 1-mile) zone, traveling within the same 15-min time period, and going to the same destination zone. In areas and at times where few matches were available, the home origin was expanded to the surrounding 20-km^2 (8-mile^2) area.

Concurrently, the broker used the media to aggressively market ride sharing to the community. There was an extensive television, radio, billboard, and newspaper advertising program that stressed a telephone number that individuals could call for ride-sharing matching information. A survey at the end of this program found that 72 and 46 percent respectively of the commuter population were aware of KCP and knew how to contact the broker.

Seed-Van Program

KCP vans are leased to individuals having a one-way commuting distance greater than 24 km (15 miles). The monthly lease rate is based on the daily round-trip commuting distance and computed on the basis of eight paying riders for 12-seat vans and nine paying riders for 15-seat vans. This rate structure allows the driver to ride free and, if desired, keep those fares above the minimum limit. Rates are negotiated between driver and riders in a free marketplace and are often cut if suggestions lead to increased profitability by increasing volume. In a few cases, drivers have switched from 12- to 15-passenger vans in an effort to lower rates and attract more riders and thus increase profit.

In the lease agreement, KCP is responsible for all maintenance, repairs, tires, and taxes and reimburses the driver for gasoline and oil. The KCP also makes available a backup van and provides sufficient insurance coverage.

In many cases, drivers attempting to form van pools are unable to obtain the minimum passenger load because riders are hesitant to commit themselves before the van is operating. Thus, if a driver has five or six riders, the van is leased on a trial basis, and the first month's lease is computed on the basis of the reduced number of paying passengers. The trial program has worked well; many riders have started to van pool once the van has started operation. Of the 39 vans that were started in the trial program, 28 (72 percent) continue to operate.

KCP Van-Pool Results

The primary method of promoting the seed vans has been through surveying employee travel patterns at the site of employment. In this procedure, employees are given information describing van pooling and the benefits that can be derived from riding or driving a van. In these surveys, 1321 individuals (8.9 percent of those completing a survey) expressed an interest in becoming van drivers. An additional 275 individuals have expressed interest in driving a van in response to television, radio, billboard, and newspaper advertising.

At present, KCP is operating 47 van pools—43 with 12-passenger vans and 4 with 15-passenger vans. These van pools are hauling more than 500 commuters and serve 15 different firms. Of the 47 van pools operating, 12 are composed of passengers who work at different firms. These pools are concentrated in the central business district and University of Tennessee area and demonstrate that van pooling can be successful on an intercompany basis.

Many van pools had to be terminated within 30 to 75 d of initiation when the minimum load of eight individuals could not be achieved. Termination is consistent with the concept of seed vans as an experiment. The turnovers suggest that the concept is working well with much experimentation taking place. Some of the pools that initially failed were reinstated with a new driver, but the same nucleus of riders. The key elements in the formation of a van pool are identifying a concentration of individuals through the assistance of the matching list, spreading the idea by word of mouth among coworkers and, most important, locating an enthusiastic driver willing to make contacts and market the vans.

The longest KCP van-pool trip has a one-way distance of 120 km (75 miles), and the shortest is 24 km (15 miles) one-way. The average one-way trip for vans with Knoxville destinations is 58 km (36 miles) and for vans with Oak Ridge destinations, the average distance is 55 km (34 miles).

By comparison, unsuccessful van pools had on the average 49-km (30.5-mile) one-way trip lengths, thus indicating that distance by itself is not a reason for an unsuccessful van pool.

KCP Van-Pool Driver and Rider Characteristics

The characteristics of KCP van riders can be divided into two segments—one for Oak Ridge vans and the other for Knoxville area vans. This division was made to highlight any differentiation between the two segments because of the different work forces and the extensive spatial separation of the Union Carbide (Oak Ridge) plants from neighboring residential areas. These rider characteristics were obtained through a self-administered mail survey sent to the members of each van pool approximately 2 months after the van had begun operation.

Table 2 shows that van poolers are not limited to certain occupations or income levels, but are well distributed over a broad spectrum of socioeconomic characteristics. This then gives positive indications of the acceptance of van pooling across a range of employees. The differences between Knoxville and Oak Ridge vans can be attributed to the different nature of the work forces. The majority of KCP van pools have a mixture of professional and technical workers, craftspersons and foremen, and laborers. In a few cases, the riders are all in one category because of the dominance of that occupation at the work site. Van pooling also appeals to both males and females; of the 47 KCP vans, 41 have a mixture of male and female riders with an average of 6.8 male and 3.8 female riders/van. The riders of the remaining 6 vans are all of one sex because of the nature of the work force (construction workers, sewing machine operators). The riders are predominantly noncaptive and have been making this same home-to-work trip for approximately 8 years.

Many riders have chosen van pooling to reduce the cost and inconvenience of driving each day while also conserving gasoline, and many have chosen it so that their vehicle can be made available for someone else to use during the day. The major dislikes about van pooling are not being able to leave work early and not being able to work overtime on short notice. It is impressive that 44 percent of KCP van riders have no dislikes about van pooling.

Table 3 gives an indication of how van poolers are picked up by the van in the morning. One interesting result is that more riders in Knoxville vans are picked up at their homes, but Oak Ridge vans have more riders meeting at pickup points. The average distances to pickup points are 4.8 km (3.0 miles) for Oak Ridge vans and 4.0 km (2.5 miles) for Knoxville vans. These distances may explain the greater use of pickup points by Oak

Table 2. Characteristics of van-pool riders in percentages.

Characteristic	Knoxville Vans (n = 95)	Oak Ridge Vans (n = 199)	Total KCP Vans (n = 294)	TVA Vans (n = 176)
Number of vehicles available for travel to work				
None	13.0	4.1	7.0	1.7
One	48.9	46.9	47.6	33.1
Two	30.4	40.2	37.1	53.3
Three or more	7.7	8.8	8.3	10.9
Annual household income, $				
<4 000	7.9	0.6	2.9	1.2
4 000 to 8 000	28.9	5.4	12.8	6.9
8 000 to 12 000	22.4	24.1	23.6	10.0
12 000 to 16 000	25.0	36.7	33.1	18.8
16 000 to 20 000	9.2	18.1	15.2	23.1
>20 000	6.6	15.1	12.4	40.0
Occupation				
Professional or technical	5.6	18.5	14.2	30.4
Managerial or administrative	8.9	4.9	6.2	19.4
Clerical	13.2	12.6	12.8	29.2
Craftsperson or foreman	22.2	38.0	32.8	19.0
Operator (nontransportation)	21.2	0.5	7.3	0.0
Laborer	27.8	21.7	23.7	1.2
Service worker	1.1	3.8	2.9	0.0
Sex				
Male	45.9	76.9	64.0	66.3
Female	54.1	23.1	36.0	33.7
Average time in van pool, months	2.2	2.6	2.4	11.6
Average time of making the trip, years	7.9	7.7	7.8	5.7
Average one-way trip length, km	41.9	58.0	45.1	35.1

Note: 1 km = 0.6 mile.

Table 3. Mode of travel to pickup point in percentages.

Mode	Knoxville Vans	Oak Ridge Vans	Total KCP Vans	TVA Vans
Dropped off by automobile	12.4	7.7	9.2	7.6
Parked automobile at pickup point	30.3	51.8	44.7	45.6
Picked up at house	46.1	31.9	36.4	32.3
Walked	11.2	8.6	9.7	14.5

Table 4. Characteristics of van-pool drivers in percentages.

Characteristic	KCP Vans (n = 18)	TVA Vans (n = 17)
Number of vehicles available for travel to work		
None	5.6	17.6
One	27.8	47.1
Two	55.6	29.4
Three or more	11.0	5.9
Annual household income, $		
<4 000	0.0	0.0
4 000 to 8 000	0.0	0.0
8 000 to 12 000	6.7	5.9
12 000 to 16 000	46.7	35.3
16 000 to 20 000	13.3	23.5
>20 000	33.3	35.3
Occupation		
Professional or technical	23.5	41.2
Managerial or administrative	11.8	17.6
Clerical	0.0	17.6
Craftsperson or foreman	52.9	23.5
Operator (nontransportation)	5.9	0.0
Laborer	5.9	—
Service worker	—	—
Sex		
Male	83.0	93.8
Female	17.0	6.3
Average time in van pool, months	3.8	13.5
Average time of making the trip, years	8.0	5.3

Ridge vans in that their riders may be more dispersed about the residential area, which makes home pickup more time consuming. This locational dispersion also affects the reduction in vehicle travel of van pooling and the necessity of owning an automobile to get to the pickup point.

Table 4 shows that the KCP van drivers tend to have higher incomes and job statuses than the van riders and have been making the trip for about the same length of time, 8 years. Of the 47 vans, 8 are driven by women and 13 are driven by minority members. An interesting characteristic of van drivers is that 88.9 percent were previously in car pools and thus already had ride-sharing experience.

As of June 30, 1977, there had been 82 different KCP drivers of whom 47 were still driving, 2 had bought their own vans for commuting, 9 had been replaced by other drivers with the same nucleus of riders, 3 were driving vans that were temporarily leased to social service agencies, and 3 were driving vans that were leased to two different companies in rural areas to see whether their employees would like van pooling. Thus, only 18 drivers (22 percent) who attempted to organize van pools were unsuccessful.

When the failure of these 18 was investigated, two predominant causes were found. First, those drivers typically were less enthusiastic about making contact with potential riders and generally made little effort to market their vans. Second, in some cases, even enthusiastic drivers had few potential riders to contact.

Vehicle Travel Reductions

The question of modal change and reduction in vehicle travel (VT) that will result from van pooling is answered in Table 5. The two KCP segments have different characteristics. The higher previous rate of car pooling of the Oak Ridge van poolers can be explained by their longer trips [the average one-way distance of the Oak Ridge poolers is 58 km (34 miles), while the average one-way distance of the Knoxville poolers is 42 km (26 miles)].

These modal changes from car pools to van pools can be expected to occur in the initial stages of forming van pools and should not be alarming. The important finding of the differences between the two KCP segments emphasizes the effect of the remoteness of the work site from residential areas on the number of vehicles no longer being used for commuting. In the case of the KCP vans, the major shift was from car pools and has resulted in 210 vehicles no longer being used for traveling to the work site (an average of only 4.5 vehicles/van). The removal of these 210 vehicles has resulted in daily reductions of 16 180 km (10 056 miles) of VT and 1920 L (670 gal) of gasoline and a daily average cost saving of $2.06/person.

COMPARISON WITH TVA VAN POOLERS

To gain a better understanding of van riders and drivers and the resulting impacts of van-pool programs, the TVA van poolers were compared with the KCP van poolers by using the same survey form. Direct comparisons could not be made because of differences in the work forces, but when their likes and dislikes of van pooling are compared, the two groups are basically similar. TVA riders and drivers, however, do like the increased availability and reduced cost of parking, but this is mainly due to their downtown location. TVA van poolers dislike not being able to leave work at any time and mention this problem almost twice as frequently

Table 5. Mode before van pooling by percentage of van poolers.

Previous Mode	Knoxville Vans	Oak Ridge Vans	Total KCP Vans	TVA Vans	Conoco Vans	3M Vans	Golden Gate Vans
Bus	0.0	0.0	0.0	11.2	0.0	0.0	49.0
Car pool	38.3	63.1	58.4	35.5	55.0	46.0	26.0
Drive alone	50.0	35.9	36.3	45.0	42.0	49.0	21.0
Drive with other family members	5.0	0.5	2.5	2.4	0.0	0.0	0.0
Other	6.7	0.5	2.8	5.9	3.0	5.0	4.0

as KCP van poolers, but this higher response may largely be attributed to their longer experience with the inconvenience.

The major difference between the two programs is in the mode of travel before van pooling. In the case of TVA riders, a greater proportion previously drove alone than car pooled. The TVA vans have one-way commuting distances of only 35 km (22 miles), but the primary reason for the low car-pooling rate is the higher income and professional status of these riders and the greater number of vehicles they have available for traveling to work. This higher drive-alone rate has resulted in 110 vehicles being no longer used for commuting (an average of 6.1 vehicles/van).

COMPARISON WITH OTHER VAN-POOL PROGRAMS

Comparing the KCP and TVA van-pool programs with other programs can be done in only a few areas because rider surveys are not available.

The major area of concern for which data are available is the method of travel before van pooling. The results of the Conoco and 3M Company programs in Houston and Minneapolis respectively (as given in Table 5) show results that are similar to those of the TVA program (5, 6). This probably can be attributed to the fact that all three have a majority of professional, higher income employees who enjoy greater mobility and the ability to drive their own automobile to work. Thus, these three programs on the average replace 6 vehicles/van. When the previous mode used by van poolers in the Golden Gate corridor is examined, a different set of results emerges (7). The bus mode is the dominant previous mode (49 percent). This diversion was the result of decreased travel time by van as compared to bus. These surveys suggest that when estimating the expected results of a van-pool program on VT reduction and energy conservation, one must look closely at area employment centers, their spatial relation to employee residences, the types of employees involved, and the extent of transit service in the area.

In the cases of Conoco and 3M, the vans are serving only one company and not carrying riders of other firms. In the Golden Gate corridor, on the other hand, 17 of the 18 vans are carrying riders who work in different firms. These intercompany vans are once again a positive indication of the potential of van pooling in areas having a cluster of small employers.

In all of these programs, van poolers are happy with van pooling and have few complaints.

SUMMARY

The TVA commuter pooling demonstration project and the KCP have done much to foster areawide appreciation of and experience with van pooling. The demonstration project introduced a new mode of commuter transportation—van pooling. At present, 47 KCP and 18 TVA vans are operating daily in Knoxville and serving more than 700 commuters working in 16 different firms. As 39.5 percent of the van poolers formerly drove alone, the programs have eliminated 22 809 km (14 176 miles) of VT daily.

The results from the two van programs suggest some important findings concerning the potential market for van pooling. First, van pooling, due to economic constraints, is generally felt to be attractive for one-way commuting distances greater than 24 km. In the KCP, 85 percent of the van pools had one-way trip lengths greater than 40 km, and 58 percent were in the range of 40 to 56 km (25 to 35 miles). This indicates that the differential in travel cost by van versus that of driving alone is not sufficient to compensate commuters for the inconveniences created by van pooling for distances less than 40 km. In the case of TVA vans, where travel costs are higher because of downtown parking charges, 50 percent of the vans have one-way commuting distances less than 40 km. Thus, specific elements of the TVA program (such as parking charges, traffic congestion, increased travel time due to pickup and delivery, and incentive programs) may encourage employees with shorter travel distances to van pool. No one cause can be singled out, but all relevant factors should be considered when marketing a van-pool program.

Second, van formation has more potential and is easier to arrange at large employment centers, preferably those involving a single large employer. Although the experience in Knoxville indicates that vans can operate with riders drawn from various employers, the ease of forming and maintaining the pool is much simpler if only a single large employer is involved because of compatibility in work times, closeness of work site (reduced travel time and cost), and the ability to recruit new riders easily.

Third, no one particular type of occupation appears to be attracted to van pooling. KCP vans are serving a variety of occupational classes including manufacturing-plant, hospital, central business district, and university-area workers. Van pooling is acceptable to a wide range of individuals. The mixing of both males and females representing a broad spectrum of income and occupations in the same van has been received quite favorably.

For planners, it is important to recognize the potential contributions of van pooling. It is also important to note alternative delivery systems available—both employer-oriented and communitywide brokerage programs. The success of these programs in diverting the solo driver from the automobile will vary by type of employee, the extent of transit service available, and the spatial relation between employee residences and work site, and care must be taken when projecting the expected energy and VT reductions of van pooling.

ACKNOWLEDGMENTS

Special acknowledgment is made of the assistance provided by Stanley Stokey of the TVA and Frank Davis of KTBS. Also acknowledged is the assistance of John Beeson and Kenneth Faulkner of KTBS for help in obtaining ride-sharing information, and of the members of the evaluation team, Thomas Bell, Thomas Hood, and Brent Miller, for general guidance and help in obtaining ride-sharing information. The work reported in this paper was conducted under a contract from the Urban

Mass Transportation Administration service and methods demonstration program.

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Evaluation of an Employer-Based Commuter Ride-Sharing Program

Frederick J. Wegmann and Arun Chatterjee, Department of Civil Engineering, University of Tennessee
Stanley R. Stokey, Tennessee Valley Authority, Knoxville

The commuter ride-sharing program developed by the Tennessee Valley Authority for its employees in Knoxville, Tennessee, uses a variety of transportation modes—express buses, van pools, and car pools. The program has been very successful with 2686 employees (79 percent of the total work force of 3400 employees) participating. The program has different implications for the employer, the employees, and the community; these implications for each interest group are quantified in terms of benefits and costs. The analysis shows that by supporting the ride-sharing demonstration program, the employer was able to avoid the cost of constructing a new parking structure for the employees and that the resulting annual savings are larger than the annual cost of the subsidies to the program that are paid as an incentive to participating employees. From the standpoint of the employees, the program resulted in a substantial reduction in commuting costs. The reduction in fuel consumption that can be attributed to ride sharing was quantified, and the consequences in terms of improved traffic operating conditions along a major travel corridor and the favorable impact on the local transit system were examined.

The traditional approach in transportation planning has been to increase the supplies of transportation facilities and services to match the growing levels of travel demand. Recent events and trends, such as the energy crisis and the fiscal constraints faced by public agencies in financing capital improvement projects, have led to a reexamination of this approach. Today, a greater emphasis is being given to transportation alternatives that can respond to the immediate travel needs and achieve greater use of the facilities and services already available to a community. Among the examples of such alternatives are promoting the use of high-occupancy vehicles such as buses and vans and increasing the occupancy of private automobiles.

Many communitywide demonstration projects on car pools and van pools, sponsored by public agencies, have been implemented across the country, and there are also several ride-sharing programs that have been developed and supported by private employers for their own employees. One of the employer-based programs, which has received national attention, is the commuter-pooling demonstration program of the Tennessee Valley Authority (TVA) in Knoxville, Tennessee. These programs have apparently been successful, but there is a lack of readily accessible data on their benefits and costs. With the increased interest in such programs, questions are being asked about the effectiveness of those already implemented, and it is appropriate to develop the needed information. The object of this paper is to quantify the benefits and costs and identify the nonquantifiable implications of the TVA program.

PROGRAM DEVELOPMENT

The commuter ride-sharing program in Knoxville evolved gradually over 3 to 4 years (1973 to 1977). Before the inception of express buses and van pools, TVA employees participated in ride sharing primarily in the form of car pooling and to a lesser extent through the use of regular bus service. The first proposal for an express bus was made at a citizens' meeting with city traffic engineers and planners in West Knoxville. The citizens were concerned about the traffic congestion on I-40 and that sole reliance was being placed on the automobile to meet all current and future needs in the corridor. The group represented an area that had a large concentration of TVA employees, and they seriously pursued the proposal for an express bus.

A commuter express bus was initiated on December 3, 1973, and was highly successful. Joint efforts between the city administration and the TVA employees proved effective in promoting ride sharing and, by the end of 1974, there were 10 express buses and 6 van pools, all of which were primarily serving TVA employees.

A major change in the ride-sharing program occurred in January 1975, when the TVA incentive program, which was called the commuter pooling demonstration program, was initiated. This incentive plan called for

1. A one-third discount on commuter bus tickets,
2. Issuance of a $5/month municipal parking ticket to each bona fide car pool (defined for this purpose as a group of three or more riders including at least two TVA employees),
3. Credit to van-pool accounts of $11/month for each TVA employee participating in the van pool, and
4. Reimbursement to handicapped employees for the direct cost of parking in a commercial lot convenient to their place of work.

Table 1. Actual numbers of automobiles and vans used for commuting at different time periods.

Mode	November 1973		December 1974		January 1977	
	Employees	Automobiles and Vans	Employees	Automobiles and Vans	Employees	Automobiles and Vans
Drive alone	1918	1918	1260	1260	612	612
Regular bus	103	-	90	-	102	-
Express bus	0	-	330	-	952	-
Car pool[a]	885	277	1200	375	1394	436
Van pool	0	-	69	6	238	18
Bicycle, walk, and other	44	-	51	-	102	-
Total	2950	2195	3000	1641	3400	1066

[a]Average occupancy of car pools is 3.2.

Table 2. Estimated numbers of automobiles and vans for commuting at different modal-use patterns at current level of employment.

Mode	November 1973		December 1974		January 1977	
	Employees	Automobiles and Vans	Employees	Automobiles and Vans	Employees	Automobiles and Vans
Drive alone	2210	2210	1428	1428	612	612
Regular bus	119	-	102	-	102	-
Express bus	0	-	374	-	952	-
Car pool[a]	1020	319	1360	425	1394	436
Van pool	0	-	78	6	238	18
Bicycle, walk, and other	51	-	58	-	102	-
Total	3400	2529	3400	1859	3400	1066

[a]Average occupancy of car pools is 3.2.

The impact of the incentive program was significant. There was an immediate reduction of 12 percent in the number of TVA employees driving alone to work, and the number of express bus and van-pool riders continued to increase. Two private bus operators had to be used in addition to Knoxville Transit Corporation (KTC) to meet the increased need for express bus service during peak hours. By January 1977, there were 23 express buses—13 public and 10 private—and 18 van pools serving the TVA employees. [A detailed account of the development of the program and related activities is given in a recent article by Stokey and others (1)].

There are three stages in the development of the TVA ride-sharing program that are significant for the purposes of comparison and evaluation. The first stage is represented by the level of ride sharing that existed in November 1973 when there were no express buses and van pools. The second stage began with the introduction of the express buses and van pools that were encouraged by TVA, but had no formal incentives. The level of ride sharing during December 1974 represents the last observation before the initiation of the incentive program in January 1975. Since then, ride sharing has increased continuously and only recently began to level off. The current level of ride sharing can be represented by the use of ride-sharing modes in January 1977. The modal distribution of TVA employees during the key time periods are given by Wiersig and Wegmann in Table 1 of a paper elsewhere in this Special Report. The benefit/cost analyses will be based on comparisons of the modal-use patterns of November 1973 (before any organized ride sharing) and December 1974 (before initiation of the incentive program) respectively with that of January 1977.

IMPACT ON VEHICLES USED FOR COMMUTING AND EMPLOYER'S BENEFITS

One of the direct impacts of the ride-sharing program is the reduction in the number of vehicles used by the employees to commute to work, which has had several implications for the employer, the employees, and the community. In this section, the actual number of vehicles eliminated from commuting is estimated, and the resulting benefits accruing to the employer are quantified.

Number of Automobiles and Vans Eliminated

The actual numbers of automobiles and vans used by TVA employees were estimated for three time periods—November 1973, December 1974, and January 1977 (Table 1): The estimates of vehicles for each time period are based on the number of persons employed during it. The table clearly indicates that despite the increased employment at TVA, a substantial number of vehicles have been removed from the roadway and the demand for all-day parking in downtown Knoxville has been reduced. In comparison with the situation in 1973, TVA employees now require 1129 fewer parking spaces, although employment has increased by 450 persons. In the time since the beginning of the commuter-pooling demonstration program, the demand for spaces has been reduced by 575, even though employment has increased by 400 persons.

A more meaningful approach is to compare the numbers of automobiles and vans needed for commuting for a common employment level. Table 2 shows the estimated numbers of commuting vehicles required for the current employment level of 3400 with different modal-use patterns. A comparison of the projected estimates with the current situation shows the magnitude of the impact of ride sharing. Without the express buses and the van pools and with an employment level of 3400, an additional 1463 parking spaces would have been needed in the downtown area. With the level of ride sharing just before the initiation of the incentive program, an additional 793 parking spaces would have been needed.

Employer's Benefits Due to Reduction in Parking Needs

Automobile parking in the downtown area of Knoxville always has been a problem. The parking supply consists primarily of small surface lots, which have been decreasing in number because of the construction of new office buildings. The only parking garage in the general area is not within easy walking distance to the center of downtown. The parking situation has grown worse in recent years as several major developments eliminated about 1500 parking spaces.

For years, TVA employee unions attempted to negotiate parking for employees, and their case was made stronger when it became evident that the new twin towers office complex for TVA alone would remove more than 1000 parking spaces. Two alternatives were given serious consideration: (a) building parking garages for the employees and (b) an employer-subsidized public-transportation-oriented solution. The probable cost of the first alternative, building and operating parking garages for the employees, can be analyzed at two levels of automobile use—the modal-use patterns of November 1973 and December 1974. As estimated above, the modal-use pattern of 1973 would require 1463 additional parking spaces, and the modal-use pattern of 1974 would require 793 additional parking spaces.

The cost to TVA of providing employee parking was estimated based on a typical design for a parking garage. The annual cost of constructing and maintaining parking garages for 1463 and 793 spaces would be $628 206 and $337 820 respectively. These cost savings can be regarded as benefits derived by TVA by virtue of relying on a ride-sharing approach.

IMPACT ON MAGNITUDE OF TRAVEL AND EMPLOYEE'S BENEFITS

The ride-sharing program basically represents an adjustment in the mode of travel used by TVA employees for commuting to work. As such, the program did not have any impact on passenger travel, but there was a substantial impact on vehicle travel (VT) because of the reduction in the number of vehicles used for commuting. This reduction of VT has several types of implications. It directly affects the persons participating in ride sharing and indirectly affects other motorists and the community in general. In this section, estimates of the reduction in VT will be presented, and the resulting benefits accruing to TVA employees will be outlined.

Reduction in Vehicle Travel

The approach used in the estimation of changes in the VT of TVA employees was similar to that used in estimating the number of vehicles used for commuting. The VT was estimated for the current level of employment of 3400 employees and the modal-use patterns of the three different time periods.

The results of the VT calculations reflecting the modal-use pattern of January 1977 are given in Tables 3 and 4. The estimates shown in Table 3 represent the VT generated by the primary ride-sharing modes of travel, whereas those shown in Table 4 represent the VT that can be attributed to obtaining access to the primary ride-sharing modes—e.g., driving to a park-and-ride lot and travel to pick up car-pool passengers—and termed the excess VT. The travel estimates reflecting the modal-use pattern of November 1973 are given in Table 5, and those reflecting the modal-use pattern of December 1974 are given in Tables 6 and 7. All vehicular modes of travel used by TVA employees—automobile, van, and bus—are included in the VT estimates.

In the calculations of VT representing different modal-use patterns, the current passenger travel was used as a control total, which implicitly assumes that the availability of increased ride sharing did not have any significant impact on altering residential location decisions. This assumption is not entirely correct since it is known that new TVA employees have tended to find housing in areas with express bus service. However, since the express bus routes cover the suburban areas quite extensively, the average work trip length of TVA employees has not changed to any significant extent.

A comparison of the VT estimates shows that the present level of ride sharing can be credited with a reduction of 49 906 km/d (31 000 miles/d) in comparison with the situation in November 1973. The reduction in daily VT by all modes that can be attributed to the incentive program is 26 464 km (16 444 miles). The breakdown of these changes in VT by mode is given below (1 km = 0.62 mile).

Modal-Use Pattern	Change in Daily VT (km)			
	Automobile	Van	Bus	All Modes
November 1973	-52 980	+1333	+1741	-49 906
December 1974	-28 430	+888	+1078	-26 464

Reduction in User Cost

One of the direct consequences of the reduction in VT is the saving in vehicle operating cost, and the TVA employees participating in ride sharing have realized a direct benefit in this respect. Recent statistics released by the Federal Highway Administration indicate that the average cost of operating a vehicle is 11.1¢/km (17.9¢/mile) for a standard size automobile, 9.1¢/km (14.6¢/mile) for a compact, and 7.8¢/km (12.6¢/mile) for a subcompact (2). These costs include depreciation, maintenance, fuel, parking, insurance, and taxes. The following analysis is based on a compact automobile and excludes the 1.4¢/km (2.2¢/mile) cost attributed to parking (which is eliminated to avoid double counting with the parking structure costs discussed above), thus resulting in a cost of 7.7¢/km (12.4¢/mile). If the vehicles eliminated from commuting are sold, all of the savings in operating cost (at 7.7¢/km) are passed on to the TVA employees, thereby increasing their disposable income. If an employee does not sell his or her second automobile because of ride sharing, but only uses it less, his or her savings would be about half of those given here.

Savings in vehicle operating cost, however, are offset to some extent by the cost of ride sharing. The user savings (costs) needed to derive the net benefits to TVA employees are given below (1 km = 0.62 mile):

Saving (cost)	Modal-Use Pattern	
	November 1973	December 1974
Annual reduction in automobile VT, km	13 244 539	7 107 474
Cost reduction of less automobile driving, $	1 020 520	548 000
Bus fares paid, $	151 810	14 960
Van fares paid, $	83 010	55 340
Van- and car-pool subsidies, $	28 800	28 800
Total employee savings, $	814 500	506 500

Reduction in Accidents

The potential for physical injury and property damage to the TVA commuters because of traffic accidents is substantially reduced by ride sharing. The largest proportion of traffic accidents in the city occurs during the peak hour. Assuming the national average accident rates of

3.27 accidents/million km (5.26 accidents/million miles) of VT on the arterial highway system and 1.16 accidents/million km (1.86 accidents/million miles) of VT on the freeway system, and with an approximate 50-50 split of travel on freeways and arterials, the ride-sharing program is helping to avoid about 30 accidents/year by TVA employees commuting to work. Considering only the incentive program (since December 1974), the accident reduction would be 15 accidents/year.

Increase in Convenience

Opinion surveys of the TVA employees who are ride sharing have indicated many additional desirable aspects of the program. Bus riders and van poolers are particularly conscious of the reduced costs of commuting and the reduced energy consumption. Another significant effect, but more difficult to quantify, is the perceived relief from the tension of driving every day. A third important factor is that the commuting vehicle becomes available to other family members during the day.

Other Consequences: Benefits to Community and Other Travelers

The community at large and particularly the travelers in certain corridors of Knoxville have also benefited from the ride-sharing program. The quantification of these

Table 3. Estimated daily vehicle travel by primary ride-sharing modes: modal-use pattern of January 1977.

Mode	No. of Employees	No. of Vehicles	Daily Passenger Travel (km)	Daily VT (km)			
				Automobile	Van	Bus	Total
Drive alone	612	612	21 668	21 668	–	–	–
Regular bus	102	–[a]	1 641	–	–	–	–
Express bus	952	23	33 705	–	–	1741[b]	–
Car pool	1394	436	49 354	15 436	–	–	–
Van pool	238	18	17 619	–	1333	–	–
Bicycle, walk, and other	102	–[c]	985	–	–	–	–
Total	3400	–	124 972	37 104	1333	1741	40 178

Note: 1 km = 0.62 mile.

[a] Employees traveling on regular buses do not contribute additional VT.
[b] VT contributed by motorcycles is insignificant.
[c] Includes deadhead distance.

Table 4. Estimated daily excess vehicle travel for access to primary modes: modal-use pattern of January 1977.

Mode	Modal Use (%)	No. of Employees	No. of Automobiles	One-Way Trip Length[a] (km)	Daily VT by Automobile (km)
Access to regular and express bus stops					
Automobile drop-off	12	126	126	3.2[b]	811
Park and ride					
Drive alone	28	295	295	4.8	2848
Car pool	18	190	59[c]	3.2	380
Other	42	443	–	–	–
Total	100	1054	–	–	4039
Access to van-pool pickup points					
Automobile drop-off	7	17	17	8.0	274
Park and ride	40	95	95	5.3[b]	1009
Other	53	126	–	–	–
Total	100	238	–	–	1283
Pickup of car-pool passengers[d]	–	–	–	–	1544
Total	–	–	–	–	6866

Note: 1 km = 0.62 mile.

[a] Based on bus and van-pool rider surveys.
[b] The automobile drop-off of some riders may involve two round trips from home, while other riders may be dropped off by someone en route to another destination. It is assumed that the average daily VT will be two times the one-way trip length.
[c] Average occupancy of car pools is 3.2.
[d] 10 percent of primary car-pool VT.

Table 5. Estimated daily vehicle travel: modal-use pattern of November 1973.

Mode	No. of Employees	No. of Vehicles	Daily Passenger Travel (km)	Daily VT (km)		
				Automobile	Van	Bus
Primary ride sharing						
Drive alone	2210	2210	83 518	83 518	–	–
Regular bus	119	–	1 915	–	–	–
Express bus	0	0	–	–	–	0
Car pool	1020	319	39 046	12 211	–	–
Van pool	0	0	–	–	0	–
Bicycle, walk, and other	51	–	492	–	–	–
Total	3400	–	95 727	95 729	0	0
Pickup of car-pool passengers[a]	–	–	–	1 221	–	–
Total	–	–	–	96 950	–	–

Note: 1 km = 0.62 mile.

[a] 10 percent of primary car-pool VT.

Table 6. Estimated daily vehicle travel by primary ride-sharing modes: modal-use pattern of December 1974.

Mode	No. of Employees	No. of Vehicles	Daily Passenger Travel (km)	Daily VT (km)			
				Automobile	Van	Bus	Total
Drive alone	1428	1428	52 542	52 542	–	–	–
Regular bus	102	–	1 641	–	–	–	–
Express bus	374	10	13 241	–	–	663[a]	–
Car pool	1360	425	51 213	16 004	–	–	–
Van pool	78	6	5 774	–	444	–	–
Bicycle, walk, and other	58	–	560	–	–	–	–
Total	3400	–	124 971	68 546	444	663	69 653

Note: 1 km = 0.62 mile.
[a] Includes deadhead distance.

Table 7. Estimated daily excess vehicle travel for access to primary modes: modal-use pattern of December 1974.

Mode	Modal Use (%)	No. of Employees	No. of Automobiles	One-Way Trip Length (km)	Daily VT by Automobile (km)
Access to regular and express bus stops					
Automobile drop-off	12	57	57	3.2	367
Park and ride					
Drive alone	28	133	133	4.8	1284
Car pool	18	86	27	3.2	174
Other	42	200	–	–	–
Total	100	476	–	–	1825
Access to van-pool pickup points					
Automobile drop-off	7	6	6	8	97
Park and ride	40	31	31	5.3	330
Other	53	41	–	–	–
Total	100	78	–	–	427
Pickup of car-pool passengers[a]	–	–	–	–	1600
Total	–	–	–	–	3852

Note: 1 km = 0.62 mile.
[a] 10 percent of primary car-pool VT.

consequences is difficult in some cases. Nevertheless, an attempt has been made below to outline these benefits in as much detail as practicable.

Impact on Energy Consumption

The transportation sector of the national economic system is one of the major users of energy, and the share of urban transportation is substantial. It is estimated that in 1971, travel by private automobiles in the United States consumed 265 billion L (70 billion gal) of gasoline, which is 31 percent of the domestic petroleum consumption. In the same year, automobile driving in urban areas accounted for 63 percent of the nationwide fuel consumption by automobiles (4). Thus, urban transportation is a prime area for energy conservation.

The TVA employee ride-sharing program has contributed toward energy conservation by reducing vehicle travel, which can be translated to savings in fuel consumption. It is estimated that 1 742 639 L (460 358 gal) of fuel are saved annually because of the present level of ride sharing as opposed to that of the level of the modal-use pattern of November 1973 and that the saving in comparison with the level of ride sharing in December 1974 is 903 795 L (238 758 gal). A breakdown of the changes in fuel consumption by mode is given below (1 km = 0.62 mile and 1 L = 0.264 gal).

Change	Modal-Use Pattern	
	November 1973	December 1974
Annual VT, km		
Automobile	-13 244 941	-7 101 474
Van	+333 125	+222 083
Bus	+435 316	+269 558
Annual fuel consumption, L		
Automobile (at 6.4 km/L)	-2 076 985	-1 114 547
Van (at 4.3 km/L)	+78 358	+52 238
Bus (at 1.7 km/L)	+255 988	+158 514

These estimates of fuel savings are more meaningful when they are expressed in terms of automobile use for all trip purposes. An automobile for private use is driven approximately 16 000 km/year (10 000 miles/year) and consumes 2525 L (667 gal) of gasoline. The estimated fuel savings thus can be expressed as sufficient for operating 690 and 358 automobiles annually since November 1973 and December 1974 respectively.

Impact on Public Transportation Systems

The employee ride-sharing program of TVA has stimulated both the public and the private bus systems in Knoxville. The express bus riders, who mostly are TVA employees, represent approximately 8 percent of the annual ridership of KTC and contribute 15 percent of its annual fare-box revenue.

Private bus operators in the Knoxville area, as in other areas, are faced with serious economic problems, and the prospects for their future growth before the TVA ride-sharing program were bleak. However, the ride-sharing program has improved their situation by giving them the opportunity to generate additional revenue by providing express bus service on several routes. The addition of the private suppliers did not adversely affect the public transit system because this approach was taken only after KTC had exhausted its available supply of peak-hour buses. The van pooling also did not compete with the public bus system because the van riders came from areas without bus service. The implications of the revitalization of private operators and the demonstration of the use of a mix of public and private suppliers are significant; this program may be a model for other ride-sharing efforts.

Impact on Traffic Flow

It was estimated above that the employee ride-sharing program eliminated a substantial number of commuting vehicles from the roadways in Knoxville (1463 in comparison with the modal-use pattern of November 1973 and 793 by comparison with the modal-use pattern of December 1974). Because approximately 33 percent of TVA employees live in the West Knoxville area, the reduction in vehicle trips will probably be most significant in this travel corridor. Also, because 50 percent of the express buses (both before and after the incentive program) serve the West Knoxville area, it is reasonable to assume that the propensity toward ride sharing is higher in this area than in other sectors of Knoxville. Thus, it is estimated that 40 percent of the vehicle trips eliminated by ride sharing formerly occurred in this western corridor.

The major roadways in the West Knoxville corridor are Middlebrook Pike, I-40, Kingston Pike, and Lyons View Drive. However, due to the configurations of these roadways and the location of the TVA offices, the majority of the TVA commuting trips along this corridor use I-40. It is estimated that 75 percent of the work trips by TVA employees living in the West Knoxville area use the section of I-40 between the Papermill Road interchange and downtown. Thus, the elimination of 1463 commuting vehicles means a reduction of 439 vehicles from I-40 during the morning and afternoon commuting hours of travel. Similarly, the removal of 793 vehicles means a reduction of 238 vehicles from I-40 during rush hours.

The working hours of TVA in Knoxville are not staggered, and the work trips of TVA employees on I-40 can be assumed to be concentrated within a time span of 20 min each in the morning and afternoon. The average highest hourly volume in the peak direction in the morning is 3038 and occurs between 7:15 and 8:15 a.m., and that in the peak direction in the afternoon is 3398 and occurs between 4:45 and 5:45 p.m. This amounts to an average traffic volume of 1073 vehicles/20-min period, and the two 20-min periods containing TVA employees fall within these hours.

The operating condition of I-40 on the section between the Papermill Road interchange and downtown during the commuting time periods of TVA employees can be described as level of service D, which represents an operating speed of 64 km/h (40 mph) and a situation approaching unstable flow. The capacity analysis of I-40, which is a four-lane freeway with several closely spaced on-and-off ramps in the downtown area, shows that if the 439 vehicles had not been eliminated from I-40 the operating condition would have been similar to that of level of service E, which represents unstable flow with an operating speed of 48 km/h (30 mph) (5). Thus, the current users of I-40 during the 20-min periods of TVA employee commuting enjoy better driving conditions and their operating speed is 16 km/h (10 mph) higher than it would have been without any ride sharing. The improvement that can be attributed to the elimination of 238 vehicles is estimated to be an increase in the average operating speed of 8 km/h (5 mph)—i.e., from the 56 km/h (35 mph) that reflect the situation in December 1974 to the 64 km/h that represent the current situation.

The benefits of the improved level of service and increased operating speed on I-40 can be quantified in terms of the reduction in vehicle operating cost accruing to the current road users. However, since these benefits will not be as large as those estimated above, they need not be quantified in detail. Nevertheless, the positive contribution of the ride-sharing program toward easing the traffic congestion on I-40 during the rush hours (which is one of the most severe traffic problems in Knoxville) must not be overlooked.

ANNUAL COST OF INCENTIVE PROGRAM

The costs of the TVA ride-sharing program can be categorized by the items summarized below:

Cost	Amount ($)
Bus ticket subsidy	
KTC	47 156
Private lines	27 563
Total	74 917
Bus line guarantees	
KTC	1 993
Private lines	8 190
Total	10 183
Credit union administrative fee	11 231
Car-pool parking	1 860
Van-pool subsidy (18 vans)	27 000
Total	125 000

CONCLUSIONS

The commuter ride-sharing program organized and implemented by TVA has benefited all parties involved directly or indirectly—the employer, the participating employees, the local transit operators, and other motorists traveling in a congested travel corridor. The question that arises is whether this experience could be transferred to other situations, i.e., whether the benefits could be realized if another large employer organized a similar ride-sharing program. A direct affirmative answer to this question is possible only if the two situations are identical in all respects. There are many background conditions that played a significant role in the success of the TVA program, and some of these may not be apparent at first. One must be aware of all these conditions and consider them when comparing the TVA program with another situation.

First, the benefit to TVA as an employer occurred because of the parking situation faced by the management. This may not be the case for all employers, even if they are of equal or larger size. Second, the magnitude of the employee and community benefits are closely related to the extent of employee participation, and one must recognize that the positive response from employees can be attributed to several factors. The financial incentive played an important role, especially because of the technical background of the employees who were conscious of the cost of transportation. Also, the ride-sharing service provided was of high quality and strongly consumer oriented. The role of the transportation coordinator in the planning and promotion of the express bus routes and the van pools was extremely significant. Finally, but not least, is the important role of the esprit de corps among the TVA employees who encouraged others to use the program.

The TVA program is an ideal example that other employers could follow, but each program must be very carefully organized to ensure its success.

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Comparisons of Productivity of Four Modes of Service in Orange, California

Al Hollinden and Rebecca Blair, Institute of Transportation Studies, University of California, Irvine

The Orange County Transit District has operated a community-service transit program in the city of Orange, California, since May 1975. Because of an adverse court ruling and a subsequent successful appeal, this service underwent four modal changes. These four modes provide a unique opportunity for comparison. In order of implementation, they were a demand-responsive dial-a-bus, a three-loop fixed-route bus system, a two-loop fixed-route bus system, and a demand-responsive dial-a-taxi system. The four systems were compared by using five performance indicators. The two demand-responsive systems were found more efficient and effective than the fixed-route systems. The dial-a-taxi system, during its first 3 months of operation, compared very favorably to the dial-a-bus system, and continues to show monthly improvements on each indicator. The information gained in this study may be of limited transferability, but the data suggest that dial-a-taxi can be very efficient and effective in serving cities or suburban areas with population densities of 1900/km^2 (5000/mile^2) or less.

One of the goals of the Orange County Transit District (OCTD) is the development of an extensive community-service program. This program is being used to supplement the basic OCTD fixed-route bus system [a 1-km (1-mile) grid spacing and 30-min headways] in areas where transit dependency is greatest. Each community service is associated with a city or area for name identification and takes one of the following forms: dial-a-bus, dial-a-taxi, or an intensive fixed-route loop system. The dial-a-taxi mode may involve the use of some buses in areas where heavy peak-hour traffic merits the use of larger vehicles.

The community-service program that was developed in the city of Orange presents a unique case for study. The original service used a dial-a-bus mode. This was terminated after a court decision (Yellow Cab of Northern Orange County versus Orange County Transit District, No. 229461, Orange County Superior Court, 1975), and the second service—a three-loop, community fixed-route system—was inaugurated. Next, this was converted to the third service—a two-loop, community fixed-route system.

Finally, after an appeals court decision (Yellow Cab of Northern Orange County versus Orange County Transit District, 65 CA App. 3rd 268, 134 CA Rptr. 909, 1976) reversed the ruling of the county court, the fourth service—a dial-a-taxi mode—was inaugurated. The four key dates are those of the service changes given below:

Date	Service Change
June 2, 1975	Initiation of dial-a-bus
July 6, 1976	Replacement of dial-a-bus by community fixed-route service
January 2, 1977	Change of community fixed-route service from three to two loops
July 6, 1977	Replacement of community fixed-route service by dial-a-taxi

This paper describes the results of a study comparing the passenger responses to and the operating costs of the four different modes of community service in the city of Orange.

Obviously, direct comparisons of cost and performance data for different modes or for different areas may have little validity and require careful interpretation, but it is believed that there are performance indicators that at least facilitate comparisons. In the case of the city of Orange, the geographical area and the population served remained constant. The first three modes used were all operated by the same contractor and used the same types of vehicles.

ORANGE COUNTY TRANSIT DISTRICT

Orange County, California, is one of the fastest growing metropolitan areas in the United States. In 1960, its population, assessed valuation, and taxable sales were $704 000, $1 142 000 000, and $759 000 000 respectively. By 1970, the figures had increased to $1 420 000, $3 534 000 000, and $2 819 000 000, and the 1976 figures are $1 729 294, $8 525 901 232, and $6 965 894 000 respectively (1).

Throughout the first 3 years of this period, Orange County residents had to rely almost exclusively on the automobile as the mode of urban travel. The lack of high-density development, the extensive network of wide streets and arterials, and the network of freeway interconnections with other southern California areas resulted in and from this complete dependence on the automobile.

In 1971, however, the OCTD was formed for the purpose of providing cost-effective public transportation to county residents. Its task was not easy. There were two dominant obstacles. One was the unusually strong attachment of southern Californians to their automobiles—brought about in large measure by the ease with which great distances can be traversed at relatively low costs, and the other was the travel pattern of county residents—diverse and diffuse in both space and time.

To compete with the automobile in this environment of diffuse travel patterns, OCTD developed innovative concepts. The goal was to provide a well-balanced, integrated transportation system composed of a number of community or local-area bus or taxi systems that can simultaneously serve intracommunity travel needs and act as collection and distribution subsystems for a countywide network of bus routes designed to facilitate intercommunity travel. In the future, this countywide system will, in turn, act as a collection and distribution subsystem for the regional transportation system of the Los Angeles basin.

The first step in the development of a transportation system that could both serve the needs of those without access to an automobile and compete with the automobile was the inauguration of a pilot dial-a-ride service in the city of La Habra, in February 1973. Since then, OCTD has increased its community service with fixed-route services in Orange, Buena Park, and Westminster, a dial-a-taxi in Fullerton, and expansion of the La Habra service into Brea. Three other community services are expected to go into operation before July 1, 1978.

CITY OF ORANGE

The city of Orange, the second city selected for community service, is located in the center of Orange County, approximately 42 km (26 miles) south of Los Angeles. On the edge of the southern California coastal plain, Orange is situated at the foot of the Santa Ana Mountains, with both the Santa Ana River and Santiago Creek running through the city (2). It has an area of 43.5 km^2 (16.8 $miles^2$), an estimated total population of 83 900, and a population density of 1928/km^2 (4994/$mile^2$). One-fourth of the population is under 15 years of age, and the elderly, another major transit-dependent group, constitute approximately 7 percent of the population. Recreational opportunities abound; there are six city parks, three public pools, and many horse and bicycle trails.

A wide variety of housing opportunities, ranging from low-cost apartments to expensive condominiums, are available in the city of Orange. Typical costs for housing range from $35 000 to $200 000. Major trip attractions for residents include two regional shopping centers and 1350 retail establishments. Educational facilities include Chapman College within the city and three major universities in the surrounding area. The city also contains four major hospitals including the University of California Medical Center, seven medical laboratories, and seven convalescent homes.

The main industrial area is located on the western edge of the city and covers approximately 5.0 km^2 (1230 acres). This is divided into 0.5 km^2 (120 acres) of M-1 zoning and 4.5 km^2 (1110 acres) of M-2 zoning. Major industries include those concerned with transportation, machinery and metal products, plastics, rubber, fiber products, building materials, and chemicals.

Industry provides employment for 27 068 in the city of Orange, and the mean income is $14 317/year. Thirty-seven percent of the nonagricultural wage and salary employment is in manufacturing, 11 percent of which is devoted to aerospace. Another 25 percent are employed in trade, 19 percent in services, and 16 percent in government. Seventy percent of the work force commute more than 8 km (5 miles) to their place of employment, with 38 percent commuting more than 16 km (10 miles). Fifty-seven percent of the families have two or more automobiles, and only 6 percent of the families do not have an automobile (3).

Orange County has two types of cities. The first is the completely new city that has rapidly grown on the areas previously used for agriculture. The city of Orange is typical of the second type, i.e., an existing small city with a definite community and cultural center and rapidly expanding new development around the older center. This type of city generally has a more compact destination area and is more responsive to demand-responsive trip consolidations.

COMMUNITY-SERVICE MODES

As a result of the success of the pioneer demand-responsive dial-a-ride in La Habra, the Board of Directors of OCTD decided to expand the local community-service program. A three-tiered policy was developed for use in the selection of cities to receive the service. The first phase was an objective scoring system based on the following demographic characteristics: number of persons over 65 years old, number of persons 14 to 16 years old, existing fixed-route service, and number of low-income families. This phase identified the most eligible eight communities.

The second phase of the policy was the determination that eligible cities that were willing to pay one-third of the operating deficit would be considered for immediate implementation. (This policy was changed on February 1, 1976, and cities were no longer required to share in the cost.) The third phase of the policy dealt with modal selection with community fixed-route and dial-a-bus services the two alternatives.

The city of Orange was among the three most eligible communities, and the Orange City Council committed the city to paying one-third of the operating deficit. Dial-a-bus was selected as the operational mode, and on June 2, 1975, the Orange dial-a-bus began operating in the southern half of the city; 14 d later, operations were expanded into the northern half of the city.

Dial-a-Ride Operations from June 2, 1975, to July 5, 1976

The management and operation of the dial-a-bus system were contracted out. The services provided included the employment and supervision of all personnel including drivers; the operation of a driver training program for additional personnel after the initial training period; supervision of the maintenance and repair of equipment used in the system; preparation of budgets and financial reports; and the clerical, statistical, and bookkeeping services required so that the operation of the system could be compared with the performance of other transit systems.

The maximum yearly total cost to OCTD, including a fixed fee and two incentive fees, was not to exceed $518 815. The first incentive fee was $0.07/revenue and transfer passenger/month, and the second incentive fee was an additional increase per passenger if more than 320 000 passengers were carried in the first year of operation. All fares collected were revenue for OCTD.

Operating on a many-to-many basis, the dial-a-bus was in service Monday through Saturday from 7:00 a.m. to 7:00 p.m. (4). Seventeen 19-passenger Transcoach vehicles provided residents with service to anywhere within the city for a $0.50 fare. Residents could obtain this service, which combined the door-to-door convenience of a taxi ride with the economy of bus service, through a phone call to the OCTD control center. The average response time was 30 min, although wait time during the peak-hour periods averaged 60 min. This was in contrast to a planned response time of 20 min and illustrates the problems with the system.

Subscription service that enabled a passenger to call the control center and request a pickup at a certain time each day was also available and accounted for 2 percent of all passengers. This type of operation provided a convenient way to commute between residence and place of employment if both were within the city of Orange. The operation of the control center has been described by Fielding and Shilling (5).

The dispatcher scheduler combines customer information regarding location, number of riders, and desired pickup time with information regarding vehicle positions, tentative routes, and trip characteristics of other passengers. Using preplanned scheduling and dispatching procedures and a radio communication link to a fleet of small buses, the dispatcher assigns a vehicle to pick up and deliver each customer from origin to desti-

nation. The customer is advised of the expected pickup time and, perhaps, the fare and then waits until the vehicle arrives.

A large metal-backed map and magnetic pieces are used in the control center. The magnetic pieces hold trip tickets containing customer trip data—different pieces denoting origins and destinations. When a trip is assigned, colored markers corresponding to the vehicle are placed on both pieces. These markers also serve as pointers to the vehicle's next stop and effectively trace out a tentative route for each vehicle. When the bus arrives at a stop, the driver notifies the control center, which updates the bus position on the map and in turn notifies the driver of the next stop. The map therefore represents quite accurately the true state of the system, i.e., vehicle position, customers on-board, and customers waiting. Given a full view of the system, the control staff can alter tentative routes as necessary to accommodate new trip requests.

Community Fixed-Route Service from July 6, 1976, to July 5, 1977

As a result of litigation by taxi companies, the dial-a-bus was discontinued, and a community fixed-route service was implemented in July 1976 (6). An extensive analysis of the dial-a-bus trip tickets was made by OCTD staff, and a three-loop system was designed to continue to serve those patrons who had used the dial-a-bus. Service operated Monday through Friday, 6:00 a. m. to 9:00 p. m. on 30-min headways. Saturday service operated on 60-min headways from 9:00 a. m. to 6:00 p. m. The management contract was retained with a few minor amendments. The maximum total cost to OCTD remained at $518 815.

Beginning in July 1976, three community-service routes using seventeen 19-seat Transcoach vehicles were in operation. An evaluation by OCTD showed that this service was not as productive as other fixed-route bus operations and did not approach the established policy standards. In January 1977, the three existing routes were replaced by two new routes, which left eight vehicles operating an average of 37 000 revenue km/month (23 000 revenue miles/month). It was attempted to link the two new routes to major trip attractions whenever possible and feeder distribution to the regular fixed-route bus service was also a factor in scheduling, but the end result for many patrons was long travel times for relatively short direct distance travel.

The replacement of the three routes with two new routes was made when marketing analyses showed that patrons prefer to walk out of their neighborhoods (1 to 3 blocks) to major arterial streets for the trade-off benefit of faster travel time. In other words, residents were willing to sacrifice convenience (closer service) for reduced travel time. Because the community-service routes penetrated deeply many neighborhoods, travel time was increased to the point where ridership was discouraged.

The change from a three-route system to a two-route system was also a result of a policy decision to cut total costs. The appellate court decisions had been rendered in OCTD's favor, and preliminary planning had begun to reinstate a demand-responsive system. Thus, it was decided to reduce the fixed-route service during the interim period and do minimal advertising. Total costs were greatly decreased, but the individual indicators reflected the high costs per passenger.

Dial-a-Taxi Operations from July 6, 1977, to the Present

On July 6, 1977, a new dial-a-ride consisting of taxicabs and Transcoach buses replaced the community-service operations in the city of Orange. This new system included Orange and Orange Park Acres as well as the city of Villa Park, a community of 7200 people that was not included in the original dial-a-ride service area. Since Villa Park is surrounded by the city of Orange, the dial-a-taxi can effectively serve Villa Park without significantly increasing the cost of operations (7).

Service is provided by a contractor and consists of 12 vehicles—seven 7-passenger sedans provided by the contractor and five 19-passenger Transcoach buses provided by OCTD (8). The contractor operates and maintains all vehicles and is responsible for hiring and supervising all personnel including drivers, dispatchers, supervisors, and maintenance employees. These services are provided on a cost-plus-fee basis. OCTD monitors the efficiency of the operation to ensure that the transit district service standards, safety, courtesy, and maintenance are followed. In addition, OCTD provides uniforms and conducts initial training for all drivers. According to the officials involved, this new service concept is a "step forward in public agency relationships with private industries."

A unique feature of the contract is that the contractor retains all passenger revenue. This is an incentive feature for the operator, who becomes a real partner in the attempt to increase patronage. The advantage to the transit district is the ability to plan for a fixed cost of service. Increases in patronage are reflected in the performance statistics as decreasing costs per passenger carried.

PERFORMANCE ANALYSIS

Research in performance evaluation generally concludes that direct comparison of demand-responsive and fixed-route services by using performance indicators is not proper because of basic differences in service. Such differences as vehicle size, access to vehicles, and that one service is demand activated while the other provides continuous service over specific routes result in statistics that are inherently different (9).

However, in the case of the city of Orange, the fact that the two services were offered in much the same area during successive time periods makes some comparison possible. Vehicle size was identical for the dial-a-bus and fixed-route vehicles, and this aids in the comparison. In addition, the two services had the same administrative structure so that there was very little difference in overhead expense between them.

The indicators used in this analysis are (a) net cost per vehicle service hour, (b) percentage of population served, (c) revenue passengers per service-area population, (d) passengers per vehicle service hour, and (e) net cost per passenger. The certain basic operating and financial statistics needed to prepare these indicators include the monthly totals for patronage, net cost, and vehicle service hours. The data from which these can be calculated are summarized in Table 1.

Before comparing the performance indicators, it will be informative to look at the monthly averages for patronage, vehicle service hours, and net cost. These statistics cannot be exactly compared with each other, but they give a general picture of the four systems over time.

1. Passengers per month: The dial-a-bus served an average of 15 051 passengers/month with a peak (March 1976) of 19 200. When the first (three-loop) community fixed-route service was implemented, the average fell to 7231 passengers/month—a decrease of more than 50 percent. During the peak month of this service (December 1976), 8100 passengers were carried. When this service was replaced by the two-loop service, the average fell to a low of 3412 passengers/month. During this period, patronage remained relatively stable with no real peak month. After only three months in service, the dial-a-taxi is serving an average of 8861 passengers/

month, and this is increasing each month. In the most recent month (September 1977) for which data are available, 10 100 passengers were carried. Month-by-month passenger totals are shown in Figure 1.

2. Vehicle service hours per month: This is a measure of total units of service produced during a certain period of time (in this case, a month); thus, it follows that a higher value means that more service was provided. Figure 2 shows that the dial-a-bus and the three-loop, community fixed-route system provided nearly the same amount of service. The implementation of the two-loop, fixed-route system, however, resulted in a 62 percent reduction in service. After 3 months of operation, the dial-a-taxi is providing approximately 482 h/month of service more than the two-loop system. Although these figures tell us how much service was provided, they do not tell us how much of the provided service was used.

3. Net cost per month: This is a measure of net input per unit of time (again, one month). A lower cost indicates either a more efficient system or a lower level of provided service (i.e., total service hours). The largest value ($62 550) was that for the three-loop, community fixed-route system; the next largest was that for the dial-a-bus ($49 290). The two lowest values are those of the two-loop, community fixed-route system ($32 431) and the dial-a-taxi ($23 268). The net cost per month for the new dial-a-taxi is a reduction of 53 percent from the first dial-a-bus and of 63 percent from the first community fixed-route system. The monthly net cost figures are summarized in Figure 3.

Table 1. Operating and financial statistics: city of Orange.

System	Total Passengers	Total Vehicle Service Hours	Total Net Cost ($)	Total Months of Operation
Dial-a-bus	195 663	44 980	640 782	13
Community fixed-route service				
Three loop	43 388	20 842	375 301	6
Two loop	20 470	7 924	194 587	6
Dial-a-taxi	26 583	5 409	69 806	3

Figure 1. Passengers per month for the city of Orange.

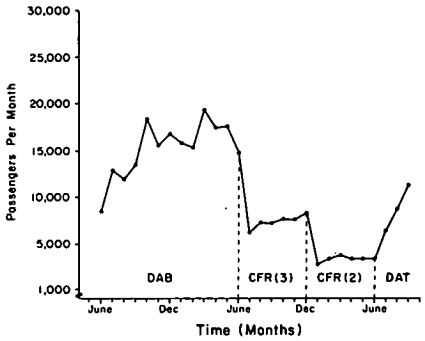


Figure 2. Vehicle service hours per month for the city or Orange.

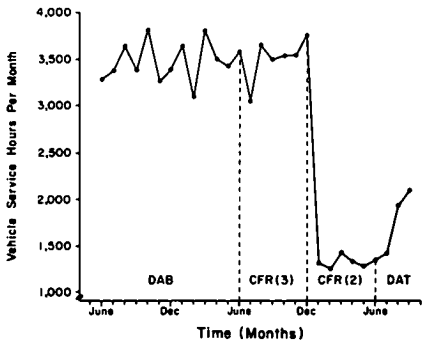
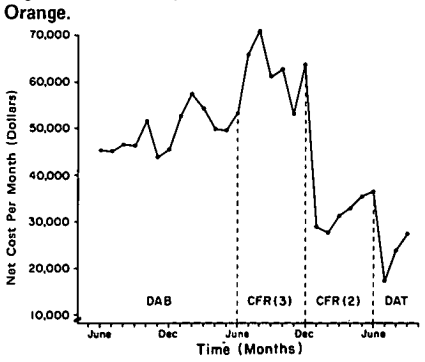


Figure 3. Net cost per month for the city of Orange.



Performance Indicators

The performance indicators used in evaluating and comparing transit systems in general and the four modes used in the city of Orange in particular can be categorized as those that evaluate efficiency and those that evaluate effectiveness (Table 2). "Efficiency concerns the process by which services are produced, particularly through the relationship of inputs to produced output; that is, it concerns doing things right" (9). "Effectiveness is concerned with the service which is actually provided: its accessibility to the area residents, and its correspondence to the transportation requirements of the particular area" (10). It is concerned with doing the right things. The interpretation of the performance indicators may differ somewhat among service modes, and these differences must be considered when making comparisons.

Comparison of Orange Services

1. Net cost per vehicle service hour: This is an efficiency indicator of the net inputs per unit of service produced. A low value is favorable. Thus, by this measure, the new dial-a-taxi is the most efficient system. However, to determine service utilization, performance indicators that evaluate effectiveness must also be examined.

2. Percentage of population served: High values on this effectiveness indicator are favorable, but it must be remembered that demand-responsive systems, by definition, present service to 100 percent of the population of the area they serve, a score that is given without consideration of the hours of operation or the planned response times. In the fixed-route systems, the residential population within 0.4 km (0.25 mile) of the route is considered to be served.

3. Revenue passengers per service-area population: This effectiveness indicator has more meaning than the percentage of population served because actual service use is involved. High values are favorable. Thus, by this measure, the dial-a-bus was the most effective system, but the dial-a-taxi is approaching an equivalent value.

4. Passengers per vehicle service hour: This is an effectiveness indicator of system patronage with high values being most favorable. Thus, by this measure,

Table 2. Performance indicators for four city of Orange systems.

Performance Indicator	Dial-a-Bus	Community Fixed-Route Service		Dial-a-Taxi
		Three Loop	Two Loop	
Net cost per vehicle service hour, $	14.25	18.01	24.56	12.90
Percentage of population served	100	86	48	100
Monthly revenue passenger per service-area population	0.18	0.09	0.04	0.10[a]
Passengers per vehicle service hour	4.35	2.08	2.58	4.91
Net cost per passenger, $	3.27	8.65	9.51	2.62

[a]In the peak month of September 1977, this value increased to 0.13.

Table 3. Comparison of Orange services with other services.

Performance Indicator	Dial-a-Bus in October 1975		Community Fixed-Route Service in October 1976			Community Fixed-Route Service in April 1977			Dial-a-Taxi in September 1977		Regular Fixed-Route Service in September 1977 Countywide[a]
	La Habra	Orange	Westminster	Buena Park	Orange Three Loop	Westminster	Buena Park	Orange Two Loop	Fullerton	Orange	
Net cost per vehicle service hour, $	14.64	13.54	12.00	11.26	17.52	17.12	9.58	25.36	12.89	13.47	28.85
Passengers per vehicle service hour	7.17	4.72	5.87	3.38	2.16	7.15	5.44	2.69	4.68	5.43	23.04
Net cost per passenger, $	2.04	2.87	2.04	3.33	8.10	2.39	1.76	9.43	2.76	2.48	1.23

[a]Values based on budget and allocation model estimates. Values include both regular-fixed route and park-and-ride services. Park and ride accounts for 1 percent of total cost and 1 percent of total passengers.

the dial-a-taxi is the most effective system.

5. Net cost per passenger: This is an effectiveness indicator of net inputs per trip within the system; thus, a low value is favorable. It is really an overall performance indicator combining efficiency (net operating costs) with effectiveness (number of passengers). Usually, systems with low passenger volumes, by virtue of their service characteristics (demand-responsive), will have high costs per passenger, and systems with high ridership and short trip lengths will have low costs per passenger. However, contrary to this prediction, Table 2 shows that both community fixed-route systems had much higher net costs per passenger ($8.65 and $9.51 respectively) and that the current dial-a-taxi has the lowest value.

All the effectiveness indicators showed that the two dial-a-ride systems were more effective than the community fixed-route systems.

Systemwide Comparison

Table 3 gives 1977 data for the OCTD fixed-route system and four of its community-service operations. These data were selected for months appropriate for comparison with the performance indicators of the Orange systems.

1. Dial-a-bus: When the Orange dial-a-bus is compared to the La Habra-Brea dial-a-bus, the difference in efficiency is not great. The net cost per vehicle service hour in Orange is $1.00 less than that in La Habra, but this is of little significance because of vehicle and personnel variables.

The effectiveness indicators, however, tend to favor the La Habra dial-a-bus. The lower number of passengers per vehicle service hour of the Orange system indicates that the La Habra system was used at a higher rate than the Orange system, and this is supported by the net cost per passenger, which is also lower for the La Habra system.

2. Three-loop, community fixed-route service: When this service is compared to the community fixed-route service in either Buena Park or Westminster, its inefficiency and ineffectiveness are readily apparent. Both its cost per vehicle service hour and its cost per passenger are higher than those of the other two systems, and its number of passengers per vehicle service hour is lower.

3. Two-loop, community fixed-route service: The implementation of the two-loop, community fixed-route system did not improve the situation in Orange: An inefficient system was replaced by an even more inefficient system. The cost per vehicle service hour increased significantly, although the total cost per month did decrease due to the drastic reduction in vehicle service hours.

The number of passengers per vehicle service hour did show a slight increase, but still remained substantially below the other two systems. The net cost per passenger increased, indicating that although the total net cost decreased with the service reduction, passenger use decreased even more. In an attempt to cut cost, OCTD had lost a large number of passengers.

4. Dial-a-taxi: When the Orange dial-a-taxi is compared to the Fullerton dial-a-taxi, Orange, after only 3 months of operation, is very close to Fullerton in all categories. The net costs per vehicle service hour and the net costs per passenger are both very close. The effectiveness measure, passengers per vehicle service hour, is higher for Orange than for Fullerton.

Ridership Survey

In August 1977, OCTD conducted a ridership survey of all dial-a-taxi patrons in both Orange and Fullerton. All riders calling for service were asked the single question, "How did you make this trip before the dial-a-taxi?" Their responses are given in Table 4.

The most surprising result in the case of Orange was the extremely small number of people that had previously used the three- and two-loop community fixed-route services. It appears that the patrons for the two types of services come from two different populations. Fullerton did not have a prior community service.

As expected, the availability of the dial-a-taxi did not have much impact on automobile drivers, but 16.5 percent of the Fullerton trips and 18.3 percent of the Orange trips had previously been made as passengers in someone else's automobile.

Table 4. Ridership survey: August 1977.

Respondent	6:00 to 9:00 a.m.		9:00 a.m. to 3:00 p.m.		3:00 to 7:00 p.m.		Total	
	Orange	Fullerton	Orange	Fullerton	Orange	Fullerton	Orange	Fullerton
Automobile driver, %	1.8	3.1	4.3	1.1	0.6	0.0	6.7	5.2
Automobile passenger, %	6.1	7.3	7.3	8.1	4.9	1.1	18.3	16.5
OCTD fixed-route passenger, %	5.5	2.3	13.3	11.5	1.2	2.3	20.0	16.1
Community fixed-route service passenger, %	2.4	0.0	1.2	0.0	0.0	0.0	3.6	0.0
Did not make trip before, %	1.8	6.5	8.4	11.9	3.0	8.8	13.2	27.2
Other (walk, bicycle), %	7.9	8.5	20.0	22.5	6.1	3.5	34.0	34.5
No response, %	0.0	0.4	1.2	1.1	3.0	0.0	4.2	1.5
Total	25.5	28.1	55.7	56.2	18.8	15.7	100.0	100.0

The impact on trips made by the OCTD fixed-route system is comparable to the reduction in automobile trips. Approximately one-third of the patrons had previously used some other means (e.g., walking or bicycling) for their trip making.

Twenty-seven percent of the patrons in Fullerton and 13.2 percent of the patrons in Orange indicated that they had not made the trip before. This may indicate that this service is playing an important social function by allowing senior citizens and other transit-dependent persons to participate in recreational and educational activities.

SUMMARY

This study did not produce any conclusions that could be directly transferred to other cities or areas. Many factors such as population density, street patterns, and population characteristics should be considered when determining whether or not a community transit service is required and what mode of service would be most efficient and effective.

After 3 months, a dial-a-taxi appears to be the best choice for communities such as the Orange County suburban cities having population densities of 1900 persons/km^2 (5000 persons/$mile^2$) or less. The dial-a-taxi as implemented in Orange and Fullerton uses some small buses during the peak hours, and this provides for higher performance in the important indicators of passengers per vehicle service hour and cost per passenger. It is not an all-taxicab system.

Dial-a-taxi has gained wide acceptance in the community of Orange. It is strongly supported by the city council, the chamber of commerce, service and social organizations, and the local newspaper. Letters and comments to the OCTD by patrons and relatives of patrons have been highly favorable, and the complaint level has been lower than that of any other OCTD service.

ACKNOWLEDGMENTS

Funds for the research and writing of this paper were provided by the state of California. The planning department of the Orange County Transit District was instrumental in providing the necessary data.

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Discussion

Douglas J. McKelvey, National Transportation Policy Study Commission

The history and productivity comparisons of different types and levels of service in Orange, California, have a number of implications for rural transit and raise some questions.

IMPLICATIONS FOR RURAL TRANSIT

The history of the transit service changes in Orange is very informative. The comparison of costs and ridership for differing types and levels of service systemwide for the same area is a first in transportation research. Other demonstrations have attempted to measure and compare changes in ridership and costs. However, most of these have not been systemwide or representative of the extent of change that occurred in Orange County. Moreover, that the Orange County services were not federal demonstrations may have resulted in a better understanding of the demand for different types and levels of service because many persons may perceive a demonstration service as a temporary service and choose not to try it or rely on it.

One interesting finding of the Orange experience is that the costs per passenger were less for the demand-

responsive services than for the fixed-route services. This was primarily due to the higher ridership on the demand-responsive systems and is important for rural passenger transportation because it helps disprove the common belief that fixed-route service is less expensive (cost and subsidy required) than demand-responsive service. Thus, local and county officials in rural areas might be more willing to consider alternatives other than the known fixed-route type of service. Also, the Orange performance indicators help dispel the belief that rural public transportation is so expensive (at least as compared to urban transit). Data from 16 rural systems in Pennsylvania showed an average cost per passenger trip of $1.17, compared to $2.87 and $2.48 respectively for the dial-a-bus and the dial-a-taxi in Orange (11). This is important because rural transit operators often must justify their costs and put them into perspective for local rural officials who, in turn, often must convince taxpayers and state legislatures that their rural passenger transportation systems provide efficient service and deserve financial assistance.

Another important finding is that Orange provides another example of a situation where an existing taxi operator is able to provide more, but less costly, service than a public agency. The use of taxis in rural areas has great potential for satisfying public transportation and social service needs. However, the potential will be achieved only if private operators are involved from the beginning in the development of the rural service and users, decision makers, operators, and agencies recognize the mutual benefits of such coordination. This will require educational efforts and institutional changes: All concerned must understand how to write equitable contracts and improve service, and institutional arrangements and interpretations of laws that inhibit such service and innovation must be amended.

A third implication of the experiences in Orange, as well as in Westport, Connecticut, and the other places is that incentives to improve system efficiency will result in lower costs and subsidies per passenger trip. This finding is important for both rural and urban systems faced with inflation and pressure from decision makers and taxpayers to be more efficient and accountable.

SOME QUESTIONS

The paper also raises some questions. They are summarized below.

1. Are the performance indicators useful for comparing systems providing service in different places? My opinion is that other measures, such as cost per passenger unit trip length, will be necessary for sensitivity to different passenger trip lengths and patterns.
2. Are the performance indicators sufficient and useful to the operator? If not, what additional measures are needed and what is the cost of collecting such information?
3. What changes and cautions would be necessary if such indicators were used to allocate state or federal funding for passenger transportation?
4. The performance indicators used provide estimates of the effectiveness and efficiency of the service, but what measures could be used to estimate the equity (12) of the service? (Many workers ignore or blur the distinction between efficiency and effectiveness. Efficiency is an economic measure relating input to output, while effectiveness and measures of effectiveness relate to the objectives of the system, which may not be strictly economic. Both types are important for comparing and improving service, but it is important to distinguish between them and use appropriate indicators.)
5. The Orange experience suggests what incentives are appropriate for privately owned or operated transportation systems. What incentives would be effective for publicly owned or operated systems?

DISCLAIMER

The preceding comments do not necessarily reflect the views of the National Transportation Policy Study Commission.

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Costs, Constraints, and Operational Considerations

Cost-Revenue Squeeze in Conventional Transit

David W. Jones, Jr., University of California, Berkeley

Transit ridership is increasing after more than 2 decades of decline. But the share of the travel market held by transit continues to decrease relative to that of the automobile, and the reverse of patronage decline has been achieved at enormous cost. Operating losses have escalated at a rate (more than 30 percent/year) that cannot be sustained. In part, this is due to inflation, the increasing cost of fuel, the aggressive bargaining posture of transit unions, and a policy of fare stabilization. But the more fundamental reasons are (a) the evolution of urbanization and social interaction patterns that are incompatible with the operating regime of conventional transit and (b) the introduction of costly and underused services stimulated by formula subsidy programs based on fair-share politics. The cost of transit deficits is evident in taxes. But there are other, less evident, costs of expecting too much from transit. These include the failure to develop a coherent national policy toward the future of the automobile and the highway system. Paratransit can be a part of the solution if it offers a way of lowering expectations and focusing attention on the cost-effectiveness and market potential of competing alternatives. It can be part of the problem if it creates new expectations that serve to establish the right to service regardless of need. The best possibility for restraining costs and matching services to needs seems to lie in the reform of the subsidy allocation process. If regional planning agencies or general purpose governments could be given greater discretion to allocate federal funds, competitive bidding arrangements could be used to secure quality service from the most efficient vendor. This would entail severing the direct connection from the federal treasury to the transit properties and designating nonoperating agencies as the recipients of federal operating funds.

The lead story in the Wall Street Journal on March 1, 1977, was headlined, "Public Transportation Wins More Passengers—At Taxpayer Expense. Government Funds Help Cut Fares, Expand Routes, But the Deficits Deepen." The heading at the top of the page added, "Riders Return."

Each week, Passenger Transport tells the success side of the transit story—the accounts of transit properties that have reversed the postwar trend of declining ridership and posted increases in patronage. Sometimes the increases are dramatic. In the San Francisco Bay Area, for example, Golden Gate Transit doubled the patronage in its bridge-bound corridor only 1 year after taking over operations from the Greyhound Bus Company, a private operator. The Southern California Rapid Transit District (RTD) increased its patronage by more than 25 percent from 1975 to 1976. And the aggregate nationwide patronage increased for the first time in 1973 after 28 years of decline.

But, as the Wall Street Journal observed, "transit gains come at a price—one that is usually paid by taxpayers." The size of the price is, in fact, staggering. A 45 percent increase in vehicle operating distances and a 53 percent increase in operating expenditure were required for RTD to register its 25 percent gain in patronage. The experience in Minneapolis is comparable: A 1973 to 1974 ridership gain of 8.3 percent was achieved by increasing regularly scheduled bus operating distances by 22 percent.

However, the bottom line for transit, which is currently viewed as a merit good, is no longer profitability. Under public management, the critical question is not the magnitude of operating losses, but the size of the anticipated unfunded deficit versus the quality of the service. Unfunded deficits are operating losses for which there are no currently available offsetting subsidies or revenues without a tax or fare increase. In California, for example, transit properties are facing a cumulative 5-year unfunded deficit that will probably exceed $600 million (1, p. 11). The Chicago Regional Transportation Authority has estimated its unfunded deficit for the 1976 to 1981 period as being in excess of $400 million (2, p. 25ff). And the Tri-State Regional Planning Commission in the New York-New Jersey-Connecticut region anticipates a 5-year unfunded deficit of approximately $1.2 billion (3, p. 29). These estimates include all currently available and authorized federal operating assistance. In fact, it appears that financing the nationwide unfunded deficit over the next 5 years would require an operating subsidy program almost as large as the current federal program and, even then, the funds would not be distributed in the manner necessary to relieve the debit position of older urban properties where the deficits are most pressing and the local tax bases least robust.

We do not have to look to forecasts of unfunded deficits to become alarmed at the rate at which the tax cost of mass transit is escalating. Between 1971 and 1975, transit operating losses increased 410 percent nationwide—an unsustainable compound growth rate of more than 30 percent/year (4, p. 28).

Numerous factors can be advanced to explain the rapid escalation of transit deficits:

1. Significant increases in service areas and service frequencies;
2. Public policies of fare stabilization intended to maintain and increase ridership;
3. The reduction of transit fares for the elderly, handicapped, and other special-need groups;
4. Maintenance cost increases associated with higher standards of vehicle performance and comfort;
5. The impact of inflation on operating expenses (hourly wage rates have approximately paced inflation, and work-rule changes have increased take-home pay, resulting in settlements in excess of the inflation adjustment);
6. The success of transit unions in bargaining for wage increases and improved benefit plans;
7. The impact of cartel-priced fuel on operating expenses; and
8. Increases in the planning and professional staff necessary to compete for federal grants and comply with external reporting requirements.

Of these explanations for the rapid escalation of operating deficits, labor costs have received the most attention. Transit management has focused the blame for rapidly escalating costs on the monopoly powers of labor unions and their ability to hold cities ransom through prolonged strikes. Labor costs do account for about 75 percent of the unit-cost escalation of recent years. But the escalation of unit costs should not be confused with the escalation of deficits. Among California transit properties, annual increments in the unit cost of labor, for example, have been averaging only 7 to 11 percent/year—increments that, in most cases, keep pace only with inflation. Cost-of-living adjustments account for less than half of the escalation of deficits and should not be viewed exclusively as debits on the ledger of community economics. To the extent that transit wages are spent for consumer goods and recycled through local economies, they represent an asset to the service sector and the local economy.

For a more convincing explanation of the rapid escalation of transit deficits, we must look beyond cost-of-living adjustments and focus on the political economy of the decline and rebirth of transit. It is in the consideration of transit as a merit good to which all jurisdictions have a rightful share that we can find the most convincing explanation for the escalation of deficits at a rate that has far outpaced the cost of living.

POLITICAL ECONOMY OF TRANSIT DEFICITS

Mass transit is the stepchild of franchise economics. During its early growth years, many private and quasi-private properties maintained their profitability by joint endeavors such as service supply, electricity sales, and real estate development. Similarly, commuter railroads realized profits by using trackage and equipment for joint passenger and freight operations. But, with the expansion of local roads and state highway systems, trucks and the private automobile captured a rapidly increasing share of these markets and eroded the transit profit base established on land development, freight operations, and passenger revenues. The market share of transit began to decline in the 1920s, but the dynamics behind this trend were masked by the great depression and World War II—both of which suppressed the diffusion of automobile ownership and the buying power of would-be homeowners (5, p. 87 ff; 6, p. 28).

Municipal ownership and subsidy rescued some transit properties from abandonment, but the fiscal distress of local governments in the 1930s led to a pattern of chronic underinvestment in fleet renewal and replacement. Political pressure to maintain the 5¢ fare generally prevailed, and capitalization and maintenance suffered. In many urban areas, private owners (many of them electrical utilities) wrote down capital assets, sought route abandonments, and won fare increases, accelerating the loss of patronage.

The market share of transit recovered, increased rapidly, and peaked during World War II, because of the effects of gasoline and rubber rationing, suspended automobile production, and the urbanization of population fostered by wartime mobilization. But, in the postwar recovery period of the late 1940s and the 1950s, the dynamics of ridership decline that had begun in the 1920s took over in full force. In a period of unparalleled economic growth (the United States and Canada were the only major industrial powers that did not have to rebuild war-ravaged economies), both home and automobile ownership increased dramatically. The sale of single-family homes and the diffusion of the automobile reconfigured the social interactions and spatial organization of urban America. Changes in technology and economic organization—the automatic transmission, the home freezer and other convenience appliances, the radio and later television, the shopping center and supermarket, the practices of tracting and subdividing, and changes in the scale of manufacturing and distribution processes—combined with federal home-loan guarantees and the automobile to reshape the structure of metropolitan areas.

State highway programs were placed on a firm financial basis in the first 5 years of the postwar period. With the growing power of urban constituencies and the continuing fiscal distress of local governments, routes of statewide significance were designated in metropolitan areas. Highway development fostered the growth of trucking and relaxed the constraints of labor and sales-market proximity that had confined industrial location in earlier years. Dependent, but vigorous, suburban service economies developed in metropolitan areas. As these trends accelerated, highways were built to bring the customers back downtown and to accommodate the growth of traffic generated by the expansion of the management and administrative apparatus associated with corporate multinationalism and federalism.

With improved access to downtown jobs and the growth of suburban industry, subdividers were able to assemble large tracts of land and market moderately priced housing on the assumption that highway construction would follow. Local governments in rapidly developing areas soon found themselves plagued with too much traffic, too many bedrooms, and too many children. The fiscal position of moderate- and middle-income bedroom suburbs led to pleas for state assistance in expressway development and local efforts to attract an industrial and commercial tax base by providing the services of an urban infrastructure on a promotional basis.

The cumulative dynamics of metropolitan growth have all the hallmarks of a social, cultural, and spatial revolution. These forces interacted with highway investments in a particularly intensive way after World War II because of the nation's favored position in the postwar world economy and the exploitation of wartime technological advances (electronics, for example) in the commercial marketplace. What should also be understood, however, is that the income gains of this period of unprecedented economic growth only reinforced consumption and location desires already evident in the 1920s. These desires—the preferences for private transportation and private homes—had been at work earlier, eroding transit patronage and discouraging capital reinvestment.

Thus, the escalation of transit deficits is rooted in the economic, social, and spatial dynamics of automobile-

oriented patterns of urbanization. These trends were eroding the share of the urban travel market occupied by transit long before the Interstate highway program was funded.

Efforts to recapture ridership are proving excessively costly because the spatial configuration of metropolitan areas has been so strongly influenced by the capabilities and availability of the automobile.

POLITICAL ECONOMY OF TRANSIT REVIVAL

Transit ridership declined from 23 billion to 9 billion passengers between 1945 and 1960 (4, p. 32). The decline in passengers and revenues was accompanied by bankruptcies, route abandonments, and fare increases. Predictably, the failing industry was unable to modernize its capital assets, attract innovative managers, or secure technological innovation by equipment suppliers. It is probably not exaggerating to say that the industry fell a generation behind in the techniques of market analysis, fleet procurement, labor relations, fiscal planning, and mass marketing.

By 1955, mass transit had become a creature of neglect: Commuter services were an unwanted second cousin of railroad operations whose major profits were based on land-holding subsidiaries and long-haul freight, and municipal properties were becoming an increasing drain on property tax revenues and, therefore, a political liability.

Pleas for federal and state assistance were typically rebuffed by legislatures with a representational bias toward rural areas. The message was clear: Cities would have to pay for their transit services themselves or abandon those services.

The abandonment crisis became much more serious in 1959 as eastern commuter railroads seized on a provision of the Federal Transportation Act of 1958 that permitted discontinuation of interstate commuter services without approval by state railroad commissions. Thus, the issue of financial assistance came before Congress with urgency in 1960 (7, p. 38).

The political atmosphere of 1960 was significantly different from that of the late 1950s when the first overtures for urban transit assistance had been rebuffed. The transit question now carried with it the political imperative of crisis, but more important, the demand for assistance came at a time of change in the coalition structure of American politics. The most obvious of those changes was the election of a new president beholden to the urban wards of Chicago and the industrialized cities of the East. President John F. Kennedy was accessible to big city mayors and labor leaders whose influence had been limited during the Eisenhower years. These mayors had forged local coalitions of common interest with the patrician leadership of their central business districts—the financial and commercial elites of their distressed cities. Kennedy was told that a public commitment to urban renewal and redevelopment was necessary to secure private reinvestment in the city. A partnership of public and private interests having the ability to command bipartisan support was in the making.

Kennedy was also accessible to a brain trust of urban intellectuals whom he recruited to serve in the new administration. They brought to Washington an awareness of the racial dynamics of the central city and the problems of urban poverty and a faith in social planning and public intervention.

Gains in the influence of urban elites were matched by larger structural changes in the location of political power. Migration and differential birth rates had increased the voting power of those living in metropolitan areas to an absolute majority. Constitutional reform and legislative redistricting had also begun to change the urban versus rural balance of congressional delegations (and state legislatures).

Attitudes toward governmental intervention and federal assistance were also changing. The cold war partnership between the U.S. Department of Defense and the aerospace industry and the mixed economy of the oil-automobile-highway sector were demonstrating to nominal conservatives the merit of public-private collaboration in economic development. A Marshall Plan type of operation for urban areas would still be opposed by most conservatives, but a growing minority of self-consciously progressive businessmen were discussing ways in which the enterprise of the private sector could help solve urban problems.

A federal role in transit—along with urban renewal—was a natural first thrust for the new urban coalition. Transit was perceived as vital for urban redevelopment and the economic welfare of the central business district; it had become a burdensome drain on local fiscal resources; its revitalization commanded labor and minority support. Later, it would also be perceived as an opportunity for the conversion and stabilization of the aerospace industry as the space program was cut back.

Just as important, transit was an issue that allowed the formation of a common-cause coalition between central cities and their suburbs.

The transit coalition gained momentum with plans for the Bay Area Rapid Transit (BART) offering an exemplary case of the opportunity to be seized and the excesses of urban freeway construction associated with the Interstate highway program offering a rallying point for highway opponents.

The first successes of the still tentative and fragile transit coalition were limited—a demonstration program located in the predecessor agency of the U.S. Department of Housing and Urban Development. But the rapidly deteriorating financial position of local transit properties and commuter railroads increased the pressure for a more aggressive federal role—one that was assumed with congressional approval of the Urban Mass Transportation Administration (UMTA) capital grant program in 1964.

UMTA capital grants permitted the public acquisition of failing transit properties, the tax financing of commuter railroad fleet replacement, and a limited but costly program of rapid transit construction.

However, while fleet modernization and replacement reduced the unit cost of maintenance, these savings were overwhelmed by the increases in operating losses that accompanied fleet expansion. These losses increased by $1.2 billion between 1964 and 1975 and led to congressional acceptance of a 6-year, $3.975 billion program of federal operating assistance. This operating-assistance program was given added impetus by the petroleum embargo of 1974, the emergence of an active environmental movement in the early 1970s, and the increasingly effective political voices of the elderly and handicapped.

The federal operating-assistance program (and predecessor state subsidy programs) embody formula-financing arrangements that reflect the areawide metropolitan base of the political support of transit. The votes of suburban legislators and congressmen have been necessary in obtaining majority support for transit finance legislation. As a consequence, transit routes have been extended and service deployed on the basis of the tax equity consideration of a fair share of the service.

The logic of fair-share politics and the associated policy headways (i.e., headways determined by political obligation) is illustrated by a staff report written for the Santa Clara County (California) Transportation District.

The primary means of paying for the deployment of buses influences that deployment. The resources that are available for operating cost payment are collected from the entire county. The deployment of buses should reflect the source of these funds....

A strict cost-per-rider measure of transit effectiveness is a narrow efficiency approach with an inherent assumption that the objective is to deploy vehicles so as to secure the most riders per hour. That objective is not now a part of the General Transit Plan.... Social concerns clearly govern, rather than costs.

The logic of fair-share politics is also captured in a January 19, 1976, report in the Palo Alto Times headlined, "Transit Plan Shortchanges Palo Alto."

Palo Alto won't get a fair and reasonable share of bus system improvements from a proposed half-cent sales tax increase for Santa Clara County, according to city traffic engineer Ted Noguchi.

The county has proposed the sales tax increase to expand the bus fleet from 236 to 516 buses and make other transit improvements. A county election on the increase is set for March 2.

Noguchi, in a report to the City Council, said that Palo Alto would get only 6 percent of the available peak-hour bus hours of service, but that 14 percent of county jobs are in Palo Alto and 10 percent of total vehicle trips are in Palo Alto.

Also, he said, of the 440 miles of extra bus routes that would be added to the existing 860 miles, only 8.1 miles, or 1.8 percent, would be in Palo Alto.

Palo Alto's present share of the peak-hour buses is 9.5 percent, which would drop to 6 percent of the expanded fleet, he said.

A few cases from the San Francisco Bay Area will illustrate the financial consequences of fair-share policies in service deployment and subsidy distribution. AC Transit operates bus service in both the dense Oakland-Berkeley axis of Alameda County and the postwar suburbs of Fremont and Union City. The cost per rider in the central service area is $0.80, but in the suburban area, it is $1.65.

The San Francisco Municipal Railway (Muni) carries 125 million passengers/year and recovers 39 percent of its costs from the fare box. In Santa Clara County, a 5-year-old transit system carries 5 million passengers/year and in 1975 recovered only 15 percent of its costs from the fare box. Muni carries 26 percent of the transit riders in California and operates 13 percent of the coach travel distance in the state. In comparison, the Santa Clara County system carries 1 percent of the statewide ridership and operates 1.5 percent of the statewide coach travel distance. Despite these operating results, Santa Clara County receives 9.1 percent of the state transit-assistance-program funds while Muni receives only 3 percent. A comparable situation prevails in the distribution of federal operating subsidies. Because of the formula structure of the operating assistance program, Muni must compete with BART, AC Transit, San Mateo, and Golden Gate Transit for a fractional share of $102 million, while the Santa Clara County Transit District will receive a free and clear apportionment of $32 million during the 6-year life of the federal program.

This begins to suggest another explanation for the escalation of transit operating deficits: The structure of state and federal aid programs is encouraging the expansion of transit beyond its natural market in densely populated urban areas and heavily trafficked corridors. At the same time, the local politics of fair-share service deployment are impelling transit managers to neglect fare-box recovery and service utilization as indicators of system effectiveness and service need.

We can state this another way: The political economy of transit revival is perversely out of synchronization with prevailing trends in spatial organization, household location, and automobile ownership. The preponderance of operating assistance funds are being directed to areas where transit will have limited and sometimes negative impacts on air quality and energy conservation; where the availability of operating funds encourages the introduction of services with low fare-box recovery capability; and, in some cases, where there is virtually no history of local financial contributions.

HIDDEN COST OF TRANSIT EXPANSION

The deterioration of transit service in older urban areas was, in my view, an appropriate matter of national concern. The revitalization of the San Francisco Muni and the impressive gains in ridership made by Golden Gate Transit indicate the merit of a social investment in the revival of an industry that has had insufficient capital investment and limited managerial competence during its last 4 decades of private ownership.

But transit revitalization has brought promises and expectations that cannot be fulfilled. Transit has been sold as a significant strategy for congestion relief, air pollution reduction, energy conservation, and the revitalization of downtown areas. Certainly the demise of transit in its natural markets would seriously compromise each of these social goals—air quality, energy conservation, and center city revival—as well as that of greater equality of mobility.

But the impact of losing heavily used services should not be confused with the effectiveness of new or extended services that will probably be chronically underused and underfinanced, never reaching the critical density of service frequency necessary to compete on favorable terms with the private automobile. In fact, some low-density services are probably emitting more pollutants and using more energy than an automobile-only alternative.

These costs may be minor compared with the hidden cost of transit revival based on exaggerated expectations and unachievable objectives. Despite state and federal operating-assistance programs, older urban areas still face a heavy burden of operating deficits.

The primary component of these operating losses is labor costs. It can be argued that the wage settlements in excess of the cost of living that are normal in the transit industry are, in part, a result of the labor-protective provisions of federal legislation. But it can also be argued that the aggressive bargaining posture of transit unions is a result of exaggerated public expectations about the social value of mass transit in reviving cities, combating congestion, and conserving energy. If transit is as important to society as its advocates maintain, then it is quite reasonable for transit workers to expect to share—through wage gains—the value added by the labor they supply. In this sense, the promotion of transit and the selling of its benefits can be seen as creating labor expectations—expectations that its work should be valued at the price commanded by an essential worker. Older urban areas have the most to lose from these rising expectations, for theirs is the greatest dependence on transit and the largest share of operating costs.

But suburban areas also have much to lose from exaggerated expectations about transit and its impacts. Suburban areas have the greatest stake in the future of the automobile and the highway program. The selling of mass transit has created exaggerated expectations about the ability of transit to capture ridership from the automobile. Transit advocates have also oversold the merits of transit as the centerpiece of a national strategy for energy conservation and air quality. This debate has confused the demonstrable energy efficiency of well-used transit operating in its natural market with the marginal energy efficiency of transit operating with low load factors in low-density, recently urbanized areas.

The exaggerated claims made for mass transit as a shaper of urban structure and conserver of energy entail

an opportunity cost that will be borne by the nation at large. Scarce resources, both intellectual and monetary, are being spent where they will probably have only marginal impact. The opportunity cost of focusing the attention of transportation planners and federal policy makers on transit, rather than the future of the automobile, is, I would submit, immense. Since 91 percent of personal trip making occurs by automobile or truck, the priority attention of transportation policy makers should be focused on automotive research and development; the economic stability of faltering automotive manufacturers; the rationalization of federal energy, safety, and air quality policy; and the managed introduction of new automobile technology. Instead, the debate over transit versus highways has preempted the attention of both Congress and recent administrations.

These are not meant as unkind words for mass transit. The revival and stabilization of public transportation in transit-dependent urban areas is a major accomplishment. But this accomplishment has occurred within the structure of fair-share politics and modal rivalry. As a consequence, the revival of transit has entailed the substantial excess cost of including suburban jurisdictions and the opportunity cost of our failure to develop a coherent national policy on the future evolution of the automobile and the highway system.

PARATRANSIT: PART OF THE PROBLEM OR PART OF THE SOLUTION?

Hardware and software fads occur in the transportation community on a regular basis. Transportation professionals have preached rail rapid transit, personal rapid transit, people movers, light-rail transit, dial-a-ride, and, most recently, transportation system management. Each has been promoted as the next generation innovation that will solve the transportation problem. Each has been able to establish a limited niche in the travel market; none has realized more than a subsidiary role in the larger urban mobility system.

Is paratransit another fad with a half-life of 2 or 3 years of professional enthusiasm? Or is it a meaningful response to the financing and budgeting problems that face conventional mass transit?

The answer, I suspect, depends on how much we expect from paratransit and how we proceed to deploy and manage it.

I think we have reason to be optimistic about paratransit if it

1. Serves to focus attention on the strategy of market segmentation as a method of service design and delivery;
2. Serves to lower the expectation of low-density areas that transit can offer a significant alternative to the automobile for most trip makers and trip purposes;
3. Offers a mobility lifeline for the elderly, handicapped, and automobileless without engendering demands from each and every political jurisdiction for a rightful share of service (i.e., if user needs, not jurisdictional shares, determine deployment);
4. Leads employers to share some of the costs they impose on the transportation system by their locational and scheduling decisions;
5. Provides a premium service whose operating costs can be recouped at a premium price;
6. Refocuses the metropolitan transportation planning process on the market potential of services rather than on the seldom-realized social benefits of services based on policy headways and level-of-service standards;
7. Provides an impetus for nonoperating agencies with fiscal powers to assess the cost-effectiveness of service provided by private vendors versus that provided by public operators;
8. Challenges the operators of conventional transit to pay more attention to market analysis, market segmentation, service differentiation, and consumer relations;
9. Engages cost-conscious private vendors and private employers in the dialog over transportation system efficiency; and
10. Provides a strategy for satisfying minimal level-of-service expectations in low-density areas while redirecting operating assistance to high-density markets where conventional transit can offer efficient services at a reasonable cost per rider.

At the same time, we should be careful that paratransit does not become part of the competition for limited resources that contributes to the rate of escalation of operating losses. This could happen if paratransit is conceived and deployed in a fashion that

1. Provides high-quality service at low prices, regardless of the ability and willingness of many users to pay a premium price for a premium service;
2. Embroils private taxi operations in the reporting, procurement, and labor-relations requirements of intergovernmental finance;
3. Eliminates the incentives for efficiency that motivate private vendors to economize;
4. Establishes the right of all jurisdictions, regardless of need, to a share of the service;
5. Establishes the right of employers to expect public assistance in getting their employees to work;
6. Fosters financially unrealistic expectations on the part of suburban and rural areas; and
7. Fails to determine which market segments will find paratransit useful for which trip purposes.

In short, paratransit can be part of the solution if its deployment is guided by rigorous assessment of market potentials and a realistic pricing policy. It can be part of the problem if the politics of rightful entitlement and jurisdictional shares prevail as they have in the deployment of conventional transit.

GETTING FROM HERE TO THERE: STRATEGIES OF COST CONTAINMENT AND SERVICE DIFFERENTIATION

In most metropolitan areas, transit authorities receive state and federal operating subsidies on the basis of formula entitlement. Formula entitlement programs were devised on the basis of legislative and congressional consensus about the fair share of expenditures owed to urban, suburban, exurban, and rural constituencies. They reflect the distribution of political power more realistically than the distribution of potential benefits from the introduction of transit service.

It would be naive to believe that the politics of formula apportionment can be suspended and each dollar allocated with attention to the marginal benefit of the incremental dollar. But there may still be room for improving cost-effectiveness within the constraints of formula apportionment. It may be possible, for example, to follow the example of Chicago and the San Francisco Bay Area in severing the direct connection between the federal treasury and the transit operator. In those regions, a planning authority, rather than an operating agency, is the designated recipient of federal operating-assistance funds and transit operators must justify cost increases and compete for operating funds—rather than receiving them as a matter of formula entitlement. In this way, transit

subsidies are allocated in a manner that bears some resemblance to competitive bidding.

If there is any canon of public administration that has withstood the test of time, it is the merit of competitive bidding as a means of service procurement. The status of most transit properties as the designated recipient of federal and state operating subsidies violates this principle of public finance and gives programming and budgeting powers to the member of the system with the least ability to work around the burdensome constraints of established work rules and the cost of full-time labor.

For many reasons, transit properties have been reluctant to subcontract peak-hour service, purchase service from taxi companies, or cope with the problems associated with negotiating contracts that permit hiring part-time personnel. Nor have they been eager to complicate maintenance management and personnel deployment by developing specialized services to accommodate localized or specialized needs.

The technology biases of transit operating agencies and their inability to circumvent the fixed costs associated with established work rules both argue for locating greater programming authority with regional planning agencies or general purpose government. Where this has been accomplished, in Chicago and San Francisco, planning has been redefined as service procurement and at least limited gains have been made in treating subsidy-allocation decisions as a competitive bidding process. Neither region has seriously solicited claims from unconventional service vendors, but an institutional apparatus that would accommodate competition between vendors is in place. The most important element of this institutional apparatus is the discretion to allocate state and federal operating-assistance funds among competing claimants. In practice, this discretion has been sharply limited by the rapid escalation of operating losses and the imperative of keeping the buses running.

As these agencies—the Chicago Regional Transportation Authority and the San Francisco Metropolitan Transportation Commission—mature, both politically and analytically, one can hope that they will be able to make de facto use of the discretion they already possess in the de jure sense. This will mean distinguishing between the imperative of keeping the buses running and the policy of moving people at a reasonable cost. If there is any hope of distinguishing between means and ends, between running buses and moving people, it lies with planning agencies and general purpose governments, not with agencies committed to a particular technology. And, I would argue, if there is any hope of restraining costs, it lies in the procedure of service procurement through competitive bidding.

None of these thoughts deals with the problem of fair-share politics and the disperson of funds in a way that encourages transit service in markets where it is unlikely to attract significant ridership. Here, too, there is at least limited promise in awarding designated recipient status to a nonoperating agency. This would permit local jurisdictions to use their fair-share entitlement to procure services designed for their specialized needs. This could well mean contracting with a transit property for service, which is an appropriate course of action if it is the result of a search among alternatives and not the only option available. In short, it is time for transit to compete. There are good reasons why transit should not be expected to compete on the terms of the marketplace. But there is no good reason why it should not be asked to compete in terms of cost and service quality with less conventional forms of public transportation.

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Costs and Productivities of Innovative Urban Transportation Services

Kiran Bhatt, Urban Institute, Washington, D.C.

The aspects of supply and demand that determine the costs and productivities of paratransit services are described, the variations in performance of the services are explained, and ways of improving them are suggested. Publicly owned dial-a-ride services are observed to be very expensive operations and, although the potential for cost reduction exists, these trip costs will probably remain high. The current practices of ubiquitous dial-a-ride services and extremely low fares are questioned. It is also suggested that increased participation in paratransit operations by the private sector—the taxi industry—promises significant improvements in the cost performance.

Productivity and costs are critical aspects of paratransit operations. They determine the financial viability and economic success of these innovative urban transportation services, and improvements in them will be important determinants of wide-scale success of these operations. This paper discusses the factors that affect these costs and productivities and suggests possible ways of improving them. Costs are affected by the ownership and organization of the providers, the level and type of service, the local regulatory environment, existing labor agreements, and vehicle characteristics. Productivities are determined by the ability of the service to attract

ridership, the nature of the market served, demand density, level of service, and fare structure. The purpose of this paper is to identify the manner in which these aspects of supply and demand affect costs and productivities, to summarize the costs and productivities of some existing operations, and to develop strategies for potential improvements.

The paper is organized in the following manner:

1. The various innovative services are defined and categorized. This classification of the services and the markets in which they operate sets the stage for the comparison of costs and productivities. It is emphasized that comparisons across different markets are not very useful in developing suggestions for improvements in costs and productivities, but that comparisons among different services within a particular market are important. It is suggested that from the standpoint of understanding costs it may be preferable to classify paratransit services from the perspective of their organizational and operating structures rather than by their usual generic distinctions.
2. The second section of the paper summarizes the costs of the common paratransit operations providing service for different travel markets. Variations among the different services and ranges within a particular service and the causes of these variations are discussed and possible ways of decreasing costs are suggested.
3. The third section discusses the productivities of different operations and probable causes of variations. Potential ways of increasing vehicle productivities and ridership are described.
4. The fourth section combines the costs and productivities given in the preceding two sections and presents derivations of the cost per trip for different operations. The interrelations among fares, demand, quality of service, and trip costs; their collective influence on net costs; and the need for financing the deficits are discussed, and the potential for decreasing the cost per trip is considered.
5. The final section summarizes the implications of costs and productivities for future policy and identifies major topics for discussion.

The data presented in this paper are of different vintages. The costs and productivities of the existing operations have been collected from secondary sources (1, 2, 3, and others) that contain information for different systems at different times. However, the numbers are generally compatible. Also, because most of the data are empirical, some existing operations might conceivably fall outside the ranges shown. Another problem arises because most of the data are for relatively new systems that are probably still in the process of learning and adjustment. Thus, to the extent possible, hypothetical numbers—which would perhaps exist after the initial shakedown period—have also been discussed.

SERVICES AND MARKETS

Family of Services

The services of interest are the paratransit operations that commonly provide greater route and schedule flexibilities when compared with conventional fixed-route bus services. Thus, they are inherently more responsive to the needs of the potential markets. These service concepts, their supply-and-demand characteristics, and their operating environments are described elsewhere (1, 2, 3).

Prearranged ride-sharing services (car and van pools and subscription buses) and hail-or-telephone services (dial-a-ride, taxi, and jitney) are the most common service innovations. They represent a diverse set of operations providing a wide range in quality of service at different locations in a variety of travel markets. They use different vehicle technologies and operate under diverse organizational and institutional arrangements. Dial-a-ride services are widespread. Typically, they are publicly organized and operated and provide door-to-door areawide service. They operate in different markets (low-density, off-peak travel, and line-haul feeder). Some provide many-to-many services, while others provide more limited services. Many of these operations are 10- to 12-passenger vans, but some use 20- to 30-passenger buses. There are also some taxi-based, shared-ride operations that provide dial-a-ride service. These are privately owned, use standard automobiles, and often operate in a less stringent institutional environment typified by a weaker regulatory framework and a more flexible labor supply situation. Ride sharing and pooled services may use standard automobiles (car pools), vans (van pools), or buses (subscription buses). In the latter two categories, the level of service often varies according to the type and size of vehicle and the route-access characteristics.

In addition to dial-a-ride, taxi, and group-riding (pooled) services, there are other concepts such as jitneys (legal and illegal) and route-deviation services. However, these are not common, and data are scarce. They will not be discussed in depth in this paper. These services are generally thought to provide some flexibility in routing and scheduling and probably fall somewhere between a conventional bus and the more common paratransit services. Although experience in the United States has been limited, many believe that jitneys could readily serve many of the markets being served by more common paratransit operations today. If the cost structures and efficiencies of the existing jitneys (such as the legal fixed-route services in San Francisco and Atlantic City, New Jersey, and the illegal operations in Pittsburgh, Chicago, and other places) could be sustained, they could provide strong competition for many of the other paratransit operations. Again, however, the data are insufficient. It is difficult to speculate on what might happen to the low costs and high efficiencies shown by jitneys over the long run if they were allowed to enter the travel market on a large scale.

Generic categorization of the common service innovations into dial-a-ride, taxi, car pool, and bus has been useful for initial identification and understanding of their operating characteristics. This classification has been inadequate, however, for defining and understanding their costs. This is because the organizational and institutional structures and management practices have greater impacts on costs than does the nature of the service. For example, from the standpoint of the service concept, a many-to-many dial-a-ride service (e.g., that in Rochester, New York) has more characteristics in common with a shared-ride taxi service (e.g., El Cajon, California) than it has with a dial-a-ride operation providing subscription feeder service to a line-haul commuter mode (e.g., Bay Ridges, Ontario). From the standpoint of costs, however, a publicly organized and operated, van- or bus-based, many-to-many, dial-a-ride service has more in common with a dial-a-ride subscription feeder service than it has with a privately owned and operated shared-taxi service.

The organizational distinctions between dial-a-ride and taxi operations will be emphasized here in an attempt to classify them. Thus, in this paper, dial-a-ride refers principally to van- or bus-based services that are publicly organized, use union drivers, and operate in a heavily regulated environment. Taxi services, on the

other hand, refer to privately owned and operated services that typically use low-wage drivers and standard automobiles and operate in a relatively less stringent regulatory environment. Thus, taxi operations include group, shared-ride, and taxi-based dial-a-ride services (e.g., El Cajon; Levittown, New York; Davenport, Iowa; and St. Bernard Parish, Louisiana). Taxis can and do provide the same range of services as publicly operated dial-a-ride systems.

Different Markets

It is useful to distinguish the different markets in which the various innovative services currently operate or could be potentially provided. The trip and cost characteristics of a service across markets may be very different. Thus, cost and productivity comparisons make sense largely in a particular market. For the purpose of this discussion, three markets have been identified in which the service innovations are concentrated: (a) the low-density market that has a diverse set of origins and destinations, (b) the line-haul feeder market, and (c) the home-to-work commuter market. Each has distinct travel requirements. The low-density market that has diverse trip patterns can be served by dial-a-ride (as in Rochester and Ann Arbor, Michigan), taxi (as in Davenport and El Cajon), and conventional bus operations. This market consists of late evening, weekend, midday, and other low- or medium-density travel demands—particularly those having diverse sets of origins and destinations. A market consisting of the elderly, the handicapped, and others not able to use automobiles also belongs to this category. Dial-a-ride (Ann Arbor and Bay Ridges), taxi (St. Bernard and Peterborough, Ontario), and conventional bus operations also serve the line-haul feeder market. The home-to-work commuter market is typified by regularly scheduled trips with a long line-haul portion. Neither dial-a-ride nor taxi operations are particularly suited to serving this type of trip. Car pools, van pools, and subscription buses (e.g., Reston, Virginia; Specialty Transit in St. Louis, and Golden Gate in California) are appropriate for this travel.

This classification of markets enables us to identify the ranges of costs and productivities for particular generic modes. The cost and productivity variations among services across different markets are probably due mostly to their different sets of operating parameters (e.g., average speeds and route deviations).

COSTS OF DIFFERENT SERVICES

Costs of providing service by different paratransit operations common in the particular travel markets are summarized in Table 1. Conventional bus is included for two of the markets because, traditionally, it has provided service in these markets, and thus it serves as a benchmark. The costs per vehicle hour are empirically-based numbers. The potential for decreasing the costs of dial-a-ride exists, because in principle, these costs can be as low as the lower costs of taxi operations. The costs of public systems shown exclude vehicle purchase costs, while those of privately run systems include them. The costs per seat hour are derived numbers that account for the effect of the size of vehicle. Costs per seat-travel distance can also be derived if seat-travel distances per vehicle hour are known or can be estimated. There are significant variations in costs per vehicle hour (even within a particular travel market), but the variations in costs per seat hour and costs per seat-travel distance are smaller. In general, larger vehicles have larger costs per vehicle hour, but smaller costs per seat hour.

Table 1. Costs of different paratransit operations in various urban travel markets.

Travel Market	Type of Paratransit Operation	Cost ($)	
		Per Vehicle Hour[a]	Per Seat Hour[b]
Commuter (few-to-one)[c]	Car pool	3.00 to 6.50	0.75 to 1.60
	Van pool	7.00 to 11.00	0.60 to 0.90
	Subscription bus	10.00 to 60.00	0.20 to 1.20
Low density (many-to-many)	Conventional bus	12.00 to 30.00	0.25 to 0.60
	Dial-a-ride	10.00 to 25.00	0.80 to 1.65
	Taxi	5.00 to 10.00	1.25 to 2.50
Feeder (many-to-one)	Conventional bus	12.00 to 25.00	0.25 to 0.50
	Dial-a-ride	10.00 to 25.00	0.80 to 1.65
	Taxi	5.00 to 10.00	1.25 to 2.50

[a] Observed (1, 2, 3).
[b] Derived by using estimates of seats per vehicle.
[c] Ranges are due to differences in trip length and (for subscription bus) organizational diversity.

Within each of the travel markets, the costs per hour of each type of service show a wide range. There are several reasons for this. The variations for car and van pools in the commuter market are simply due to the different trip distances assumed (e.g., the range of $3.00 to $6.50 for car pools). Costs of these operations are primarily vehicle-travel-distance related if no hourly paid operator is used. Thus, the costs per hour of longer trips that allow faster speeds are higher. The variations in subscription bus operations are due partly to variations in trip distances and partly to the different organizational and ownership arrangements. The lower value ($10.00) is for short trip distances and services such as that exemplified by Specialty Transit that is operated much like a car pool—with the members sharing the driving burden and vehicles being owned and maintained privately—resulting in very low costs. The higher value ($60.00) at the other extreme is for long trips and services such as the Reston Express where the vehicles are leased from the local transit agency whose lease rates include the heavy burden of highly paid union drivers and the pro rata burdens of high administrative and overhead costs typical of many large transit companies.

In other travel markets, the variations for a particular type of operation within a market are primarily attributable to differences in local wage rates, labor rules, and dispatching policies. These factors account for the variations in dial-a-ride service costs of $10 to $25/vehicle·h. For example, the dial-a-ride operation in Santa Clara County, California, costs $20/vehicle·h with a driver wage rate of $6.85/h while the Benton Harbor operation with a driver wage rate of only $3.40/h costs $13/vehicle·h. Operations that use midibuses instead of vans are more expensive, partly due to high maintenance costs. The range of $5 to $10/vehicle·h for taxi-based operations also reflects different wage rates and labor practices.

Costs of privately owned, taxi-based operations (e.g., El Cajon and Levittown) are significantly lower than those of publicly operated, van-based dial-a-ride operations (e.g., Ann Arbor and Santa Clara County). Typically, the maintenance, labor, administrative and overhead, and dispatching costs are lower for experienced, privately owned and operated taxi firms than for recently established, publicly owned dial-a-ride operations. A synthesis of the costs given above shows that four critical factors determine the cost per vehicle-hour or per seat-hour of a particular service. These are summarized in the following discussion.

Labor Use

This is probably the single most critical determinant of costs because labor typically accounts for almost 80 per-

cent of transit costs—driver's wages and benefits represent approximately 50 percent and other workers' wages and benefits represent approximately 30 percent of the costs of transit services. The low-cost operations described above, in most cases, have relatively low operator costs. Some have been able to hire operators at low wages (through employment of nonunion drivers or those belonging to unions with weak negotiating positions), some use part-time drivers (students and housewives), some use drivers with flexible split-shift rules, and some use idle drivers in off-peak hours. Low operator costs may be possible through direct labor agreements or through innovative organization of the service where vehicles and operators are leased from other firms that are able and willing to arrange for leases at incremental costs. Charter bus and transit companies, commuter van-pool operators or organizers, and taxi and limousine companies are possible sources of such arrangements so long as the innovative service being considered operates during the off-peak period for the leasing firm. For example, innovative commuter services could lease vehicles or operators at low cost from charter companies that generally operate outside commuter hours. Similarly, owl and weekend services and off-peak, many-to-many services in low-density areas might lease low-cost vehicles and drivers from limousine, transit, or taxi companies.

Ownership and Organization

The way in which vehicles and operators are acquired can be critical for costs of innovative services. Most existing services operate their own vehicles and employ their own drivers. The above discussion suggests, however, that leasing of vehicles might be cost-effective if the lease is feasible at incremental, rather than average, costs or if the lessor can provide drivers with lower wage scales. The evidence also suggests that the costs of publicly organized and operated dial-a-ride services have been significantly higher than those of privately owned, highly competitive, profit-motivated services (e.g., taxi and shared-taxi operations). This is most likely because the successful owners and operators of the latter have usually evolved many cost-saving techniques and procedures and make lower profits. The efficient faction of the taxicab industry has long experience with such services and managerial skills for efficiently dealing with dispatching, employee utilization, and vehicle maintenance. Their overheads have been brought down over the years. Their operating costs are low because of skillful management of maintenance, lower driver wages (taxicab owners have usually been able to attract nonunion drivers or those belonging to relatively weak unions, and the competitive labor market structure has minimized labor wage spirals), flexible work rules, and use of part-time workers.

Publicly operated, van- or bus-based dial-a-ride services have had high costs per vehicle hour. Lack of experience has resulted in high overheads, high maintenance, and high dispatching costs. Reliance on transit union operators (in most cases required by the institutional organization) has meant heavy labor costs. Unfortunately, even the vehicle itself has often proved costly to own and maintain.

Labor pressures have traditionally been less severe in the taxi industry. Although they may increase in the future, particularly if the industry enters the markets of concern on a large scale, the pressures will probably be lower due to the open-market labor situation and fewer regulatory constraints. On the other hand, labor pressures in public systems will increase—particularly in the current and foreseeable environment of assistance, subsidies, and budgets. With large fixed budgets and formula-based allocation of outside subsidies, there appears to be little opportunity or incentive for management to bargain hard at negotiating time. However, some agencies have been able to do this—either by dissuading drivers from unionizing or by keeping the wage spiral at a low level. This has been achieved with an argument stressing mutual benefits to both parties. Transit unions appear to be tending toward greater flexibility. For example, there may be an agreement to accept significantly lower salaries for paratransit operations in Cleveland, and a similar agreement is evolving in Rochester.

Public operations can learn a great deal from the more able segments of the taxi industry regarding efficiency in maintenance, dispatching, administration, vehicle purchase, labor utilization, labor negotiations, and incentive structures. At the very least, the publicly operated services can probably learn about dispatching and overall management.

However, although efficient segments of the taxi industry might provide lessons to publicly owned systems, some caution is necessary. Not all taxi operators are efficient. Many are on the edge of bankruptcy. Labor exploitation and hard working conditions are said to exist. The potential for efficiency might be greater, however, with a competitive environment and a profit motivation.

Regulatory Environment

The relatively favorable cost structure enjoyed by the taxi industry is due partly to astute management and partly to the institutional environment. Although the taxi industry operates under regulatory restrictions on entry, exit, service changes, and competitive activities, these restrictions are much less severe than the institutional environment of the transit industry. The transit industry has not been able to respond to changing markets and labor situations as quickly as the taxi industry. Less regulation is reflected in lower costs for taxi service in areas such as Washington, D.C. For example, taxis can reduce or increase services (within limits)—areas of coverage, times of operation, and routes can be adjusted. This flexibility allows better labor utilization and increases output (seat travel per vehicle-hour). To some extent, low taxi costs reflect practices that might be illegal or semilegal (e.g., low insurance coverage and service refusal). However, flexibility in tailoring service coverage, duration, and routing can help lower costs of all operations. A successful campaign for less regulation can improve the cost picture for both private and public services by encouraging more competition and allowing greater operating flexibility.

Vehicle Characteristics

Size and type of vehicle have a direct impact on costs. Larger vehicles (with more seats) generally have lower costs per seat-hour. However, automobiles, small vans, and large conventional buses are likely to be more cost-effective than midisized buses. Midibuses have been observed to have greater maintenance costs per seat when compared with large buses or vans and cars, probably because there is little experience in maintaining them. Acquisition costs per seat for these vehicles have also been relatively high, probably because very few vehicles of this type are being manufactured. In spite of their cost advantage per seat-hour, large vehicles make sense only in situations where high vehicle use or productivity can be achieved. In most markets (except the peak-period commuter travel market), the productivities achieved are likely to be so low that vehicles larger than

vans are seldom appropriate. Even for the commuter market, only very long trips and high patronage justify large vehicles.

The comfort and convenience features of a vehicle (e.g., air conditioning, lifts for the parambulatory, seat cushions, and communication systems) also affect the cost. On the other hand, these features increase the quality of service. Thus, a potential reduction in cost per vehicle-hour must be judged in the light of possible decrease in patronage and hence a possible increase in cost per trip. (A similar situation is encountered in considering reducing dispatching costs by eliminating the callback to the prospective user about the pickup time and possible variance.)

The above discussion suggests several strategies for reducing the costs of the different service innovations. The common elements are (a) reducing labor costs by using part-time or low-wage operators or operators who are being paid for the time but are temporarily idle; (b) introducing taxi-industry management know-how to publicly operated, transit-based service; and (c) using the taxi industry as providers of service. However, these are not easy tasks. Special incentives will be needed to entice taxi operators into becoming providers of paratransit operations. Moreover, one might want to guard against the possibility of provider side contracts that reduce competition and efficiency. Cartel developments (e.g., Orange County, California) are also not desirable. The userside-subsidy concept might be one efficient way of providing the required incentive to taxi operators without sacrificing efficiency and competition.

VEHICLE PRODUCTIVITY AND PATRONAGE

Vehicle productivity is crucial in determining the viability and efficiency of the service. Productivity provides a proxy measure of vehicle occupancy for calculating the success measure (cost per trip). There are several alternative measures that can be used (e.g., passenger trips per vehicle-hour or seat-hour, passenger trip distances per vehicle-hour or seat-hour, or passenger trip distances per vehicle unit distance). Each measure defines the level of success in attracting patronage. The first measure is most commonly used for the innovative services since the costs of other services have traditionally been defined in this way. However, the measure of trips per seat-hour might be more appropriate because it accounts for vehicle size. And the use of passenger trip length might be even more appropriate because this is a much better indicator of user benefits than is number of trips per se. This measure has not been commonly used because the measurement of passenger trip length per passenger has been difficult and because fares are usually determined on a trip basis rather than on a trip-length basis (which would more closely reflect costs). The last measure, which defines productivity on a vehicle or seat distance basis, probably provides a much better perspective on the actual operating load factors and hence is potentially more useful in making decisions about vehicle size.

Table 2. Vehicle productivities of different paratransit operations in various urban travel markets.

Travel Market	Type of Paratransit Operation	Productivity: Passengers per Vehicle Hour[a]	Productivity: Passenger Trip Distances per Vehicle Hour[b] (km)
Commuter	Car pool	–	48.0 to 240.0
	Van pool	–	144.0 to 576.0
	Subscription bus	–	560.0 to 1680.0
Low density	Conventional bus	2.0 to 20.0	6.4 to 64.0
	Dial-a-ride	3.0 to 10.0	9.6 to 32.0
	Taxi		
	Regular	2.0 to 3.0	6.4 to 9.6
	Shared	2.5 to 6.0[c]	8.0 to 12.8
Feeder	Conventional bus	20.0 to 30.0	48.0 to 72.0
	Dial-a-ride	8.0 to 20.0	19.2 to 48.0
	Taxi		
	Regular	2.0 to 3.0	4.8 to 7.2
	Shared	2.5 to 8.0[c]	5.6 to 12.0

Note: 1 km = 0.6 mile.
[a] Observed (1, 2, 4).
[b] Derived using hypothetical (but plausible) estimates of passenger trip distance per passenger.
[c] Observed values fall between these hypothetical (but plausible) extremes.

The productivities of existing operations are summarized in Table 2. The values given for dial-a-ride, conventional bus, and single-ride-taxi (regular) operations are typical numbers observed. The shared-taxi productivities are estimates since little empirical evidence exists. Variations across different travel markets are significantly greater than are variations among services within a particular market. Typically, the productivities of commuter-pool services are the highest. These modes are characterized by high overall speeds due to small route deviations and dwell periods and the highly predictable nature of demand with fixed origins and destinations. On the other hand, the productivities of operations within the low-density market are very low. This is principally due to their low demand density, relatively large route deviations, low effective speeds, and diversity of origins and destinations. The lowest values for each operation in this market are for late night and weekend services, but productivity of conventional buses in this market could possibly be even lower than that of dial-a-ride services. Variations across operations within a particular market represent a wide range in quality of service (access characteristics, waiting times, and travel times). For example, the shared-taxi productivities are 50 to 100 percent greater than the regular taxi productivities. However, the level of service provided by the former is lower. The variations also represent operations in different locations.

The productivity of a particular operation is influenced by various factors: (a) type and quality of service, (b) level of vehicle utilization, and (c) level of patronage.

Productivities can be improved by increasing the overall vehicle travel distance per vehicle-hour. However, a particular operation is exemplified by the type and level of service it provides. Thus, although increased overall speeds and productivities can best be achieved through curtailment of service, this causes the quality of service to deteriorate. For instance, dwell time can often be a significant proportion of total time; several dial-a-ride operations have reported dwell times of 2 min/pickup. For an operation with an average productivity of 6.0 passengers/h, about 10 min/h of operation might be saved if dwell time were eliminated. The speeds and productivities can be increased greatly by reducing the dwell time. However, such reductions result in lower service levels. For example, dwell time can be reduced by eliminating the doorstep escort service provided by many dial-a-ride operations, but use by the elderly and handicapped will then decrease. Similarly, a changeover from door-to-door to block-to-block service reduces route deviation significantly and increases productivity (as exemplified by operations in Ann Arbor and Merced, California). But, the service level will decline. Many dial-a-ride operations have reported that long times are required to find addresses after the request for service is received. This time can be shortened if the level of demand responsiveness can be sacrificed. Requiring requests well in advance (1 or 2 h or even 1 d in advance) would enable prior search and reduce pickup time. In

summary, reductions in dwell time and deviation, although very effective in increasing productivity, essentially change the level of service. However, many dial-a-ride operations have productivities so low that they might have no choice but to reduce service levels if there is a desire to raise the productivities.

Level of vehicle utilization (vehicle travel distance per hour) is another factor affecting output. Thus, productivity can be increased through improvements in effective speed. Two possible methods for this are to provide priority treatment for the vehicles in traffic and at intersections and to improve vehicle performance. Although, for most operations, the potential improvements do not appear very significant, vehicle-performance improvements can lead to higher overall speeds in cases where large vehicles are being used. Small vehicles—particularly standard automobiles—show much better acceleration, deceleration, and braking characteristics than do large vehicles—particularly minibuses. In services that require frequent stops for pickups or due to traffic conditions, small vehicles can achieve significantly higher average speeds. This has been observed in Orange County. The other method for achieving better overall utilization of the fleet is through improved control strategies—dispatching procedures, deadhead policies, and strategic prepositioning of empty vehicles. For large systems, computerization may help evolve efficient operating policies. These actions might offer some potential for improved productivities without significantly affecting the quality of service.

The third important factor is the patronage the service is able to attract, since significant economies of scale exist in these operations. In general, productivities increase with demand density. There are limits to the extent to which this can be done, beyond which the productivity cannot be increased without a significant decrease in service, but it is believed that none of the operations has reached these limits. Thus, higher demands will bring increased productivities in most of the service innovations. Higher patronage would require effective and aggressive marketing. More information is needed about the aspects of service valued most by the various types of potential travelers. This would help in efforts to tailor the services accordingly and devise effective campaigns to attract riders. Much more information about the elasticities of the various markets with respect to different aspects of service should be developed and analyzed.

In summary, then, adjusting the service level downward provides the greatest opportunity for improvement in productivity. This, however, requires the careful tailoring of services and reevaluation of the market to be served and the level of service to be provided. To an extent, some privately operated taxi operations (e.g., Davenport; Hicksville, Long Island; and Levittown) have been able to do this. Perhaps their instinct to survive in a competitive market and make profits has led them to implement many of the improvement measures described above. But again these appear to be exceptional cases. Many other taxi operators are struggling to stay in business and could themselves benefit from more efficient dispatching and control strategies.

COSTS PER PASSENGER TRIP

In the preceding sections, total costs of providing service (dollars per vehicle-hour) and productivities (passenger trips per vehicle-hour) have been discussed. Total costs represent the value of resources consumed in providing a particular operation. Total costs and productivities together determine costs per passenger trip. Thus, costs per trip can be decreased either by decreasing total costs or by increasing productivities. The prices that the users face—fares—have had little relation to the cost of providing their trips, except in privately run systems operating for profit. In publicly operated systems, typically, the user costs or fares charged to ride the system have been only small fractions of the costs of providing the trips. Thus, these systems have required heavy subsidies.

Table 3 summarizes the existing evidence on costs per passenger trip and per passenger trip length for the various types of operations. Low-cost operations signify relatively more attractive cost performances and productivities. Again, comparisons across travel markets have significance only for illustrative purposes. These represent significantly different trip characteristics. The commuter-pool trip costs are lower because of low total costs and high productivities. Within other markets, the dial-a-ride operations have costs per trip that are somewhat higher than private taxi-based operations, reflecting, principally, the better cost performance of the latter. In spite of lower productivities, taxi trip costs are low. The differences among services within a particular market are due to various causes, such as different service levels, total cost performances, and productivity achievements. The upper range of trip costs for public operations serving the low-density market are particularly revealing. These extreme values represent weekend or late night services for which drivers are paid high overtime wages and the patronage and productivities are extremely low. The large values shown at the high end for taxi operations are hypothetical. The taxi industry, which is basically unsubsidized, generally chooses to not serve these market conditions. More important are the low values. These low costs are probably achievable.

It is important to remember that the ranges shown within a particular market represent the wide range in quality of service provided by existing operations in a diverse set of locations. Thus, a comparison of the lowest values does not necessarily suggest the cheapest operation. For example, the $0.60 cost for conventional bus is for service in a medium or higher density area, while the $0.80 cost for dial-a-ride is probably from a low-density area. In aggregate, it appears that in the low-density markets where existing dial-a-ride operations are concentrated, the operating environment is such that the costs per trip of public dial-a-ride operations providing a particular level of service are likely to be lower than those of a conventional bus service providing the same level of service. In this environment, a privately operated shared-ride taxi will possibly be even less expensive than the publicly operated dial-a-ride service.

Fares (User Costs) and Subsidies

The economic and financial stability of paratransit operations depends on both the costs per trip of providing the service and the fares that are charged. If the fares are lower than the costs (as with most dial-a-ride and conventional bus operations), public subsidies become necessary. Table 4 presents the costs incurred in providing the various services, the fares actually charged (paid by the users), and the differences (which amount to the net subsidy per passenger). Car pools, van pools, and subscription bus operations generally raise sufficient revenue from users to pay their costs. There are examples, however, of indirect subsidies: Some subscription bus operations receive small subsidies (e.g., Golden Gate) and some of the costs of organizing company van pools are absorbed by employers and not reflected in the costs considered in Table 1. On the whole, however, where

such subsidies exist, they are very small. Moreover, the market is probably such that even if these extra costs were passed on to the users in terms of small increases in fares (subscription rates), the operations would remain quite healthy.

Privately operated taxi services apparently receive no direct subsidies. The fares pay the costs of providing the service. That these services charge relatively high fares and still continue to operate suggests that their level of service is highly valued by the market in which they operate. This may actually suggest that the current fares on dial-a-ride and bus systems are too low. Of course, the taxi industry is not healthy across the board; many operators are in precarious financial situations. Thus, over the long run, public subsidies might be required to entice them into other markets on a large scale.

The financial conditions of dial-a-ride and transit operations are not very attractive. They have required significant levels of public subsidies. Although the values in Table 4 suggest this, the actual conditions are probably even worse. For example, Ewing and Wilson (3) indicate that dial-a-ride operations are able to raise only 10 to 40 percent of their costs from the fare-box. This has created tremendous pressures on local budgets. At present fare levels, these operations may not be able to survive for long unless there are significant cost reductions.

Table 3. Costs per passenger trip.

Travel Market	Type of Paratransit Operation	Cost ($) Per Passenger Trip[a]	Cost ($) Per Passenger Trip Kilometer[a]
Commuter[b]	Car pool	—	0.06 to 0.03
	Van pool	—	0.05 to 0.02
	Subscription bus	—	0.02 to 0.04
Low density[c]	Conventional bus	0.60 to 15.00	0.20 to 4.70
	Dial-a-ride	1.00 to 8.00	0.30 to 2.50
	Taxi		
	Regular	1.70 to 5.00	0.55 to 1.50
	Shared	0.80 to 4.00	0.35 to 1.25
Feeder	Conventional bus	0.40 to 1.25	0.20 to 0.50
	Dial-a-ride	0.50 to 3.00	0.20 to 1.25
	Taxi		
	Regular	1.70 to 5.00	0.65 to 1.95
	Shared	0.60 to 4.00	0.40 to 1.70

Note: 1 km = 0.6 mile.

[a] Derived from Tables 1 and 2.
[b] Variations within each type of operation reflect different trip lengths (differences in average speeds) for the three services. Organizational structure also contributes to the variations shown in costs of subscription bus operation.
[c] Within a type of operation, the high costs are for systems with expensive total costs providing owl and weekend service with very low productivities. The low costs are for relatively inexpensive operations providing service with higher productivities.

Table 4. Trip costs and fares.

Travel Market	Type of Paratransit Operation	Cost per Passenger[a] ($)	Fare per Passenger[b] ($)	Subsidy per Passenger[b] (net public cost) ($)
Commuter	Car pool	—	—	0
	Van pool	—	—	0
	Subscription bus	—	—	0
Low density	Conventional bus	0.60 to 15.00	0.25 to 0.50	0.50 to 14.00
	Dial-a-ride[c]	1.00 to 8.00	0.25 to 0.60	0.50 to 7.00
	Taxi[b]			
	Regular	1.00 to 2.00	1.00 to 2.00	0
	Shared	0.80 to 2.00	0.80 to 2.00	0
Feeder	Conventional bus	0.40 to 1.25	—	—
	Dial-a-ride	0.50 to 3.00	—	—
	Taxi[b]			
	Regular	1.00 to 2.00	1.00 to 2.00	0
	Shared	0.60 to 1.50	0.60 to 1.50	0

[a] Derived.
[b] Observed.
[c] Typically, dial-a-ride trip costs in this market are $1.25 to $2.00 while fares are between $0.25 and $0.50. Thus, subsidy per passenger has been more than $1.00.

Fares, Demand, Quality of Service, and Trip Costs

Before concluding the discussion of trip costs, it might be useful to explore the trade-off among fares, demand, quality of service, and trip costs. Unfortunately, little hard evidence exists that would provide definitive guidance regarding these factors and the interactions among them. However, some tentative observations can be made. The preceding discussion has suggested that productivities and costs per trip can be improved significantly if sacrifices in quality of service are acceptable. This observation needs to be qualified. There is a two-way relation between productivity and quality of service. Cutting back some aspects of service (e.g., escort service or door-to-door operations) could bring about a proportionately greater reduction in patronage and thus increase trip costs. This can happen in a service catering to the elderly and handicapped, for example. The critical point here is the value that potential travelers put on the aspect of service involved. If the demand is very inelastic with respect to the aspect of service, cutbacks will not decrease patronage greatly. Unfortunately, we know little about such measures of elasticity or where they might become critical. It is believed, however, that most services are operating under conditions where some cutbacks would be cost-effective.

Fare charged has much the same implications. Currently, the demand served by these operations appears to be fare inelastic, except perhaps for certain special groups such as the elderly. This observation is reinforced by the success of taxi operations in attracting significant ridership at much higher fares. If this is indeed true, then some increase in fares would not reduce patronage greatly. Thus, the decline in productivity and the resulting increase in costs per trip would be minor. But in most cases, the economic situation would improve because the additional fare would bring in greater net revenues, which would decrease the net public costs (subsidies). This scenario must remain tentative until greater evidence about fare elasticities is available. If the fare elasticity for a particular service is high, a fare increase would bring about a significant decrease in productivity, which would result in a large increase in costs per trip—possibly more than the increased revenues, thus increasing the requirements for public subsidy.

Potential for Decreasing Costs per Trip

This paper has emphasized two approaches to lowering the costs per trip of innovative services: (a) increase productivity and (b) decrease costs. Over the long run, the reduction of total costs probably holds greater promise for improvements in costs per trip.

Commuter pool services have little opportunity to increase productivities, which are already high. Poolers already enjoy special privileges, such as close-in parking. The occupancies and productivities might be improved somewhat if measures were adopted that produced a wider difference in the prices faced by pool members and those faced by single-occupant automobile drivers. One possible, but politically difficult, proposal is to require automobile drivers to pay large additional fees for parking. So far as costs are concerned, little opportunity exists except for making incentives, such as excise-free fuels or tax breaks, available to poolers. Subscription bus operations could reduce costs, in some cases, by changing leasing practices and by using members as drivers.

The potential for reductions in costs per trip is probably greater in markets other than the commuter market. Strategies for productivity increases have been discussed above. The potential is, however, very limited if adjustments in service are prohibited by the local regulatory environment or other factors. Even if service curtailments are feasible, only a limited number of actions can be taken. Ubiquitous dial-a-ride services are probably undesirable. Dwell-time reduction and overall speed increases are somewhat promising, but beyond these, large cutbacks in dial-a-ride services might produce significant decreases in patronage and so lose the productivity gains. Dial-a-ride has greater potential for such improvements than do private taxi operations. Aside from service cutbacks, the streamlining of control strategies is perhaps the only means for productivity increases. In large operations, computerized routing, scheduling, locating empty vehicles, and deadheading strategies can bring about some productivity improvements.

The opportunity for reduction in total costs appears to be much greater for nonpool services. This potential is, however, heavily constrained by existing regulatory and labor arrangements. At least over the short run, there are good opportunities for reductions in labor costs (which account for a large portion of the total costs), as exemplified by taxi operations, provided that agreements with local labor unions can be reached. Arguments about mutual benefits might succeed, and negotiations might lead to compromises. For example, in return for additional employment, organized labor might agree to allow some participation by part-time or nonunion drivers or even be willing to renegotiate items such as split-shift penalty clauses. These actions are feasible, but would require education and hard bargaining over a period of time. A more immediate possibility is to organize multiple services, where possible, so that drivers and rolling stock are used more effectively. Diversification rather than dedication to a single service should be the aim of the operators. In fact, this is where some taxi operators have been able to do well. The competitive environment and necessity for profits have forced them to evolve multifaceted services. This possibility of providing additional service at a low incremental cost (primarily because drivers and vehicles are often idle) has attracted them to providing feeder and other innovative services.

Overhead and administrative practices are other areas where cost-reduction potential exists—particularly for dial-a-ride services. Typically, publicly owned, transit-based dial-a-ride operations have heavy administrative and overhead costs. Taxi management experience probably can provide useful lessons here. Dispatching, maintenance, labor utilization, and other practices used by efficient taxi operations could produce significant cost reductions in dial-a-ride operations. Again, the key to achieving efficiency is competition. Thus, formation of exclusive franchises should probably be discouraged.

POLICY IMPLICATIONS AND ISSUES FOR DISCUSSION

The discussion above reveals several issues of policy relevance. There are implications for the directions in which research and development of innovative services might evolve. There are lessons for areas considering such services. In low-density areas with diverse travel desires, the costs of providing service are high. Moreover, the available evidence, although not definitive, suggests that less formally organized, privately owned, competitive and profit-motivated, weakly regulated services have lower costs per trip and are less expensive on a net revenue basis. Although there is probably some potential for cost reductions, particularly in publicly owned, dial-a-ride operations, trip costs are likely to remain high. For these markets, the question of the worth of service arises. Dial-a-ride operations are certainly less expensive than fixed-route buses, but do they provide benefits worth their costs? Could some markets be best left to be served by taxi operations with special direct provisions for the needy through userside subsidies? If there are no significant cost reductions and productivity increases in dial-a-ride services as currently operated, then their future growth will be slow.

The currently available cost and productivity information is not sufficient for the development of definitive guidelines for these operations because the evidence about the trade-offs among quality of service, cost per trip, fare levels, and patronage is limited. It has been difficult to assess the level of improvements in costs, productivities, patronage, and revenue associated with these services and to rationally tailor a service to the needs of a particular market.

Some possible items for consideration are summarized below.

1. What are the trade-offs among cost per trip, patronage, quality of service, and fare levels? What is the current experience? Are service cutbacks an effective means of increasing productivity? Are most publicly operated services underpriced?
2. What is the potential for reducing control and dispatching costs and what would be the impact on quality of service? Are significant improvements forthcoming?
3. What is the potential for cost reductions through significant changes in the organizational structure of these services? Is it feasible to bring taxi management experience into dial-a-ride operations? What is the potential value? What potential conflicts might arise? Would public interest be sacrificed?
4. Can the taxi industry be induced to participate in dial-a-ride operations on a large scale under the existing regulatory guidelines? The taxi industry is believed to be in marginal financial condition and might need some incentives to enter the new markets. Are such incentives feasible and economical? Can labor costs be kept down if the taxi industry enters these markets on a large scale? Can they sustain low overhead and dispatching costs? Will the public interest be in jeopardy? Will service refusal be a problem?
5. What priority treatment techniques might help increase productivity? By how much?
6. How can labor costs be reduced under the existing arrangements? For new services, would labor unions be willing to share the available work? Would they agree to some nonunion participation if a certain amount of new employment is guaranteed for them?
7. What are the sources for leasing vehicles at low incremental costs? Can commuter van-pool vehicles be used in off-peak dial-a-ride service? Are there other possibilities?
8. Should van-based dial-a-ride operations shift to automobile-based services? If their productivities cannot be increased, this may be more cost-effective.

ACKNOWLEDGMENTS

The research leading to this paper was supported by the Urban Mass Transportation Administration, U.S. Department of Transportation. Thanks are due to Ronald Kirby, Gerald Miller, and Nigel Wilson for advice and review. The contents of this paper reflect my views; I am responsible for the accuracy of the data. The opinions expressed here do not necessarily reflect the views

of the Urban Institute or the policy of the U.S. Department of Transportation.

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Legal and Institutional Considerations in Paratransit Innovations

Frank W. Davis, Jr., Department of Marketing and Transportation, University of Tennessee
David A. Burkhalter II, Transportation Center, University of Tennessee

Transportation has a rigid background of laws, regulations, and business practices developed during the late 1800s that strongly influences the transportation options available today. This paper examines some of the assumptions on which these policies and practices are based. Several alternative approaches and ways in which they could be implemented are suggested. In addition, specific laws and practices that may need to be reevaluated are identified.

To understand the current institutional issues facing paratransit, it is first necessary to develop an overall understanding of paratransit trends. Paratransit is by no means a novel concept in the present regulatory structure in the United States. The concept has developed over a period of at least 200 years. In the early 1800s, anyone with a horse and wagon or buggy could haul people for hire, and entry into the paratransit business was easy. There were no restrictions, and there were very few, if any, regulations. The investment required was minimum, and the transportation business itself was highly competitive. For example, the New York horsecar operation was characterized by many individual owner operators who were local people and knew their passengers' special needs. Without regulation, the only protection for the passengers was that imposed by the judiciary; i.e., common carriers were required by the courts (as they are now) to exercise the highest degree of care for the safety of their passengers and their passengers' property.

During the last half (and especially the last quarter) of the nineteenth century, there was a significant change in the nature of the public transportation business. The highly capitalized railroads represented a massive leap in technology over leg power, water power (canals), and horse or ox power. On the municipal level, the horsecar lines were replaced by cable traction in the 1870s and electric streetcars in the 1880s.

The development of the electric streetcar resulted in a significant change in the method of providing public transportation because of the significant economies of scale associated with their operation. They were frequently owned by the municipal power company. A city would grant the power company an exclusive franchise to operate streetcars to the exclusion of other streetcar lines and, in return, impose certain burdens, such as obligations for street paving, maintenance, and lighting. In addition, certain taxes would be imposed. The service provided by the street railway companies was also regulated in terms of setting uniform rates for fares, establishing routes to be traveled, and prohibiting the discontinuation of routes without the express permission of the city. As creations of the states, the cities had the power to exclude competition by withholding of franchises and imposing certain reasonable regulations on operations.

The courts did impose some limits on the ability of a municipality to set rates. One such limit was that due process of law required that the rates prescribed must ensure the company a fair return on the value it employs for the convenience of the public. In understanding present policy, this limitation is important because it serves as a limitation on the federal, state, and municipal power to set rates. Also, it imposes an affirmative obligation on the part of the governmental body to do all in its power to ensure a fair return on investment. On the other hand, because the amount of return is based on the capital used, the emphasis is on high capital investment and there is little incentive for the companies to reduce the amount of capital invested.

RAILROAD-TROLLEY REGULATORY MODEL

As a result of the technological superiority of the railroads and trolley lines in the late 1800s and early 1900s, a public utility model was developed based on the following assumptions:

1. Transportation is a major component of people's lives, and the ability to control transportation availability and pricing is the power to determine which individuals, geographic areas, and businesses will prosper.
2. Government must regulate transportation to ensure that no individual, business, or region is unjustifiably discriminated against; fares are regulated to provide a reasonable and constitutionally permissive rate of return adequate for the continuation of the service, but low enough to prohibit monopolistic exploitation; schedules and service areas are such that all persons and businesses have access to an adequate level of transportation; and service in the unprofitable portions of the community is cross-subsidized through profits obtained from the exclusive franchise in profitable areas.
3. Because all costs will be essentially the same for any firm providing the required service and fares are regulated to prohibit excessive profit, any competition

that offers a lower cost alternative can do so only by providing an inferior level of service, skimming the cream by serving only the profitable areas and not the unprofitable ones, not calculating the true cost of providing service, or some combination of these factors.

The conclusions reached under the railroad-trolley regulatory model were that only one franchise should be given to the natural monopoly transportation company and that this should be carefully regulated to ensure that all areas, persons, and businesses are adequately served at reasonable prices.

REEVALUATION OF THE RAILROAD-TROLLEY REGULATORY MODEL

The twentieth century has seen the collapse of the railroad-trolley regulatory model that developed during the streetcar era. The carriers that operated under this model—rail passenger services, intercity bus services, streetcar services, interurban rail services, and city transit companies—have all declined precipitously. Virtually all carriers operating under the railroad-trolley regulatory model are now either defunct, carry only a fraction of the ridership they originally did, or are totally dependent on rapidly increasing subsidies to maintain a given level of service. The railroad-trolley regulatory model can be understood best by the limitations that the railroad tracks imposed on these modes. The service was required to be

1. Fixed route (because the rails were fixed and could not be easily altered),
2. Fixed schedule (because the vehicles could not pass and had to coordinate linear operations),
3. Operated by a large company (because individuals could not afford to build their own rights-of-way),
4. Provided by a natural monopoly (because multiple rights-of-way were not feasible),
5. Operated by professional drivers (because highly trained skills were required to operate the trains), and
6. Provided by large vehicles (because increased mass improved rail operations, increased worker productivity, and reduced the number of units on the linear track).

The service could not

1. Be on call,
2. Have flexible routings,
3. Be operated by many different individual owners,
4. Have specialized direct routing and schedules between desired origins and destinations, or
5. Use small movement units (because of the limitations of rail technology).

By 1917, the greater flexibility of the automobile began a return to the traditional, individualized, pre-railroad-trolley approach to public transportation with the advent of the jitneys. However, governments, anxious to protect a perceived tax base, passed legislation to define the railroad-trolley model as the only legal form of public transportation with the possible exception of taxicabs, and then only with adequate protection for transit. With this type of legislation, only the railroads and trolley companies could make changes. Although buses replaced trolleys, there was no change in the way the vehicles were operated.

Only their new technology enabled the airlines to free themselves from the traditional railroad-trolley model of public transportation regulation. The airline model allows each carrier to focus on the market that it can serve best and cooperate with carriers that serve other areas. The airline emphasis on target markets has established trunk lines, regional airlines, charter airlines, commuter airlines, and air taxis. Now the airlines and the Civil Aeronautics Board are pressing for even greater flexibility. Similarly, the taxicab industry is experimenting with changing organizational structures (e.g., freedom of entry, shared rides, zone rates, gypsy cabs, and owner operators). The industry is proving that more flexible regulation increases the availability of taxi service.

An examination of the historical trend provides a convincing case that the railroad-trolley regulatory model worked well during the period of technological superiority of rail systems, but that the continued adherence of public transportation policy to a model that no longer works has created an artificial transportation shortage. Despite bold efforts to rescue the railroad and trolley types of companies by providing government funding for new equipment, operating subsidies, and tax relief, their decline in market share continues while the costs of their services increases rapidly. The market share of these companies is now minimal, except in towns that primarily were constructed during the height of the railroad-trolley technological supremacy.

TRANSPORTATION BROKERAGE MODEL

With the development of new technological improvements, such as automobiles, airplanes, telephones, two-way radio communication, and the computer, a new model of public transportation regulation and operation is evolving. Local governments are no longer preoccupied with the development of expensive transportation facilities (railroads, trolleys, and highways) and are now attempting to solve community transportation problems. Cities are primarily concerned about two major areas.

1. Cities want to reduce automobile-related problems, such as pollution, congestion, and inefficient use of energy. These problems stem from the use of too many automobiles during the peak-hour work trip. Traditional transit has not been able to provide this service economically due to the inherent inflexibilities of the technology and its management (including labor use, scheduling, vehicle size, and cost).
2. Cities want to provide accessibility to goods and services for those who cannot use the automobile because of age, income, health, emotional, or other reasons.

Cities also have other major concerns, such as land-use planning and unemployment, and in general these are influenced indirectly by transportation. Unemployment, for example, can be alleviated by the construction of hospitals or housing, as well as by the public works construction of subways. Land use, on the other hand, is changed as automobile-related problems and accessibility options make some areas more accessible than others.

Interest in paratransit has evolved with this shift in emphasis. At first, paratransit was thought to be a new mode, and proponents began to operate dial-a-bus, freeway flier, and other services. However, the railroad and trolley organizations, although hampered by regulations, were used to manage and direct these services. This restricted operating options severely, but was a necessary part of the transition from the railroad-trolley approach to the brokerage or transportation system management approach. Ironically, the new model is very similar to the pre-railroad-trolley model that existed throughout history except for the short era when railroad technology was superior.

REEVALUATION OF INSTITUTIONAL ISSUES

The purpose of this paper is to examine several institutional issues and business practices that evolved during the era of railroad and trolley superiority and inhibit the development of more flexible forms of public transportation to meet today's needs.

Economic Regulation

There are economic regulations at the national level (Interstate Commerce Commission) for interstate trips, at the state level (public service commission) for intrastate trips, and at the municipal level (regional transit authority, taxicab board, and city council) for service within the municipality. These regulations generally consist of

1. Entry requirements in which a franchise or certificate of convenience and necessity is required;
2. Rate regulations set by the regulatory body based on the rate of return of the carrier;
3. Service regulations in which regulatory approval is required for the addition, deletion, or change of routes;
4. Schedule regulations in which regulatory approval is required for any change of schedules;
5. Equipment approval in which regulatory approval may be required to modify equipment or to use a different type of equipment; and
6. Interline regulations that control the terms of interconnecting agreements with other carriers.

Public bodies have felt comfortable with the traditional regulatory model because only a limited number of companies must be dealt with, discrimination of fares and service is prohibited (so there is some immunity from selective pressure groups), and changes cannot occur without the prior approval of the regulatory body.

A discussion of the theory of innovation and its diffusion into society presents an interesting perspective on transportation regulations. According to this theory, individuals can be categorized based on their rate of acceptance of a new idea.

Category	Percentage of Population
Innovators	2.5
Early adopters	13.0
Early majority	34.0
Late majority	34.0
Laggards	16.0

Innovators develop new ideas and experiment; they also make mistakes because not all ideas can be successful. After the innovators thoroughly sift the ideas, early adopters accept the best of them and implement them. Thus, the early adopters also make mistakes. The politicians elected by the early and late majorities watch the early adopters and accept only the innovations proven by this group. This is understandable because the cost of backing an idea that fails can be high for a politician.

Traditional transportation has been regulated by public bodies, and now mass transit is both operated and regulated by politicians, who are reluctant to support anything that has not been tried and proven. Furthermore, the franchise requirement prohibits innovators from evolving new concepts outside the established planning and governmental structures. Thus, government regulation and operation effectively has ensured that no innovation can occur, and if it does occur, it must be proven, tested, and widely used before it is politically acceptable. Therefore, a new transportation innovation must be structured to promote its dissemination, or it will die, not because of cost or effectiveness, but because of the institutions that have developed.

Thus, the purpose of the brokerage or transportation system management concept is the promotion of new concepts, such as

1. Flexible consumer-oriented services;
2. Specialized services for specific target markets;
3. Programs designed to improve vehicle efficiency—car pools, van pools, and other high-occupancy modes; and
4. Service to all areas—rural, suburban, and neighborhood circulation.

The broker stresses facilitation rather than police-type regulations. The harshness of existing laws and regulation on an innovator wishing to initiate a new service is best illustrated by a specific example. Assume that an individual desired to operate a van pool in Tennessee in 1975 or in the majority of states today. To examine the applicable law, it must first be determined whether the van pool is a common, a contract, or a private carrier. In 1975, a van pool in Tennessee would have been considered a contract hauler. (However, it should be pointed out that this conclusion was reached only after exhaustive reading of the statutes and examination of applicable case laws. Such a conclusion could not have been confidently reached by a lay person and probably not even by an attorney, unless the attorney was thoroughly familiar with transportation law.)

To operate legally, the van pooler would have had to apply to the Tennessee Public Service Commission for a certificate of convenience and necessity. This petition would have caused the commission to hold a hearing. At least 10 d before the hearing, the commission would have caused notices to be served on all affected and interested parties to allow them an opportunity to testify at the hearing and to contest or support the application for authority. (By rule of the commission, the applicant must give notice to all affected and interested parties and bear the expense. In addition, the applicant must pay a $25.00 filing fee to defray the cost of the hearing.)

The commission would have determined at the hearing whether the proposed service would benefit the public and not impair the efficient service of any authorized common carrier or contract carrier then serving the same route or territory. If the commission had deemed that the issuance of a permit was proper, the commission would have been granted extensive power over all aspects of operations and the van pooler would have had to obtain approval for each and every contract. A minimum rate would have had to be filed as part of the annual report. The van pooler would have been required to maintain detailed accounts and records.

Generally, the public service commission is given the power to supervise and regulate contract haulers in all matters affecting the relation between such contract haulers, their customers, and the public. Compliance with the law to obtain authority requires not only a substantial amount of time and money, but there is no guarantee that the authority will be granted. Even if it is granted, the van pooler would have faced a substantial amount of expense and paperwork. Moreover, if the permit was granted, the van pooler's insurance company would have had to file with the commission to comply with the liability insurance requirements, and the van pooler would have paid annual taxes and fees as levied by the commission. (Because of the very high liability stan-

dards of regulated carriers, many insurance companies will automatically drop anyone who is required to have a filing of insurance with the public service commission.)

Finally, the van pooler would have had to comply with the public service commission safety requirements that each vehicle have an approved fire extinguisher, an approved first aid kit, an approved reflector, and an approved flare. (It is ironic that the Knoxville transit system vehicles do not carry some of these items to discourage the operators from giving first aid at accidents to remove the possibility of lawsuits.)

The authority of the public service commission with respect to contract carriers is limited in respect to rates. The commission approves the rates, but the minimum rate set for contract haulers "shall not be less than the rates prescribed for common carriers for substantially the same service." Thus, although one of the benefits of van-pool service is that the cost is substantially lower than the cost of operating a bus, van-pool rates could not have reflected these savings. Under this statute, the passengers could not benefit from the efficiency associated with van pooling. Also, property taxes on regulated public utilities are 55 percent of assessed valuation as compared to only 25 percent of assessed valuation for private property. Contract haulers under the Tennessee statute are defined as public utilities.

If the van pool had then wished to discontinue service, a second hearing would have been required for permission. If the poolers did not comply with the law, then they might have been declared a public nuisance on the highway and denied recovery in case of accident.

The Knoxville broker used a different approach for regulating transportation. First, it submitted legislation that was enacted. This legislation has accomplished the following:

1. It exempts car pools, van pools, and station-wagon pools from all forms of economic regulation.
2. It allows private bus operators (in areas where competitive) to experiment with new service for 6 months before having to submit to public service commission regulations.
3. It allows a county to declare itself a citizen transportation area on petition to the public service commission. Since there are many counties in Tennessee where no public transportation is available currently, under this legislation the public service commission is given the opportunity to provide service to the community. If it cannot, the commission may not prohibit the citizens of that community from solving their own transportation problems as best they can. The citizen transportation area thus becomes virtually unregulated until such time as public transportation might be available.
4. It allows employers to cooperate with state and local pooling activities without increasing the employer's liability to the poolers or the public.
5. It allows individuals to purchase low-cost underinsured-motorist coverage that guarantees personal insurance protection up to the limits of the underinsured-motorist coverage no matter what vehicle they use or organizational arrangements they have.
6. It allows state agencies to locate park-and-ride lots at churches, shopping centers, and other areas and to use public money to erect signs designating these park-and-ride lots without increasing the liability of the owners of the lots or risking the loss of a property's tax-exempt status.

In addition to the legislation, the Knoxville broker has accomplished the following:

1. It has established a computer system to provide immediate information to anyone within a 10-county area about the transportation options available to them including car pools, van pools, transit, private buses, and express buses.
2. It has obtained new insurance rates for van and car pools and found companies willing to write the insurance.
3. It has established a van-pool association that would offer fleet discounts on repairs, tires, parts, and other upkeep items for all pool operators who registered their pool with the city.
4. It has established a financing program where credit unions would provide 100 percent financing (including insurance); established escrow accounts for maintenance, insurance, and parking; and placed riders (other credit union members) on payroll deduction to pay for their ride.
5. It has prepared a how-to-do-it handbook with information on vehicles, specifications, costs, fares, accounting procedures, and insurance procurement.
6. It has coordinated driver training programs through the police department to reduce insurance costs and accidents.

For social service agencies, the broker will

1. Coordinate transportation audits to help determine the cost of providing service,
2. Suggest alternative transportation arrangements for providing more effective service at lower costs,
3. Assist in negotiating with various suppliers,
4. Help in obtaining insurance to meet specific needs,
5. Manage the contracts between them and potential suppliers,
6. Locate ways in which volunteers can be used to meet needs,
7. Develop effective dispatching procedures or assume the dispatching function directly, and
8. Supply information on child restraint systems and assist in the acquisition of these restraints.

Thus, as these examples show, the broker uses managerial approaches for the development of new options, rather than harsh police-type regulations designed to force a service to meet certain preconceived standards.

The current move to convert the Knoxville Transit Authority, with its narrow, bus-only perspective, to a transportation board responsible for solving Knoxville's dual transportation problems of automobile-related congestion and lack of service to those who cannot drive is another example of the institutional shift from the railroad-trolley concept to the much broader brokerage concept. The amendment to the Urban Mass Transit Assistance Act of 1977 that was proposed by Senator Hayakawa, the Kennedy-Cannon airline deregulation bill, parts of the Railroad Revitalization and Regulatory Reform Act of 1976, the Urban Mass Transportation Administration statement on paratransit alternatives, transportation system management and the discovery of the taxicab and jitney industry are all part of the realization that all public transportation does not have to operate like a railroad.

Insurance

Traditionally, governments have relied on the common-carrier liability standard to protect passengers. This standard was developed at a time when the only type of regulation imposed on carriers was that imposed by the judiciary, i.e., that common carriers would be required to exercise the highest degree of care. Under this approach, anyone injured while riding in a for-hire vehicle could look to the owner or operator or both of the vehicle

for recovery. Since the owner and the operator of the vehicle control both the maintenance and the operation, there is virtually no way the passive rider can ever be at fault. By placing a very high standard of care on the operator, the carrier had an incentive to take extra precautions to prevent injury, and in case of injury, financial recovery was almost certain.

Governments have also recognized that the obligation of a carrier to the individual hauled should be a function of benefit as well as of liability. Therefore, many states have passed legislation called guest statutes to cover cases where individuals picked up hitchhikers or where the rider was the sole beneficiary of the ride. Under these statutes, the driver is liable only in cases of gross negligence. However, where compensation changes hands, guest statutes do not apply (even if the compensation is only reimbursement).

Now, conditions have changed. No longer are there large numbers of private companies eager to provide transportation under the existing rules. Government now provides the transportation. In the case of transit, rail passenger service, and government-sponsored social-service agencies, the cost of insurance and accident recovery is borne by the taxpayers. The liability cost to charitable institutions is borne by charity, and when it becomes too high, the charity discontinues the service; again, the burden falls on the taxpayers. Among for-profit common carriers, liability cost frequently is a major cause of going out of business, at which time the community frequently petitions the government to continue the service, and so again the burden falls on the taxpayer.

Government-provided insurance might be an effective way of providing public transportation protection if it were not for the high cost of insurance and tort settlements. The tort liability system depends on the legal process to determine fault and assess the amount of damages. This is expensive, especially in the case of high-occupancy vehicles, for several reasons. The legal process is costly; one-third of the judgment or settlement is retained by the plaintiff's attorney, and the defendant's legal fees and court costs are high. The process does not provide protection when drivers with low insurance limits or few assets are at fault.

The insurance merchandising process assumes 1.5 passengers/vehicle (total limits are only two to three times individual limits) and is grossly inadequate for high-occupancy vehicles. The process rewards small claims more than adequately because of the high cost of going to court, but serious injury or loss is seldom recovered. Under the tort liability system, insurance is designed to provide asset protection, rather than passenger protection, in case of an accident. Over one-third of all vehicles have only the minimum amount ($10 000/person, $20 000/accident) or no insurance. There is no way individuals can protect themselves except with life, hospitalization, and disability insurance unless the state has some form of underinsured-motorist-protection program that has special provisions for high-occupancy vehicles. Because much of the cost of insuring high-occupancy vehicles is charged back to the taxpayers, there should be some type of structure to control this cost.

To illustrate this point, consider the case of a social service agency operating a government-funded day care center for children with learning disabilities. The agency could probably hire several mothers to pick up other children when they bring their own at a cost of 9 to 18¢/km (15 to 30¢/mile). The family automobile would probably have the usual $25 000 to $50 000 coverage. The parents might be very willing to help, but the prudent one would ask, "What about liability?" The social agency, if honest, would have to give the following answers.

1. If you receive money, you will be hauling for hire and regulated as a public utility.
2. Becoming a public utility will increase your insurance costs by an amount larger than you will receive in expenses for providing this service.
3. Because you receive money, you have virtually no defense against liability or lawsuit. In fact, your liability to charitable passengers is probably greater than your liability to an employee. Only fate will tell whether you will be sued for everything you have. (The social service agency will probably require a hold-harmless agreement from the volunteer because the agency does not want to risk being liable for an accident involving a for-hire carrier, and besides, the social-service funding agency does not allow the social service agency to assume the risk.)
4. If you are hit and other persons are at fault, their coverage will have to be divided between you and the five passengers in the vehicle on a first-to-sue, first-to-recover basis.
5. You will not be eligible for workmen's compensation or other financial recovery from the government, nor can the government help you in your defense because you are not an employee.
6. If you decide to help carry these students, you will reap many blessings in the hereafter and receive the satisfaction of contributing to your fellows, but do not forget to pay income tax and social security on the amounts you receive greater than 9¢/km. Also, remember that your social security taxes must be paid at the higher self-employment rate; the agency cannot contribute as you are not an official employee.
7. We do not think you will have trouble getting insurance; after all, the taxicab industries get it all the time. There may be a few papers to fill out at the taxicab inspector's office or the state public utility commission.

If the potential volunteers feel that there is some degree of uncertainty about the risk and the willingness of the agency to rally to the volunteer's defense, they may not accept the job of hauling people to the agency. Another possibility for the agency is for the director to personally haul the children because the cost of this service is only 9¢/km for the expenses of the director's automobile. But if an examination of the liability issue raises questions for the director, the agency's attorney could advise the director to obtain a free government van (after all, the agency does not want to be part of a client lawsuit arising from riding in an employee's automobile). The government is self-insured and has a deep pocket, but that protection is only for authorized use of government vehicles and not for personally owned vehicles. And if the director is spending 2.5 h each morning and another 2.5 h each evening for 9¢/km, he or she may feel that the free government van is a good idea.

To get a free government vehicle, the agency must agree to operate according to strict state guidelines. As this is a new experience for the state, the state assigns a planner, a sociologist, an engineer, or an economist to draw up operating guidelines. This person has read about million dollar lawsuits and would not want the blame for not requiring adequate insurance, and so reasons that $500 000/person, $1 000 000/accident liability coverage (or possibly over $5 million) should be obtained to protect the passengers (but no underinsured motorist coverage, because then the accident would be the other person's fault). That the insurance has a provision for 60-d notice prior to cancellation is also required as proof that the agency does carry insurance.

Also, inspection by the public service commission sounds like a very good idea to ensure the condition of the vehicle. Then, the agency finds that insurance is unavailable or very costly and blames the insurance industry for not taking the risk.

It is ironic that an agency that has $20 000 in assets and is completely dependent on charity or public funding will purchase a large liability policy to protect clients when the agency is at fault, but will purchase nothing to protect them if someone else is at fault. If the agency had trip insurance (first-party medical, life, income protection, and disability) to protect the clients in any case, it would probably be much cheaper than the more limited tort liability coverage, where such a large part of the coverage goes to legal costs. The client might also have greater access to transportation, and the government would not have to be involved in buying and operating vehicles if alternative insurance approaches were available.

In essence, then, the cost and availability of insurance are the reflection of several items. These include

1. The uncertainty of existing laws with respect to new forms of transportation and the lack of information about new transportation programs,
2. A liability system that places the cost of insurance on the driver and vehicle rather than on the beneficiary of the transportation service,
3. A lack of alternative programs for providing rider protection,
4. The limited number of companies that are involved in specialized insurance areas (if only one or two companies specialize in taxi insurance, for example, and they have high claims 1 year, there is no other company available to compete for the business), and
5. A liability approach to insurance that places major emphasis on protecting assets as opposed to protecting passengers.

No-fault insurance is not a solution for the problem of the high-occupancy vehicle. No-fault insurance, especially that having a follow-the-vehicle approach, requires each vehicle to cover all injuries to every person riding in the vehicle plus providing liability protection above an arbitrary threshold level. Consider, for example, the high cost of insurance for a school bus that must cover all injuries on a no-fault basis for 60 or 70 passengers. The follow-the-family approach is much better because persons are covered by their family policy, regardless of the vehicle ridden in.

The problem of the high-occupancy vehicle will be solved only when insurance is written to cover the individual rather than the vehicle. It is nearly impossible, for example, to write insurance for van pools that may vary in size from 2 to 15 passengers unless the insurance is written on an individual basis. A classification system that is based on type of vehicle does not give an adequate measure of risk.

Tennessee has a partial solution in the form of underinsured-motorist coverage that provides coverage if the prorated amount of insurance on the at-fault vehicle is less than the underinsured-motorist limits. For example, if a van pool has $100 000/person, $300 000/accident liability coverage on the privately owned vehicle, it can obtain similar amounts of underinsured-motorist coverage. If an individual were a rider in a 10-passenger van with this underinsured-motorist coverage that was hit by a vehicle with the same amounts of liability coverage, the coverage would be divided as follows: The $300 000/accident liability coverage of the at-fault vehicle would provide a prorated share of $30 000 for each of the 10 passengers, and the $300 000/accident underinsured-motorist coverage of the van would provide $30 000 for each of the 10 passengers. The individual underinsured-motorist coverage would offer $100 000 coverage for the individual rider less the $60 000 from the at-fault vehicle and the van; thus, $40 000 of additional-underinsured motorist protection would be available, and so each individual would be assured of approximately $100 000 coverage, regardless of the vehicle or the organizational arrangement. This approach works much better than most, but still causes problems for members of non-automobile-owning families and for social service agencies.

Earmarked Funding of Transportation Programs

A major institutional barrier to more effective transportation programs is the earmarking of funds for highways and mass transit. At present, there is great pressure by various government officials to fight for the preservation of earmarked funding so that their programs do not have to compete with others. This method of funding does not encourage a problem-solving approach; rather, it encourages a preservation of the status quo because there is no discretion for experimentation with innovative forms of transportation. If there were a transportation trust fund that could be used for mass transit, paratransit, ride sharing, and highways (dependent on the greatest return on investment), then each could be evaluated according to its contribution. Unfortunately, this can be done only if the decision makers understand the contributions of the various programs equally. If they do not, they will use all the funds to preserve that which they understand and be reluctant to experiment with the new because of the political reluctance to innovate.

Labor Issues

Section 13c of the Urban Mass Transportation Act of 1964 was a well-conceived concept designed to protect workers where they might be laid off or disadvantaged by the use of tax monies to promote new technologies. Unfortunately, however, this section has been administered so as to effectively give bus drivers the veto power over any other options that a city might consider. The section 13c specter can also be used by management to preserve the status quo and forestall consideration of other options. If cities are to use new, more efficient forms of transportation, they must first accept labor costs as a given fact (including the termination costs of the 6 years guaranteed salary or up to 12 months severance pay) and design their programs around it. Communities, however, should be astute enough not to promote ineffective declining systems where older retiring employees are rapidly being replaced with young employees, so that adjusting the size of the work force through attrition is no longer an available option.

Communities should strongly avoid becoming locked into single-source labor contracts, where work rules such as the prohibition against part-time labor severely restrict the services they can provide. A regulatory policy that allows private citizens to solve their own problems and private providers the right to serve is a control against overly restrictive work rules and exclusive labor contracts. A reading of other sections of the Urban Mass Transportation Act shows that Congress did not intend to bring all transportation under public ownership and wanted to ensure the right of groups other than government to provide transportation service.

Tax Issues

The tax issues in paratransit are significant, and the tax code should be clarified so that taxation does not discourage transportation innovation. Traditionally, employers have been given a tax advantage to build parking lots, and their employees have been given free tax-exempt use of the lots. If an employer were to take the money that normally would be used to build a large parking lot and give this money to the employees so that they could ride transit, taxicabs, or van pools, the money would probably be considered taxable income to the employee. Thus, the tax policy discriminates against the use of more efficient forms of transportation and encourages the building of parking lots. There are other questions regarding the income received by the driver of a paratransit vehicle. Is the free ride income to the van-pool driver? What is the proper amount of reimbursement for car pools, van pools, or volunteers? At present, there is a great uncertainty in the overall tax area, although an earlier tax ruling clarifies the situation for some car pools. In other areas (such as the availability of tax credits, depreciation and other business deductions for paratransit vehicles, and possible deductions for expenses incurred in promoting paratransit activity), the law is very unspecific. The answers to these questions would provide policymakers greater insight into the nature of changes necessary in the tax areas.

On the state level, property tax laws are a major issue. For example, consider the person who purchases a van or bus to haul commuters to and from work for compensation. Is that person conducting a business? Under state law, this activity would probably be subject to a business-property tax assessment or possibly a public utility assessment that could be much higher than the ordinary business-property tax assessment. As a result, a person may be penalized for conducting paratransit activities by having to pay higher taxes. Moreover, if the person stored the vehicle in his or her garage, the garage might be taxed at a higher rate. Property tax laws vary among the state and need to be clarified to ensure that public transportation innovations are not discouraged by tax laws that do not consider these options.

Fair Labor Standards Act of 1938

There are some definite problems concerning the applicability of the Fair Labor Standards Act of 1938 in paratransit activity. Basically, this act establishes a minimum wage and certain provisions for overtime labor. The wage and hour division of the U.S. Department of Labor has indicated that van drivers in employer-sponsored and operated van-pool programs are not considered as engaged in compensable work if the driver is driving voluntarily and if the employer gains no profit from the operation of the van. However, the binding nature of this opinion still is being studied, and many other issues must still be resolved. Obviously, if the sponsor or organizer of a paratransit activity were required to pay overtime, even at minimum wage, expansion of van-pooling activities would be discouraged. Decisions will have to be made to make allowance for volunteers, owner operators, lessees, taxi operations, casual carriage, and other evolving groups.

Local Emphasis on Operations

When the Urban Mass Transportation Administration (UMTA) was formed, its emphasis was on preserving existing mass transit operations, rather than on transportation policymaking. New run-cutting schemes and vehicle designs were considered to be far more important than policy considerations of public transportation options. In fact, the close association between UMTA and the transit operator's trade group (the American Public Transportation Association), and the contrast with its lack of liaison with transit authority boards, city managers, and mayoral organizations is evidence of this historic emphasis. If new transportation options are to be considered, other parts of government must follow the lead of the Federal Highway Administration and work with local transportation professionals and policy makers, rather than only with the operators. Just as each community has a traffic engineer, so each community should have a transportation executive who is not allied with any particular contractor but can closely evaluate each transportation option on a cost-effective basis. One can imagine the outcry if an association composed of the portland cement lobby, the road-equipment lobby, and the highway contractors' lobby suggested that they set policy for the Federal Highway Administration; if highway contractors had exclusive cost-plus contracts for 15 or more years; or if construction workers were considered, not as contractees, but as public utility workers such as police and fire persons and kept on the city payroll whether the contractors were building new highways or not. But this is exactly what has been done with mass transit.

The key to resolving many of the institutional barriers to more effective and efficient public transportation is the development and training of regional transportation executives who are responsible for the allocation of all local transportation money (including that for mass transit, social services, and highway funding) to maximize the benefits to the community. These executives must not be biased toward any one mode but must do whatever is necessary to solve problems. The planners of individual options would report to the transportation executive and integrate their plans into an overall strategy. The current transportation system management and brokerage concepts are efforts in this direction.

SUMMARY

Public transportation is undergoing great changes, and institutional practices and customs must also change to allow the development of more flexible and economical services. Rather than continuing to protect turf, each institution will be forced to reevaluate its role as conditions change. This paper has identified some of the changes and suggested several institutional problems that should be resolved to allow these changes to occur efficiently. The more new modes are forced to conform to outmoded stereotypes, archaic concepts, or inflexible institutions, the more society will suffer from inadequate service.

Abridgment

Insurance as It Relates to Demand-Responsive Transit

Donald B. Chalker, LFC Insurance, Beverly Hills, California

The effects of the liability and malpractice insurance crisis—the decline in availability of insurance and the premiums that are far greater than seem justified based on historical loss data or than the public can reasonably afford—have been well publicized. The effects of inflation and the broadening concepts of tort liability have been particularly severe in escalating the cost of automobile insurance, and the high cost of medical services and automobile repairs have also increased loss settlements. The public transportation industry is also suffering from these problems and seeking alternatives during this period of economic uncertainty and social change.

The trend toward a ride-sharing system in the taxicab industry could not be more timely. Unfortunately, however, because the concept is relatively new and insurance carriers have been unable to adequately identify the exposure to losses for rating purposes, complete ultimate costs are not readily available. At present, this exposure is being categorized as either bus, limousine, or taxicab, depending on the individual underwriter's viewpoint. It is, however, safe to assume that the exposure to losses should be less than that of taxicab operations for a variety of reasons.

Insurance rates are more affected by accident frequency than by a few selected high-settlement losses. Unlike taxicabs, which have a high frequency of accidents, ride-sharing systems have fewer losses because of

1. Specific trip scheduling,
2. Lower speeds,
3. Limited radius of operation,
4. Fixed-salary drivers (which eliminates the competitive commission-earnings approach of the usual taxicab operator), and
5. Driver employment stability due to the fixed salary.

On the other hand, the higher passenger load factor will affect premiums because of the increased limits of liability required. A precedent for minimum limits of liability has been set by most municipalities for taxis. It is entirely possible that an increased use of ride-sharing operations will require an increase in present liability limits. Although excess-limits coverage can be obtained, the cost factor will not be firmly established until more loss results are available. From the operator's point of view, higher limits will be necessary because of potential catastrophic losses.

The insurance requirements of ride-sharing operations do not differ significantly from those of taxis (with the exception of the instances in which the city or municipality itself owns the vehicles and operates them by a leasing arrangement). For either, the basic insurance coverage recommended is

1. Automobile public liability: (a) The recommended minimum is $1 000 000 and (b) the basis of the premium is either per unit or per passenger distance traveled (with an ultimate adjustment to be based on loss experience).
2. Workmen's compensation: The classification will depend on the state of residence of the employee. Some states require a taxicab classification, and others require a bus or limousine classification (bus or limousine generally has a lower rate). Again, more extensive use of ride-sharing operations will lead to a proper rating base and a consistent classification.

If the municipality owns the vehicles and is not self-insured, the following coverages should be considered: (a) physical damage including collision, comprehensive, fire, and theft and (b) bonds as necessary. If the municipality is self-insured, separate data must be maintained to determine actual claims experience.

Currently, the insurance marketplace for purchasing transportation liability coverages is extremely limited. In California, the assigned risk plan was broadened to include coverage for these vehicles on July 1, 1976. However, this plan has an extremely limited loss experience on which to base a premium structure, and the indications are that the rate-making process will be affected by the development of true-loss data.

In summary, transportation premium costs can be lowered by education and mandated controls. Proper hiring procedures, safety programs, and thorough claims-handling procedures should be emphasized. The current tort liability, injury-fee settlement basis should be opposed, and no-fault insurance will not be a solution until injury settlements and medical treatment for injuries are placed on a scheduled fee basis, similar to workmen's compensation benefits. Other tort reforms under consideration may also provide some relief. By curtailing medical fees and their resultant high injury settlements, insurance costs can be stabilized.

Service Planning and Marketing

Anthony I. Morgan, Grey Advertising, New York

Two models are discussed for predicting the demand estimate for new transit services or service modification—macroscopic mathematical models based on land-use and population characteristics and marketing models based on consumer awareness of and attitude toward service. The way consumer marketing was applied to the Nashville marketing demonstration project sponsored by the Urban Mass Transportation Administration is described. Attitudinal change was more predictive of increased ridership than any other factor. A methodology and a predictive equation based on theoretical data for quantifying the relation between consumer attitudes and transportation ridership is proposed.

In this paper, I will focus on one particular area of the transportation planning process—the demand estimate for a new service or service modification. This area has become the subject of some of the most complex methodologies in the planning process. Macroscopic mathematical models are being used to screen alternative transportation systems and to consider the problem of estimating the numbers of trips that will be made on alternative modes. The most commonly used models separate travel into a sequential set of analyses dealing with trip generation, trip distribution, modal split, and trip assignment to network links, not necessarily in that order, and with some of the steps sometimes combined. There are many variations on the theme, but certain basic data requirements generally apply.

Trip generation is normally modeled as being dependent on land-use and population characteristics, such as dwelling units per unit area, average number of automobiles per household, and median income per household. Trip distribution is most often described by the so-called gravity model, where the number of trips from zone A to zone B is directly proportional to the trip-generating capacity of zone A and the trip-attracting capacity of zone B and inversely proportional to some measure of the impedence between the two zones. Trip-attracting capacity is usually modeled in terms of such characteristics as total employment or employees per unit area of various kinds of commercial and industrial uses. Modal split is usually described in terms of the comparative characteristics of the competing modes, as well as certain population characteristics. Thus, the input data requirements may include such factors as range of household income, number of automobiles per worker, difference in out-of-vehicle travel time between competing modes, difference in in-vehicle travel time between competing modes, and difference in cost relative to income for the competing modes.

The next step is to calibrate the model based on relevant experience and to determine the values of the constants in the equation.

In general, calibration requires the collection of sample data for the dependent and independent variables in the model system. In the case of transportation models, the dependent-variable data are basically the trip-identification quantities, i.e., the number of trips by purpose and mode and origin-and-destination information. The independent-variable data are those types of data described above. The aggregated models, where the study area is divided into zones, require sample sizes of 30 000 to 40 000 for large urban areas. The more recently developed disaggregated models require sample sizes of approximately several hundred. In disaggregated models, the unit of behavior is the individual trip maker or the household and the modeling approach is designed to use individual observations rather than zonal aggregates.

In the calibration process, the trip data are processed so that computed trips can be compared with actual trips and the models are adjusted until satisfactory agreement is achieved. When the model is to be used to evaluate alternative transit systems for an area that has little or no directly applicable local transit experience for modal-split model calibration, the usual solution is to borrow models that have been calibrated for other areas with reasonably similar demographic characteristics and then test and adapt them with whatever transit data are available for the actual study area.

Among other things, these models are being used to measure estimated ridership, potential effects on other modes, costs, and anticipated revenues. I believe it is a fair generalization to say that they are most useful in connection with the physical and service parameters of the macrosystem (plus certain policy issues) before the introduction of the service. The issue now is the relation of this process to consumer marketing and whether an understanding of marketing can aid in the development of services and the estimation of demand.

Before addressing this issue, I would like to ask two basic questions:

1. What do we mean by consumer marketing?
2. Is public transportation a consumer product?

To answer the first question, I would first like to tell you what marketing is not—it is not selling. Selling is concerned with the need to convert a given product to cash, and it focuses on the needs of the seller. Marketing, however, is a business perspective based on the concept of understanding and satisfying the needs of the consumer.

If this definition appears to be very broad, that is because marketing in the modern sense has a very broad perspective—it is the totality of understanding and responding to what the consumer wants. With this perspective, we can see that marketing includes many aspects of the business process—e.g., research, product development, pricing, distribution, strategy, promotion, and advertising. The development of a marketing plan involves four basic components—situation analysis, quantification of objectives, formulation of strategy, and the action program.

Does this planning procedure relate to the planning (modeling) process described above? In some ways it does and in others it does not. Many of the variables used in the input and calibration of the models would be included in a marketing situation analysis. These include economic variables such as employment; demographic variables such as household income and automobiles per household; behavioral variables such as trips by type, origin, and destination; and competitive variables such as modal split and relative costs. But the models do not include one of the key variables in the prediction of human behavior—i.e., the levels of awareness of and attitudes toward a given product or service. Failure to recognize the importance of these factors can lead to incorrect estimates of demand. Let me give you some examples of what I mean.

It would seem obvious that awareness of a product or service is the sine qua non of demand estimating. It is a fallacy to assume this factor to be 100 percent, especially in the case of a new service or a service modification. Consumer marketers spend tens of millions of dollars to let people know they have a new product or have changed their product. Many of you probably know of at least one situation where a service has failed and the subsequent analysis has shown that the failure was due to a lack of awareness by the persons it was intended to serve. You notice that I said "the persons it was intended to serve"; it is important that awareness be measured in terms of the potential user segment—e.g., the elderly and handicapped or shoppers—and not some other group such as politicians, advertising persons, or mothers-in-law (unless those are the consumers to whom the service is targeted).

One example of the failure to use an attitudinal demand prediction can be found in the automotive market. In 1973, a major automobile manufacturer was told that the (then) current demand for small automobiles appeared to be a function of the oil embargo and economic recession, but that attitudinal research showed an underlying desire for larger automobiles. It was hypothesized that when and if external conditions changed, the demand for large automobiles would again increase. The manufacturer involved chose not to accept this analysis, and in early 1975, after the crisis had ended, found itself with an oversupply of compact automobiles and an inability to produce enough large ones to meet the demand.

This example gives me the opportunity to mention the one variable that overwhelms all predictors—the government. Today, we see the demise of the large automobile not so much as a response to a change in consumer desires, but as a response to legislation. Therefore, when making demand predictions, one should always be aware of the legal or regulatory condition.

To return to the main thrust of this paper, we come to the second question I posed above. Is public transportation a consumer product? Some persons might argue that it is a utility, a monopoly, or something else. I believe it is a consumer product because, for most persons, it involves free choice. Although some consumers are captive to public transportation, the majority have a modal choice based on their perceptions of such things as cost, speed, comfort, and convenience. Even the so-called captive riders have an expanded trip potential because they can choose to take some trips or not depending on their perception of the transportation being offered to them. Therefore, public transportation is a consumer product because it is subject to competitive choices. If this is correct, we should be able to demonstrate that attitudes do affect choice in public transportation.

The Urban Mass Transportation Administration (UMTA) sponsored a marketing demonstration project in Nashville that was an attempt to apply the principles of modern consumer marketing to transit. A marketing plan was developed much along the lines I have described—situation analysis, objectives, strategy, and action plan. The situation analysis included a major piece of consumer attitudinal research, and these results were used as a basis for the other steps in the planning process. A major marketing and communications program was begun in January 1976 and continued through the entire year with additional input at a lower level in 1977. The program included additional travel of 380 000 km (600 000 miles) that the research had indicated would meet consumer needs—remember that marketing includes product design. The results are shown below (1 km = 0.6 mile).

Item	Time		
	12/1/74 to 11/30/75	12/1/75 to 11/30/76	8/1/76 to 7/31/77
Revenue passengers	7 027 000	7 790 000	8 249 000
Passengers per kilometer	1.1	1.1	1.2

The ridership increased 10 percent in the initial year and has continued to climb at a similar rate. Even with the increase in travel distances, the system has experienced an increase in passengers per vehicle kilometer. What changed in Nashville that would predict such an increase in demand? Not dwelling units per unit area or average number of automobiles per household or median income—what changed were attitudes. The overall rating of the bus system given below shows that the number of people in Nashville who rated the system excellent or very good increased almost 250 percent (from 17 to 42 percent) in this period.

Rating of Service	Percentage of Respondents	
	Preadvertising	Postadvertising
Excellent	4	10
Very good	13	32
Good	44	36
Fair	24	16
Not so good	6	4
Poor	9	2

For persons in the work-trip segment, those rating the bus (versus the automobile) as extremely satisfactory increased from -8 to +10 percent.

For me, this demonstration clearly indicates a relation between consumer attitudes and transportation ridership. The task now is to develop a methodology for quantifying this relation to help predict demand. Again, I will turn to work that has been done in consumer package-goods marketing to develop a predictive equation.

Let us begin by defining our terms. At any point in time, the market for a good or service has two components: new triers (NTs) and repeat buyers (RBs). A simple model can help to explain the dynamics of a market over time.

$$\text{Sales} = \text{NT} + \text{RB} \quad (1)$$

At the introduction of a good or service, NT = 100 percent and RB = 0 percent, and in the postintroduction period, NT < 100 percent and RB ≥ 0 percent. Experience has shown that trial is a function of awareness and positive attitudes, and repeat purchase is a function of experience-based positive attitudes. The next object is to demonstrate a procedure whereby values can be assigned to these terms.

In market research, dichotomous statements of purchase intent such as "yes" or "no" and "will" or "won't" have been found to be poor predictors of future behavior. In transportation planning, this is also true. The positive answers have usually overstated the results by a large factor. Because of this phenomenon, verbal scales—"extremely likely" to "not at all likely"—have been developed to express purchase intent. Thus, to estimate positive intention, it is necessary to present a description of the concept of the service change or innovation to a random sample of target-segment consumers—those persons the system is intended to serve. This process is equally applicable to fixed-route and non-fixed-route systems, transit, and paratransit. It also has the advantage of dealing with the total concept of the service product, including not only basic aspects, such as scheduling type of equipment and cost, but also amenities, such as shelters. It is important that the consumer be given a

meaningfully accurate description of the service on which to base his or her decision.

A simple mathematical formula has been developed for calculating purchase intenders (PIs) from the scalar response to a product concept.

PI = (0.5 x extremely likely) + (0.2 x very likely) (2)

However, it may be necessary to calibrate this function differently for transportation services. In a theoretical concept test, an awareness (A) among the sample respondents of 100 percent was induced, and trial rates at other levels of awareness can be estimated as shown below.

NT = 100%A x PI (3)

Estimate	Method
1	70% A x PI
2	50% A x PI
3	25% A x PI

This procedure will tell you the level of awareness that will be needed to induce sufficient trial of the service and give it a chance to succeed. This is very much an interactive model in that with each answer a new question can be asked. At this point, you can decide whether or not the concept can produce enough trial to be worthy of further testing.

Now we have estimates of trial but, to verify these estimates and calculate repeat buying, we must do a real in-market test because repeat purchase intention is based on actual experience. This is a key point—advertising can create awareness and induce positive trial intent, but the service itself must live up to expectations to create repeat buying. As an extreme example, ideal communications could create 100 percent trial, and poor product delivery could cause 0 percent repeat, so that at a postintroduction time, there would be no sales.

The in-market test can be one of two types: a vitality or a projectable test market. A vitality test market is one in which aspects of the test are artificially extreme, such as the incidence of the target segment in the population, and the level of communications used is much higher than could be expended outside the test environment. Such a test will induce abnormally high levels of awareness and trial, but will give good repeat estimates in a comparatively short time. A failure in a vitality test is usually irreversible. On the other hand, a projectable test market attempts to reproduce conditions exactly as they will occur in the total market. This produces accurate estimates of both trial and repeat purchase, but takes a longer time to do it.

In either case, it is next necessary to conduct another survey during the test market to determine the level of awareness in the target segment, the number who have tried, and the number who intend to try but have not done so yet; among the triers, we need to know those who have repeated and those who intend to repeat. By means of this research, the planner does not have to wait a year or more for the market to mature fully in terms of trial and repeat, but can use the research data to project the end results. By calculating the total estimated triers (TET) and the estimated repeat rate (ERR), we can produce a final estimate of demand (FED).

TET = actual triers + PIs (4)

ERR = actual RBs + repeat intenders (5)

FED = TETs x ERR (6)

This simple model has proven highly effective in predicting actual sales of many new products and marketing strategies. Its strength lies in its ability to reproduce the human decision-making process—positive attitudes predict positive behavior—and the key that unlocks the model is the verbal intention scale used in consumer surveys.

This process is summarized below and is being followed in the research and development project needs of the handicapped sponsored by UMTA.

Step 1: Analytically derive or hypothesize a need among a specific consumer target segment.
Step 2: Develop service concept(s).
Step 3: Test the service concept(s) through marketing research surveys to establish theoretical trial levels.
Step 4: Evaluate trial estimates to decide the workability of the concept.
Step 5: Introduce the concept into a test market.
Step 6: Conduct a survey among the target segment to establish awareness, trial intention, repeat use, and intended repeat use.
Step 7: Estimate the final demand for service.

Step 1 in this process is one possible link to the traditional transportation planning process. This is the point at which the identification of a consumer need is made. In consumer marketing, this identification is made through a situation analysis that uses secondary source material—e.g., population statistics or origin-destination studies—plus consumer attitude research. But it is equally possible to use the output of a transportation planning model at this point in the marketing process.

Step 2 takes the identified need and develops a service concept or set of concepts. These should be brief verbal (plus pictorial if possible) descriptions of the planned service innovation or modification. Although brief, the key elements of the service offer—the type of service, its frequency, its fixed-route or demand nature, whom it is intended to serve, cost to user, and such—should be included. As is being done in the study of the handicapped, the planner might want to create several different concepts aimed at the same need, each with different implied levels of service and different costs. By comparing the estimates of demand derived from these alternative concepts (step 3), he or she can then evaluate the cost-effectiveness of each.

Step 3 involves the exposure of the test concepts to a random sample of target consumers; that is, those whom the service is intended to serve. These samples can vary in size from a few hundred for a local route modification to a thousand or more as in the national study of the handicapped. From an analysis of the stated likelihood to try of this sample, the trial rate for each of the service concepts can be estimated. At this point (step 4), the planner must decide whether the level(s) estimated represent a chance for success of the service by the criteria that are being used to evaluate its feasibility (running at a profit, breaking even, or experiencing a given level of loss made up by subsidy).

Once the planner has decided that the concept is feasible in theory, he or she can introduce it into a test market (step 5). Either a projectable test market that in microcosm fairly represents the city, county, state, region, or country to be ultimately served or a vitality test market where the potential demand is known to be greater than that in the ultimate service area can be chosen. In either type of test, the reality of the service must be tested against the reaction to its verbal concept (step 6). Are the frequency, service, cost, and such as envisioned in the concept? Has the consumer been made aware; what are the actual trial rates; what are the repeat rates?

The answers to these questions must be gathered in another consumer study. The results of this research can then be used, not only to develop a final demand estimate (step 7), but also to modify and improve the service offering to enhance its appeal.

This may seem to be a complex, costly, and extended process, but many consumer marketers have found it to be less complex, costly, or extended than a process of trial and error.

ACKNOWLEDGMENT

I would like to thank Harvey Kreisberg of Chase, Rosen, and Wallace, for his help in preparing this paper.

Discussion

Robert B. Dial, Urban Mass Transportation Administration

I would like to begin by thanking Ronald Fisher for his introduction, all of you for the pleasure of being here, and Anthony Morgan for a clearly written and stimulating paper. Then, I will follow with a few of my conclusions and a stream-of-consciousness response to the paper, in support of those conclusions.

CONCLUSIONS

Morgan describes product metamorphosis in the world of marketing in six steps.

1. Research desires: We usually call this goal formulation. The planner attempts to elicit the transportation needs and goals of the persons in the study area and then translates those into objectives against which the proposed service can be judged. Most of this goal formulation is not done at the grass roots level as Morgan would recommend. For historical reasons, we have not greatly exploited attitude surveys; instead, we are very preoccupied with behavior surveys. When the highway planning process, from which we have inherited so much, began in the 1950s, there was an overwhelming desire for greater highway capacity. All that was necessary was to locate the highway, and a simple origin-destination survey was the instrument used. Unfortunately, because of the tremendous impact of our environment on our behavior, what we do does not correlate directly with what we desire. Our planning processes should make much more use of attitude surveys to investigate desires. By so doing, better transportation systems would be designed.
2. Develop a product: In transportation, this translates into design a system or a service. Here we look for a best network, highway, bus route, or other service to satisfy the desires uncovered in step 1. But, what is best? Unfortunately, the desires of the citizen are not always the overriding concern. They are often subordinate to those of the politician, the manufacturer, or the federal-grant administrator bureaucrat. But this is a fact of life and must be appropriately considered, both here and in step 1.

In its initial phases, the development of the plan must depend on the traditional macro or gross techniques outlined by Morgan. A network must be designed, and the complexity of the problem precludes simplistic approaches. Computers are and should be used to great advantage here.

After an initial plan has been developed, we can take it to the target market to obtain their reactions. Armed with network maps, hypothetical bus schedules, slides, movies, and perhaps even a computer terminal with access to a data base describing our proposed plan, we can demonstrate to the citizen our idea and explain its potential effect on his or her quality of life. Of paramount importance here is the awareness of the citizen of the implications of our plan: He or she can query us from his or her own unique but microscopic point of view, and we can survey his or her attitudes. In the case of public transportation, we are particularly interested in the expected demand for the service we are offering. In marketing terms, we want a system designed that has probabilities of trial and repeat that are high enough to justify the service. This is grass-roots citizen participation in the planning process.

3. Price it out: At this stage, the pricing out is the cost-estimation phase of transportation planning. By using the trial probabilities obtained in steps 1 and 2, we can more accurately estimate demand. With a demand estimate, revenue and fleet requirements can be calculated, and a net cost can be computed. (Needless to say, the results can cause great anguish and send the planner back to the drawing board or the bond broker.)
4. Distribute the product: At this point, we implement a subsystem. That is, we provide some service. Unfortunately, we as planners do not spend much time with a transit service after it has been implemented—except perhaps to consider its removal. Morgan advises us to use this introductory period for purposes of calculating the probability of repeat buying.
5. Promote its initial use: Before you can ask someone to repeat a purchase, you have to get him or her to buy it the first time. There must be a significant promotional effort with the introduction of a new service. Once the public has tried a service, they can be asked to use it again. That is how we calculate the probability of repeat buying; it is the sine qua non of demand forecasts in public transportation. Here, again, we have grass-roots citizen participation.
6. Advertise its continued use: Product demand changes. Different people try a product for the first time, and some repeat buyers stop repeating. We must continue to advertise our service to maintain the demand level. At the same time, we should continue to sample and calculate the probability of repeat buying so as to know where to invest our transportation and promotional resources and keep the citizen involved.

In summary, therefore, Morgan has described a commendable and affordable marketing approach that can effectively complement the technical planning process. The transportation planners' macromodels are complemented by the marketers' microsurveys. The simple, straightforward procedure outlined by Morgan can be used to help solve the three most vexing problems of transportation planners: demand estimation, cost estimation, and citizen participation. It is particularly powerful in the context of short-range planning.

SPECIFIC COMMENTS

What follows is a sampling of specific thoughts.

1. The two models described are less alternatives than they are complements. Both should have a role; they support each other's weaknesses. The proposed theoretical model may be somewhat too simple, but a simple beginning is preferable.
2. Service Planning and Marketing is a superb title. Product development, i.e., service design, is indeed

part of the marketing process.

3. The weakest part of the paper is its relatively trite treatment of traditional planning models. These models are the legacy of 1950s highway planning, and that was a time when more highways were needed and wanted. Increased income, improved automobile availability and technology, and the accumulated demand of the war years all created public support and a large budget for a national highway-improvement program. The only planning questions were where and how big to build. These questions were answered by using automobile origin-destination trip tables. These tables were obtained from origin-destination surveys, which were summarized to give present-day trip tables and projected to give future-day trip tables. The (trip-end) modal-split model was initially introduced to remove the bus riders from the trip table for the better estimation of automobile demand. As urban growth accelerated, the simple models were replaced by the gravity model and, later, when engineers were asked to plan transit services as well as highways, more elaborate (trip-interchange) modal-split models were developed and introduced into the process. These models also proved too crude, and more detailed (disaggregate) models were developed. Although it is true that these latter modal-split models can be calibrated with small samples, it has not yet been accepted that disaggregate models can accurately forecast total travel demand from only a small sample. The methods of disaggregate, direct demand forecasts still suffer some implementation difficulties.

4. Morgan could have related marketing to the traditional network design approach. Obviously, there must be a service designed, and it is a highly complex and variable package of goods that we are selling. It must satisfy many different needs and has different appeals to different segments of the market. Indeed, the government's impact is heavy here. To account for all these factors and design a cost-effective service is a challenging task. The market-survey tool is not sufficient for the whole job—although, combined with sophisticated network design models, it is a powerful aid.

5. Customer awareness is the most crucial factor. It is very doubtful that transportation planners do a satisfactory job in making the citizen aware of their transportation plans and the effect those plans will have on him or her. Thus far, awareness has revolved around the funding source (and this is as true for highways as for transit).

6. Of course, the product should satisfy potential users, rather than other groups, such as politicians and bureaucrats, but this is difficult in our political reality. Unfortunately, the transportation planned often has less to do with citizen needs and desires than it does with obtaining a federal grant. The whole planning process is affected by instances of overly stringent legislation and regulations, but perhaps the present move for greater decentralization of the federal process will lessen this problem.

7. Considering the small automobiles versus large automobiles example, it may be that our transit is a little like our small automobiles—badly built and for a misunderstood market. Also, we seem to think of both small automobiles and transit only in a crisis.

8. "Is transit a consumer good?" Of course it is (or perhaps it is a package of goods—and a package of job securities). It is not simply public or mass transportation. The specific product is determined by its service level. Different consumers purchase different products, depending on where they live, work, shop, and play, on how attractive and accessible the automobile-highway system is to them, and on the comfort, convenience, access time, line-haul time, and such of the transit system for them. These factors vary both geographically and sociologically.

9. "Marketing includes product design." This is an enlightening statement. It is the essence of the raison d'être of the paper. Initial research in consumer desires affects product design, trial survey results should affect product design, and repeat survey results (including a test system) should affect design. This would be real citizen participation.

10. In discussing his exemplary experience in Nashville, Morgan takes rhetorical liberties. Obviously, land use, income, and such factors did not change and, equally obviously, individual attitudes did change, but the most important change was the increase in bus availability. This should be emphasized.

11. Among the problems in executing a trial survey, the proper stratification of the potential users vis-à-vis the various service levels requires a sophisticated sample selection that is made easier by the use of the traditional network model and its data base. Another problem is that of providing an accurate portrayal of the (as yet unbuilt) proposed service to the interviewee. Here, again, the traditional models are useful. Computer-drawn maps, schedules, charts, and graphs are obviously useful, and a computer terminal that provides access to the planner's data base can help answer the citizen's questions concerning how the service will affect him or her personally. Finally, movies can dequantify the planning model output and depict expected service and land use. We must be sure the citizen has an accurate picture of the proposed service.

12. In-market testing should be a continuous process, so that system performance can be monitored and the probability of repeat use can be calculated.

13. Ascertaining attitudes is indeed crucial, although difficult, but even more difficult, and the heart of the problem, is forecasting attitudes. We want to correlate transportation service levels and socioeconomic characteristics with attitudes. Then we can use forecasting tools to help us design systems that maximize the expected number of highly likely and very likely users.

Sense of the Session Summary

Ronald J. Fisher, Urban Mass Transportation Administration

The consensus of the session was generally positive about the opportunity to use the methodology of commercial market research for transportation planning.

A major difference between the approach to designing new public transportation services presented by Morgan and existing transportation planning models is clearly stated in Dial's remarks that provide a nice complement to the research paper. Basically, as Dial notes, the current preoccupation is with behavior studies and goal-formulation exercises, and market research takes more of a grass-roots approach that uses attitude surveys to guide service design. Morgan's paper describes an approach to service design and modification by determining actual consumer responses during initial operations. The value of market segmentation was emphasized by several panel members, and the importance of follow-up surveys to identify reasons for repeat use, lack of repeat use, and lack of trial was brought out in the discussion.

There was relatively little disagreement about the need for market research. Perhaps the one area that

could lead to disagreement is that of determining more exactly how market research fits into the transportation planning process. The critical issue now is how to advance current planning practice by incorporating the market research techniques suggested in Morgan's paper. It was very encouraging to see such a large consensus at the session, which may serve as an historic bench mark in this regard. The direction in which short-range transportation planning methodology should move is clearly stated and, for the most part, agreed on. But, how long will it take us?

Labor, Paratransit, and Section 13c

Durwood Zaelke, Environmental Law Institute, Washington, D.C.

There are many legal and institutional strategies that transit labor can use to protect itself from unwanted innovation; this paper examines the specific protection given by section 13c of the Urban Mass Transportation Act of 1964. The paper begins with a description of the mass transportation system to which section 13c applies and then describes the use of competitive brokerage for the selection of new mass transportation services. It next discusses the historical context of section 13c and the application of this section to the acquisition of private mass transit companies by using Urban Mass Transportation Administration funds. Finally, the paper describes various applications of section 13c that affect paratransit innovation, including competitive brokerage, and recommends measures for ameliorating any adverse effects such applications may cause.

When trying to understand section 13c of the Urban Mass Transportation Act of 1964, one is tempted to search for some lawyerlike logic behind the statute's rather peculiar concept of giving mass transportation labor almost total job protection similar to the kind enjoyed by the railroad unions. But such a search provides more than the usual number of confusing detours, for section 13c is neither conceptually neat nor particularly logical. It is simply organized labor exerting pressure—first to have the provision included in the act and then to persuade the Secretary of Labor to interpret the provision in a broad and increasingly unwieldy way.

On the other hand, that section 13c lacks conceptual neatness and clear logic will not deter the courts from imposing some order when they are called on to interpret it. And there are several reasons that suggest why section 13c will soon be in the courts: (a) the constraints on the amount of state and local revenue available to run public transportation, (b) the growing competition among various transit and paratransit modes for limited Urban Mass Transportation Administration (UMTA) funds, and (c) the refusal by the U.S. Department of Labor to issue regulations imposing some reasonable limits on the scope of section 13c.

The intent of this paper is not to hasten the approaching lawsuits, but merely to suggest some equitable and logical bases for the courts to use in limiting the effects of section 13c. The paper begins by describing a systems view of transportation and the use of competitive brokerage to select new mass transportation services.

SYSTEMS VIEW OF TRANSPORTATION

Broadly speaking, a transportation system can be described as (a) a family of types and levels of transportation services, (b) allocated through some matching mechanism, (c) to serve distinct service markets. Innovation and improved system efficiency can come not only from improved hardware, but also from better techniques for identifying distinct consumer markets, better mechanisms for matching services with markets, and a more comprehensive view of the available services that make up the system.

It is encouraging that it is now being recognized that not only mass transit, but also the transportation services provided by private automobiles, taxis and other paratransit, pedestrians, and bicyclists are all elements of a single system. It is also being recognized that the goal of transportation policy should be to achieve maximum efficiency for the system as a whole. This is the perspective of the Joint Urban Mass Transportation Administration-Federal Highway Administration Planning Regulations [40 Federal Register 42 976 and following (September 17, 1975), 23 Code of Federal Regulations (CFR) section 450, and 49 CFR section 613], which assign to the metropolitan planning organization (MPO) the task of coordinating the transportation services of an area to achieve system efficiency.

This multimodal-system viewpoint contrasts with the earlier bimodal viewpoint that considered only highways and mass transit. Under the bimodal viewpoint, mass transportation generally was synonomous with conventional mass transit. This simplified the allocation of UMTA funds, which are limited to mass transportation. The only competition for funds was among urban areas, and here the use of formula grants helped UMTA avoid many difficult choices.

Today, however, the competition between conventional mass transit and other potential mass transportation services is making it increasingly difficult for UMTA to determine which service modes within a comprehensive system should be funded. This question is central to the analysis of section 13c, because the labor protection required by this section must be provided only by mass transportation services funded by UMTA.

In addition to the difficulty of determining what mass transportation is for the purpose of UMTA funding, there is the semantic problem associated with the term paratransit. Paratransit is sometimes used loosely to describe the entire range of transportation services between the private automobile and conventional mass transit. Because paratransit literally means "resembling or similar to transit," one could think that all paratransit services are also mass transportation services and eligible for UMTA funds. But this is not the case. Under UMTA's proposed definition of paratransit, the eligible services considered to be nontransit mass transportation include only some of the services between conventional transit and the private automobile: dial-a-ride, jitneys, community minibus, subscription bus service, some van pools, and other shared-ride services that are regularly available to the public [41 Federal Register 46 412 (October 20, 1976)]. A service is regularly available to

the public if it cannot be reserved for the private and exclusive use of an individual passenger. This definition specifically excludes exclusive-ride taxi services and for-hire limousines. (In the discussion below, the term paratransit will be used to denote nontransit mass transportation services only.)

PARATRANSIT AND COMPETITIVE BROKERAGE

By forcing the consideration of paratransit, a system viewpoint of transportation will facilitate its expansion. In just this way, the expansion of paratransit is being fostered by the systems perspective advocated in the joint planning regulations.

Under these regulations, the MPO is given the responsibility for coordinating the planning and decision making for the entire transportation system of an urban area. Because this role provides the MPO with a unique opportunity to influence the matching of services with markets, it is similar to the function of a broker (1). However, the function of the MPO falls far short of true brokerage because the MPO rarely has authority to implement services and must rely on transit districts, state departments of transportation, or other such agencies to operate services.

The joint regulations specifically mandate the MPOs to consider existing private mass transportation services, including jitneys and other flexible paratransit services. Only paratransit services that are included in official MPO plans can receive UMTA funds (and thus require a section 13c agreement).

In addition, UMTA's proposed policy statement on paratransit indicates that the annual review of the official MPO plans will verify that adequate consideration has been given to paratransit. The policy statement also indicates that, consistent with the Urban Mass Transportation (UMT) Act of 1964, the MPOs are to "encourage the maximum feasible participation of private enterprise" in preparing their official plans and in providing subsequent paratransit services.

The requirement for "maximum feasible participation of private enterprise" is satisfied, according to the proposed policy, when new paratransit services are selected by using a competitive brokerage process that offers taxi operators and other private transportation providers full opportunity to bid for the new service.

Although this paratransit policy has not yet been finalized, competitive brokerage is already being used to select new paratransit services in several urban areas (e.g., the Orange County, California, system).

In competitive brokerage, the broker can be either the MPO, a local government agency such as the transit authority, or a joint venture of the MPO and a government agency. The functions of the broker should include

1. Identifying the travel market,
2. Specifying the desired level of service (travel time, wait time, fare, and comfort),
3. Specifying the criteria that will be used to evaluate proposals or bids for serving the market,
4. Requesting a statement of qualifications from potential service providers,
5. Requesting proposals for providing the service,
6. Evaluating proposals against the specified criteria,
7. Contracting with the organization submitting the best proposal, and
8. Monitoring the service.

The service providers prepare competitive proposals in response to the broker's request, and the successful organization provides the new service.

Competitive brokerage offers the opportunity for selecting new services not only on the basis of direct costs, but also on the basis of indirect costs such as the social cost of environmental damage. Indirect costs can be considered by carefully selecting and weighing the criteria for evaluating proposals. Although considering social costs makes brokerage more complex, paratransit advocates (and environmentalists) should insist that it be done—because it will demonstrate more fully the inherent advantages of paratransit for many new markets. It will also make brokerage more compatible with the selection of transportation control strategies under the Clean Air Act Amendments of 1977.

The process for evaluating the service proposals is similar to that used by the federal government to evaluate research and development contract proposals. The criteria for evaluating research and development proposals are divided into two categories: technical and cost. The technical criteria for transportation brokerage might include the following:

Possible Criterion	Possible Weight (%)
Ability to provide requested level of service (understanding of market; understanding of requested service; reasonableness of management plan; type, number, and condition of vehicles and other equipment and facilities; and quality of maintenance program)	40
Effect of proposed service on energy use; air, noise, water, and visual pollution; congestion; land use (including residential and commercial displacement); and employment	30
Qualifications of provider (experience and financial responsibility)	20
Implementation schedule	10
Total	100

After the bids are evaluated against the technical criteria, all those within an acceptable range should be evaluated against cost criteria. Cost proposals should be submitted separately and include detailed information on cost per vehicle service hour and any start-up cost such as training. Generally, the technical bid that offers the lowest cost should be selected; however, the broker should be able to choose a higher cost bid if it offers a significant technical advantage.

The success of the brokerage approach for a particular application depends on many considerations. These include how accurately the broker can identify the specific markets that are to be served and, especially in the early applications of the approach, how many service providers can be induced to bid for the market and how capably they prepare their bids.

Brokers can minimize these difficulties by providing early notice of the competition, requesting preliminary statements of qualifications from all likely providers, and drafting clear and precise requests for proposals. Brokers might also hold preproposal conferences to inform potential bidders about the mechanics of preparing proposals, the criteria that will be used to evaluate the proposals, and the general level of service desired. Such conferences would allow the broker to answer questions, which is more difficult to do after a request for proposal has been issued.

Brokers should learn as accurately as possible what the requested service should cost so that the bids can be evaluated against an objective standard as well as against each other. This is especially important when brokerage is first being tried, and few bidders are responding.

If we assume that the new markets are precisely identified and the brokerage approach (or other matching mechanism) functions efficiently, the result should be a significant increase in the use of paratransit. The reason

is simple: For many new markets, some form of paratransit will offer the most efficient service at the lowest cost.

However, because labor costs are such a significant part of transit and paratransit operating costs, the increase in labor cost that accompanies the use of organized transit labor can cancel most of the advantage of paratransit. For this reason, the posture of labor, especially organized labor, toward paratransit is often the key to successful paratransit innovation.

SECTION 13c: HISTORICAL SETTING

Before the enactment of the Urban Mass Transportation (UMT) Act of 1964, almost all urban transit systems were owned privately. As private systems, labor-management relations were controlled by the National Labor Relations Act (NLRA) of 1935, and employees were guaranteed the right to organize, seek recognition, and bargain collectively (2, 3).

Suburbanization and the dramatic increase in automobile use caused transit ridership to decrease by more than 70 percent between 1945 and 1970. The loss of revenue passengers caused service reductions that, in turn, caused total union membership in the transit industry to decrease by more than 40 percent. Nevertheless, during this difficult period, transit unions succeeded both in maintaining the earning position of their members relative to that of other workers and in winning increasingly favorable (and inflexible) work rules.

The government responded to the decreasing service and growing threat of bankruptcy to many private firms with the most salutary of all government responses: money—first to help the private systems continue what was recognized as an essential public service and then to acquire the systems under outright public ownership. Most of the government money was provided by the UMT Act. It might be thought that the transit unions would have accepted the money gladly and without question, coming as it did when union membership was decreasing rapidly and when many private systems were facing bankruptcy. But such was not the case.

On the contrary, the unions felt threatened by two aspects of the UMT Act. First, they feared that UMTA research and development funds might lead to automation and loss of jobs. Second, they feared that public acquisitions using UMTA money would result in the loss of the right to bargain collectively, a right that the unions enjoyed under private ownership.

While the fear of automation seems exaggerated even today, the fear of losing the right to bargain collectively was well-grounded. The labor protection afforded by the NLRA was lost when a private system became public. Before 1964, this loss meant that transit employees were then controlled by state laws governing public-employee labor relations, many of which prohibited collective bargaining. Some states provided some labor protection, but substantially less than the NLRA.

To protect the collective bargaining rights won when transit was privately owned, the unions made it clear that they would support the UMT Act only if labor was adequately protected. Private transit management had long accepted collective bargaining and saw no reason to object to its continuation. Nor did city managers, who were assured by organized labor that no real burden would be placed on any local community by protecting labor and yet to try managing their transit system.

SECTION 13c: STATUTE AND PROCEDURES FOR CERTIFICATION

Section 13c addressed labor's fears by requiring the recipient of a grant under the UMT Act of 1964 to negotiate an agreement with the relevant transit union to protect any employees affected by the grant. The protective agreement mandated by the statute is required to be fair and equitable and to

1. Continue the right to bargain collectively,
2. Preserve rights under existing collective bargaining agreements,
3. Assure employment to employees of acquired systems and priority of reemployment to terminated employees,
4. Provide for paid retraining programs, and
5. Indemnify individual employees against a worsening of their employment condition.

Under section 13c, the Secretary of Labor, rather than the Secretary of Transportation, is given the authority to determine whether a protective agreement (the so-called section 13c agreement) includes the requisite protection and is fair and equitable. The procedures for making this determination, or certification, are described in guidelines issued by the U.S. Department of Labor (DOL) [42 Federal Regulation 3319, to be codified in 29CFR section 215 (January 18, 1977)]. Briefly stated, the guidelines request that applicants for UMTA funds (a) estimate the effects the funds will have on existing mass transportation employees, (b) identify any labor unions representing these employees, and (c) describe any steps already taken to develop the section 13c agreement. Typically, the only effects listed on applications are beneficial; the applicants do not want to alert affected employees about potential claims.

When a completed application is received by UMTA, a copy is forwarded to DOL, which, in turn, forwards a copy to any relevant union. At this point the union and the applicant are expected to negotiate the specific protective terms to be contained in the section 13c agreement. The negotiations are to be in good faith and a time limit can be set to offset the advantage a union may gain by delay.

When the agreement has been negotiated, DOL then reviews it to ensure that it satisfies the statute. If it does, it is certified by the Secretary of Labor and returned to UMTA. If it does not, the Secretary either returns it to the parties for further negotiations or sets forth the protective terms himself or herself. Similarly, if the parties are unable to agree on the terms, the Secretary will impose whatever terms he or she finds to be fair and equitable. Finally, if the affected employees are not represented by a union, the Secretary unilaterally imposes the protective terms.

SECTION 13c: APPLICATION

Applying section 13c to the UMTA funding program is becoming increasingly complex, and the worst is apparently yet to come.

Some initial complexity can be avoided by grouping together the provisions of the statute that seem legitimately to apply only to the case where UMTA funds are being used to acquire a private mass transit system. These include the provisions to

1. Continue the right to bargain collectively,
2. Preserve rights under existing collective bargaining agreements,
3. Assure employment to employees of acquired sys-

tems and priority of reemployment to terminated employees, and

4. Provide for paid retraining.

The first three of these provisions concern rights that were held by existing private transit unions before the acquisition; these rights are merely continued by section 13c. The fourth right (paid retraining) appears to be only to enforce the third (assurance of employment for employees of acquired systems). Because these four provisions should apply only to the case of an acquired private system, they should not directly concern paratransit or other new services. However, when a new paratransit service is to be managed by the same management that is operating the existing transit service, the section 13c agreement for the new service must be considered in the context of the existing labor-management relations, including any existing section 13c agreement.

The remaining provision of section 13c is the right of individual employees to be indemnified against a worsening of their employment condition. This indemnification right did not exist under previous collective bargaining agreements; to the extent it exists at all, it was created by section 13c. The right to indemnification has been applied to acquisitions, as have the other provisions, as well as to the receipt of UMTA operating money (Figure 1). In addition, it is the 13c right that most often arises in the context of paratransit or other new services.

Indemnification has two aspects: the right to new jobs and the protection of existing jobs.

Jobs

Whether a new paratransit service is managed by transit management or by other management, section 13c does not give the transit union any right to the new jobs. On the other hand, in both management situations, the fact that a section 13c agreement must still be negotiated with the transit union means that the union may have the opportunity to win the new jobs during the negotiations. Management may be able to foreclose this opportunity, however, by determining in advance of the negotiations such conditions as who is to get the new jobs and at what wages. This could be done by selecting the service provider through competitive brokerage before conducting the negotiations with the union.

When a new paratransit service is to be managed by an existing transit management, the existing labor-management relations may provide the union with other opportunities to assert jurisdiction over the new jobs (Figure 2). For example, the existing collective bargaining agreement or other section 13c agreement (e.g., paragraph 23 of National Section 13c Agreement for UMTA Operating Assistance) may contain a provision granting the transit union exclusive jurisdiction over all new jobs. Where such a right does exist, job classification, wage rate, and such generally will be determined by collective bargaining.

Having a new paratransit service managed by an organization that is separate from the transit organization is the easiest way for the new service to take advantage of nonunion labor and the accompanying lower costs and greater flexibility (Figure 3). A similar type of operation is used successfully in the construction industry to take advantage of nonunion labor. The construction unions have (unsuccessfully) challenged this practice, claiming that the management of the nonunion operation was controlled by the management of the union operation and should be required to abide by the existing collective bargaining agreement that gave the union the exclusive right to all jobs. Similar objections can be expected from the transit unions. Tests developed under the Memphis formula may be helpful in resolving the issue.

If the new paratransit jobs are union and the conditions (job classifications, wage rates, and work rules) are the same as those of transit, the cost advantage of using paratransit to serve the new market may be largely lost. However, in at least one case (Cleveland), where an earlier paratransit service had been awarded to a taxi operator after competitive bidding, the transit union agreed to a new job classification for service to the elderly and handicapped. This resulted in wages that were one-third lower than transit wages and in more flexible work rules.

When transit management manages a new paratransit service, the new job classifications, lower initial wages, and more flexible work rules such as were obtained in Cleveland probably represent the most favorable labor conditions that management can expect. A possible danger in this approach, however, is that the union may demand in subsequent collective bargaining sessions that the wages of the paratransit employees be equalized with transit wages. What the Cleveland union does will be instructive. This problem might be solved by limiting the term of the initial contract to 3 to 5 years and then using competitive brokerage before renewing (or not renewing) it (giving due consideration to the acquired experience of the existing provider).

The example of Cleveland illustrates another significant factor: the effect of potential competition. The question is this: How important to the outcome in Cleveland was the union's fear that unless it relaxed its work rules and lowered its wage rates, the new service and jobs would go to a competitor such as the local taxi operators?

In public-sector wage determinations, the absence of the budget ceiling imposed by competition is often accused of inflating union wages and benefits and contributing to the fiscal crises of many cities. However, in most public services, wage increases are at least constrained by the aversion politicians have toward increasing taxes to expand the municipal budget (4). To the extent that UMTA (and state) funds are available to subsidize wage increases for transit employees, even this control is absent. The use of competitive brokerage, however, offers the opportunity to change this.

Indemnification

The complex issue of indemnification is closely related to the issue of jobs. Indeed, the basic right (if it exists) is to be protected under certain circumstances from losing one's job or from being forced to accept a lower paying job. Accordingly, if the transit union is successful in asserting jurisdiction over the new jobs and obtaining equal wages and working conditions, the transit employees are completely indemnified. Even if the new paratransit service is so successful that it drives the existing transit service out of business, the corresponding expansion of the new service will absorb all displaced employees (given a similar ratio of riders to operators).

This is total indemnification for transit employees. But what of other mass transportation employees who lose their jobs because of competition from the new paratransit service? Must they be indemnified also? Thus, we come to the question, Who must be indemnified by whom and from what harm?

What Harm

There appear to be at least three types of harm contemplated in the UMT Act of 1964. The first is the possi-

bility that collective bargaining rights and jobs may be destroyed either from the direct acquisition of a private system or by automation. The second is the possibility that a new public service will compete so directly with the existing private service that state or local law will find an inverse condemnation and require just compensation. (This is contained in section 3e of the UMT Act and is separate from section 13c.) The third (if indeed it was contemplated at all) is the indirect harm caused by UMTA-funded competition.

Funding new paratransit with UMTA money generally presents the issue of indemnification against indirect competition. For example, UMTA-funded paratransit may attract riders from existing mass transportation services in such numbers that the existing service is forced to reduce its work force in advance of natural attrition. Presumably, if the existing mass transportation service is privately owned, section 3e will require compensation in those cases where the competition is so severe that state or local law finds an inverse condemnation. However, without a specific buy-out statute, considerable diminution in the value of the private service will be allowed before an inverse condemnation will be found under a state constitution.

While compensation paid to a private service will probably not benefit the employees, it is not at all clear that section 13c indemnification was intended to protect employees in this situation. The employees are, after all, free to demand such protection from private management in the event of a future buy out. Similarly, when

Figure 1. UMTA money for public acquisition of private transit system; effect on union employees.

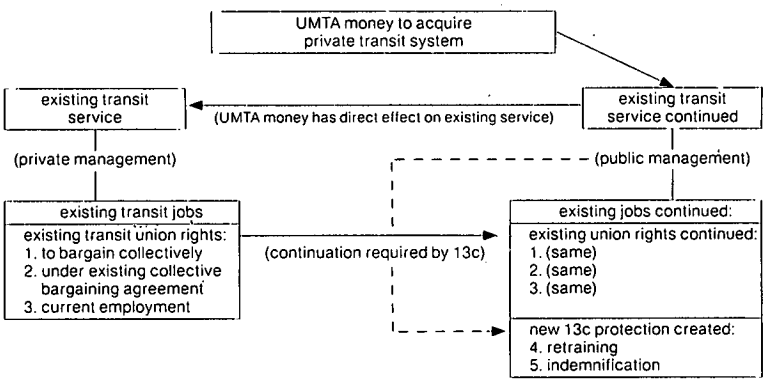


Figure 2. UMTA money for transit and paratransit with same management; effect on union employees.

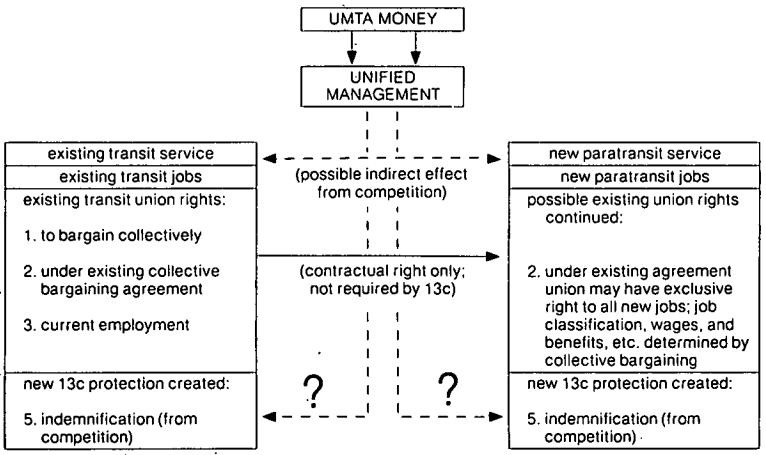
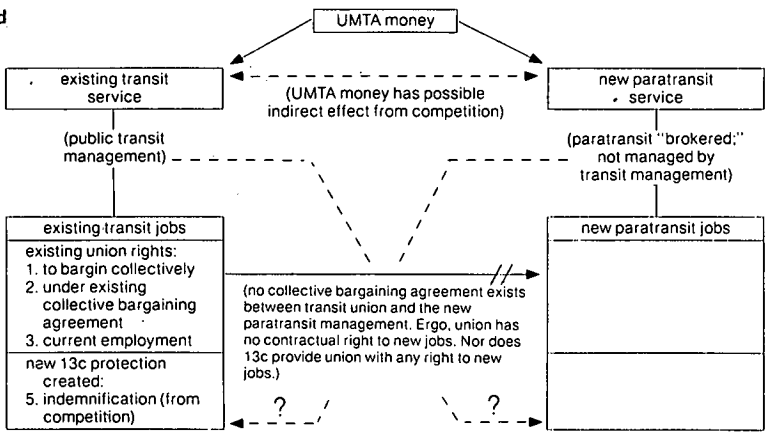


Figure 3. UMTA money for new paratransit not managed by transit management; effect on union employees.



UMTA-funded competition with an existing private service is not so severe as to require compensation under section 3e it is not clear that section 13c indemnification applies. It may be that the only protection against competition available to private systems (and their employees) is section 3e. Possibly, the need for this compensation could be reduced by giving the existing private service the right to bid for the new service with which it might otherwise be forced to compete.

Because section 3e is expressly limited to private systems, protection for existing public mass transportation service must come, if at all, from the indemnification provided by section 13c. But even to suggest that public transportation services indemnify one another seems absurd.

Obviously, competitive harm will not occur so long as new services grow by inducing new travel or by attracting riders from services that do not have paid drivers (especially private automobiles). Indemnification would not be necessary if automobile restrictions were imposed and their drivers forced into mass transportation.

Nor will competitive harm occur if the services agree to avoid competition. Accordingly, many section 13c negotiations have addressed indemnification by agreeing in advance to avoid competition. This is done in several ways. One is to keep the new market geographically separate from the existing market. Another is to separate the markets by time of day; thus, new paratransit service might be limited to off-peak hours. Finally, markets can be kept separate by limiting the type of service in terms of fare and level of service. High-fare, high-service-level (door-to-door) paratransit does not compete with line-haul transit. Nor does service to the elderly and handicapped. By requiring the careful and precise selection of markets for new services, the use of competitive brokerage can limit competition.

The dilemma that arises from limiting competition by indemnifying existing mass transportation employees from competitive harm is that it seems desirable for a new service to attract riders not only from automobiles, but also from any existing service that is less efficient or that imposes greater external social costs (such as environmental damage or congestion).

However, to the extent that only some services are eligible for UMTA funds or other subsidy, it may be inequitable to rely exclusively on the market (the consumer) to determine which service is most efficient. For example, one service may capture a larger market share and appear more efficient only because it receives a larger UMTA (or other government) subsidy. In addition, the market is not an effective judge of external social costs.

Who Is Indemnified and by Whom

Originally, section 13c indemnification appears to have been concerned exclusively with protecting unionized mass transit employees. UMTA funds threatened private mass transit employees most directly, especially when used for acquisition, and the transit unions themselves proposed section 13c as a remedy. It seems fairly clear that little thought was given to any other transportation employees. Similarly, originally, only transit management could have been expected to provide section 13c protection, including indemnification, because only transit management was in a position to harm employees.

However, now that paratransit is receiving UMTA funds, new issues have arisen. These include (a) whether new mass transportation services (limited here to paratransit) must give indemnification to existing mass transportation employees, (b) whether indemnification is owed to the new service by existing services that have received UMTA funds, and (c) the way in which indemnification, if it is not owed to all existing services by all new services, is to be limited?

The effective limit on who will be indemnified is, of course, who loses a job because of competition funded with UMTA money. But it must be kept in mind that indemnification (and all section 13c protections) has two fairly distinct aspects. The first is the agreement itself, which is intended to be prophylactic; it is an a priori determination of which employees will be protected and what protection they will be afforded. The second is the actual adjudication of claims under the agreement. Because the burden of proving harm under a section 13c agreement is so heavily weighted in favor of the employee, it is especially important to limit the number of eligible employees. Similarly, limiting the number of eligible employees is necessary because the indemnification must provide at a minimum the protection specified under a provision borrowed from the railroad unions section 5(2)f of the Interstate Commerce Act of 1936, which gave a harmed employee his or her full salary for 6 years from the time the harm occurs (earlier agreements specified that the protective period would begin when the money was received, not when the harm occurred).

The first attempts by UMTA to limit the number of employees entitled to indemnification is based on the restriction that only mass transportation services are eligible for UMTA funds. No distinction is made between private and public services, except that private services can only receive UMTA money indirectly (i.e., through a public organization). The next step is the postulate that if a service qualifies as mass transportation for funding purposes, such service is competing in the mass transportation market and thus should be extended indemnification against competition from other services that are receiving UMTA funds.

This reciprocity has an attractive symmetry. For example, if UMTA money can be used to subsidize a new paratransit service that competes with an existing shared-ride taxi service and destroys taxi jobs, the taxi employees may need indemnification. In this case, however, are the taxi employees also owed indemnification from competition caused by other UMTA-subsidized services that are not as similar to taxi service and that compete less directly? [An example that has been used is a new, UMTA-funded subway that competes indirectly with the private taxi service (5). If reciprocity is again followed, the taxi service will have to be indemnified from competition caused by any service that is receiving UMTA money.]

Similarly, reciprocity would seem to require that the newly funded paratransit service would also have to provide indemnification to all other services that are eligible for UMTA funds (i.e., shared-ride taxi services and other mass transportation services). This quickly becomes unmanageable. Consider whether a new paratransit service that fails because of competition from the existing UMTA-funded service deserves to be indemnified; reciprocity would seem to require it.

Clearly, reciprocity is not an adequate basis for determining who is to be indemnified by whom. If all UMTA-funded services owe indemnification to each other, there will be an exchange of indemnification. One can almost imagine a market for transferable indemnification rights that are freely traded by management and employees. As more and more services that are eligible for UMTA funds (i.e., mass transportation services) begin to receive them, such an exchange may become possible, although no less absurd.

But if indemnity is not owed to all services eligible

for (or receiving) UMTA funds by all services receiving UMTA funds, then how can it be limited?

SUGGESTIONS FOR LIMITING THE APPLICATION TO PARATRANSIT OF SECTION 13c

The first suggestion for limiting the application to new paratransit of section 13c is to eliminate it entirely. Although the history of the administration of the section is, of course, to the contrary and the unions will protest, there are many reasons to think that section 13c was not intended to cover paratransit.

The first reason is that section 13c seems to have been intended only to provide protection against direct harm that worsened or eliminated jobs or that threatened to destroy collective bargaining rights. It is against public policy to indemnify existing services against indirect competitive harm. Even if indemnification had been appropriate when UMTA subsidies were available to only some mass transportation services, this is no longer the case; UMTA subsidies are available to all mass transportation services. To the extent that a service is eligible for UMTA funds it should be estopped from receiving indemnification from competition that also receives UMTA funds. The protections available to the private taxi company that may be losing jobs to UMTA-subsidized competition are to request compensation under section 3e or its own UMTA subsidy (e.g., by bidding successfully for the new paratransit service). The opportunity to bid for the new service that uses UMTA funds may be all the protection that is needed; if the existing service cannot provide the new service most efficiently, perhaps it should not provide it at all.

The second reason why section 13c indemnification should not apply to paratransit is that, when the new service is managed by an organization that is separate from the transit management, the new management does not have direct control over the harm to the threatened employees of the existing competitors. This differs from the situation in which UMTA funds are used to acquire an existing private service or to automate a service and the new management has direct control over any harm to its employees. It is both more difficult to control indirect competitive harm and more difficult to prove the cause of the harm. More important, there is no compelling reason for management to limit competition by providing indemnification. Indeed, there may be greater benefits from encouraging such competition. Again, this differs from the case of acquisition, where section 13c may have been necessary to prevent the new management from directly destroying existing collective bargaining rights.

Finally, indemnification from indirect competitive harm is not a right that existed before section 13c; it did not exist under prevailing collective bargaining agreements (nor could it have). If the overriding intent of section 13c is to ensure that the employee will be as well off in his or her relationship with management under public ownership as he or she was under private ownership, section 13c should not apply to protect such employee from harm that is outside the control of his or her management and thus outside the purview of collective bargaining.

This view is supported by the language of the related provision that protects labor from any adverse effects of demonstration projects (16 U.S. Code section 1634). The language of the demonstration provision, which is neater and more logical than section 13c, requires protection only for the employees of the system receiving the demonstration funds and only from the management of such a system. No other systems or employees are indemnified from competition caused by the demonstration.

In addition to the optimistic position of withdrawing the application of section 13c to paratransit, there may be other ways to limit the operation of indemnification. These include the following: (Of course, only mass transportation services that are receiving UMTA funds must provide indemnification.)

1. Indemnification should be provided only to mass transportation services that are not receiving UMTA funds; this is the group most in need. Either indemnification or UMTA funds should be given, but not both.
2. If indemnification is to be provided to mass transportation that is receiving UMTA funds, a waiting period should be established before a new, UMTA-funded service becomes eligible for indemnification (although the new service might be required to indemnify other services immediately).
3. Indemnification should not be required for any private mass transportation service; private service is entitled to compensation under section 3e and to maximum feasible participation in providing new services and has no control over other mass transportation employees.
4. Indemnification should be provided only to employees of conventional fixed-route mass transit services. The legislative history supports this view. Labor itself argued that it needed railroad-type protection because transit was so similar to the railroads, and an early version of section 13c submitted by labor would have protected future employees. By omitting this language in the final version, Congress indicated an intent to protect only employees then existing—i.e., fixed-route transit employees.
5. The only indemnity provided should be a guarantee to maintain the size of the relevant bargaining unit for a specified period of time, beginning with the receipt of UMTA funds.
6. Indemnification should be provided only to mass transportation that will be competed with directly. For example, the private taxi company should at most be indemnified by UMTA-funded paratransit, not by an UMTA-funded subway.

As many persons have recommended, DOL should issue regulations that specify the precise circumstances under which section 13c applies (6). These regulations should also provide guidance on the specific terms to be contained in specific section 13c agreements. Leaving the terms solely to local negotiations has given the transit unions far more power than they had before public acquisition (and far more than seems fair and equitable). Similarly, the regulations should specify what terms will be imposed if the parties cannot agree. If DOL and UMTA cannot or will not agree to issue criteria, a petition for rule making would seem appropriate. Another alternative would be an executive order that would form the basis for UMTA and DOL to issue criteria.

Finally, UMTA should consider establishing a separate cost account for the administration of section 13c and any indemnification that is required. This would allow a more explicit accounting of the true cost of extending such elaborate protection to labor. It would also encourage new services to accept the consequences of indemnifying competing employees whom they drive out of business and would lessen the inhibitory effect section 13c has on innovation.

CONCLUSION

Many forces, including the systems viewpoint of urban transportation, are forcing a fuller consideration of paratransit. Although paratransit poses some threat to ex-

isting line-haul markets served by conventional mass transit (especially deficit ridden markets), its greatest threat is in capturing many new markets that otherwise would have gone to transit.

Not surprisingly, the possibility of missing out on these new markets and new jobs is causing transit unions considerable concern. But, aligned against the unions' interest in the new jobs is an impressive array of other factors, many of which are related to the need to reduce our dependency on the private automobile. Concern about air, noise, and visual pollution; energy use; congestion; and other unintentional social costs of automobile use have made it clear that public mass transportation must be expanded in a way that will attract private automobile users. Because paratransit is more flexible and offers a higher level of service, it has many inherent advantages over conventional mass transit for serving the automobile market.

At the same time that paratransit is being recognized as a possible alternative to the private automobile, the fiscal crises of many cities are causing general budgetary restraint and there is a growing understanding that UMTA capital and operating funds are also limited. The result of these fiscal constraints is that paratransit and conventional transit are competing not only for new jobs, but also for a limited and fixed amount of government subsidy.

A final factor favoring paratransit is the use of competitive brokerage to select new mass transportation services. By removing the institutional advantage existing transit would have for gaining new markets, competitive brokerage promises to reward the inherent advantages of paratransit, including its lower labor cost.

Against these factors is section 13c, which the transit unions are using both to block paratransit expansion and to gain control of any new jobs. While there is wide disagreement on the extent of the problem, section 13c clearly slows innovation.

But innovation will occur, and the unions have already shown, as in Cleveland, that they can be flexible enough to compete for many new markets. Flexible work rules should be a concession the unions continue to make to win new jobs. New job classifications should also be expected.

The central role of the MPO in promoting paratransit expansion makes it an ideal forum for resolving many of the debates about section 13c. In fact, many of the issues arising under section 13c are political in nature and belong more properly in the political forum provided by the MPO. It is, for example, a local political decision how to allocate UMTA money among different mass transportation services. It may also be advantageous to use the political forum to set wage rates for transportation services; a fixed budget ceiling should be the concern of all city managers. It is also a political decision to determine which transportation jobs are affected and how they are to be protected.

For these reasons, the MPO may have an increasing role in the section 13c process, from assisting management negotiate specific agreements to providing a specific account to pay claims. The MPO's political composition gives it needed authority and flexibility, as well as a concern for budgetary matters that is greater than many transit managers'.

The MPO is also in a good position to encourage trade-offs between new jobs and security for existing jobs. Agreements that are collateral to section 13c could also be used to advantage by the MPO. These agreements might set forth existing transportation conditions other than UMTA funds that can affect employees, facilitate reemployment of terminated employees, provide for the sharing of liability for claims, and keep accurate cost accounts of all claims.

In conclusion, even with the possible protection of section 13c, transit unions are being forced to be flexible to accommodate innovation and continue to expand. However, removing the application of section 13c to paratransit would accelerate this process without any serious harm to the unions.

ACKNOWLEDGMENTS

The National Science Foundation and the Urban Mass Transportation Administration supported earlier research on section 13c; Christine S. Lipaj provided a great deal of valuable research. Of course, the views expressed are mine only.

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Requirements for Paratransit Vehicles

W. G. Atkinson, N. D. Lea and Associates, Vancouver, British Columbia

The current state of the art of paratransit vehicles—the sizes and types used, the operating constraints, guidelines for size selection, a vehicle-tender selection process, current trends, and forecasts of the evolution of vehicle design over the next 10 years—is discussed. Action is suggested to reduce uncertainty over individual vehicle performance and improve utilization and design. Vans and integrally designed small

buses have proven more reliable than other types of vehicles; their use in Canada and the United States is discussed. The selection process described is used to analyze four theoretical vehicles being reviewed for procurement. The analysis shows that the most cost-effective vehicle could be a bus with the highest initial cost or a low-cost van.

A great variety of sizes and types of vehicles are currently being used in paratransit service. These include

1. Taxis and limousines (Checker Marathon and Aerobus models),
2. Vans (Fortivan, Transporter, and Maxivan),
3. Station wagons (usually for handicapped persons),
4. Modified recreation vehicles (General Motors small bus at airports and Winnebago),
5. Small buses on truck or recreation-vehicle chassis (Fleury, Flxette, Urban Transportation Development Corporation Club Car, Transcoach, Grumman, and Minibus),
6. Small school buses (Thomas, Bluebird, and Superior), and
7. Integral small-bus designs [Argosy, General Motors (series 30), Twin Coach TC-25, FMC Corporation, Rohr Flxible (series 30), and Mercedes-Benz 0309D].

The integrally designed vehicles (vans and some small buses) have been the most reliable from the point of view of the operator. Small buses created by designing a body shell and mounting it on a truck or recreation-vehicle chassis have more problems because the bodies are often too heavy for the available chassis, which results in premature brake and suspension failures and excessive maintenance costs. Many custom bus builders have gone out of business because of problems such as these.

In the United States, components for short drive trains, which are necessary for building a bus with a heavy-duty, low-profile chassis, are not readily available. To extend the life of the running gear, either a high-floor chassis must be used or the body mass must be lowered. FMC Corporation has achieved a low-profile bus through a special body design, and low-profile buses are being built in Europe (1).

Size requirements are usually based on either legal constraints (e.g., the case of taxis) or the maximum demand expected. In many cases, a larger vehicle than necessary is used by operators who are playing safe or do not want to purchase a new model for their vehicle fleet.

A general rule for selecting the sizes of buses for local collection-and-distribution service (the most common use) is given below (1 km = 0.6 mile).

Length of Vehicle Tour		
Time (min)	Distance (km)	Type and Size of Vehicle
15	<4.8	Taxi or 9- to 11-passenger van
20	<6.4	11- to 14-passenger van
30	<8	18- to 24-passenger bus
40	<16	24- to 35-passenger bus
60	<16	35- to 50-passenger bus

For communities of fewer than 50 000 persons, the following other factors should also be considered ($1 km^2 = 0.39 mile^2$).

Peak-Hour Demand (no. of passengers)	Vehicle Size (no. of passengers)
<100	6 to 11
100 to 200	11 to 15
200 to 500	22
>500	30

Peak-Hour Demand per Square Kilometer (no. of passengers)	Vehicle Size (no. of passengers)
<10	6 to 11
<20	15 to 22
>20	30

Experience with a variety of small vehicles in Canada and the United States has shown that, given the current state of the art, it is probably best to select one brand of vehicle and cope with its problems than to purchase a variety of problems. An excellent evaluation of current experience with a number of small vehicles is available from the state of Michigan (2). (The Canadian experience with small vehicles in paratransit service is almost identical to that in the United States. This paper, therefore, deals with the North American situation except where specifically noted.)

VEHICLE SELECTION PROCESS

Decisions to purchase certain types and makes of vehicles for paratransit applications are based on a variety of factors:

1. Personal preference of the operator,
2. Initial cost and resale value,
3. Availability of parts and service,
4. Ease of maintenance and operation,
5. Cost of maintenance,
6. Fuel consumption,
7. Durability (life),
8. Legislative constraints,
9. Special body or equipment options,
10. Reliability in service, and
11. Availability.

Personal Preference of the Operator

Personal preference factors are usually related to the degree of experience with a certain manufacturer or the public image of that type of vehicle. For example, the standard North American automobile is the dominant type of vehicle used as a taxi despite the fact that it is very poorly designed for the purpose. More expensive specialty vehicles such as those used in Europe and the U.S.-built Checker Cab are much better designed for taxi service but have a small share of the U.S. market (3).

It would be naive to believe that personal preferences do not enter into the selection of a vehicle when buying by public tender; both the preparation of specifications and the grouping of bid options can be used to favor a particular product.

Initial Cost and Resale Value

Decisions to purchase that are based solely on initial cost without consideration of durability and the cost of future maintenance are usually attributed to low-bid tendering by public operators. However, private operators may also be trapped into buying low-cost vehicles because of limited capital resources. Often the decision is based on price quotation only because there is a lack of in-service experience on which to base a choice among vehicles offered. Resale value is proportional to cost.

Availability of Parts and Service

This is a very important factor to both public and private operators. Most operators do not want to tie up capital funds in parts inventories and also prefer to deal with a limited number of suppliers. All operators want to deal

with the original supplier for warranty adjustments rather than with the individual component manufacturers. Operators with fewer than 20 vehicles in their fleet may want to be able to contract out their maintenance work to a local garage.

Ease of Maintenance and Operation

Many of the vehicles adapted for paratransit service are a mechanic's nightmare. In some, it is almost impossible to remove the engine or transmission as a unit because of conflicting body members. Changing a windshield-wiper assembly or other electrical component, for example, can be very time consuming. Most maintenance supervisors will resist buying such vehicles if they are consulted. Other operational considerations may include performance under extremely cold conditions or on steep grades. The ease of operation and maintenance may be partly related to the available power plant options.

Cost of Maintenance

This is a decision factor that at present is very subjective. It is known that, because of the state of the art, small buses are generally more expensive to maintain than large buses. Large, standard transit models have at least 30 years of development history. It is also obvious to anyone familiar with the automotive industry that new mechanical features, such as wheelchair lifts and ramps or kneeling buses, are likely to increase both operating costs and in-service failure rates.

What is not well-known are the differences among the various small vehicles with respect to in-service performances and maintenance costs. This results in considerable bias toward existing models.

Fuel Consumption

Fuel consumption considerations are becoming more important in an energy-conscious society. These considerations generally favor the use of diesel engines.

Durability (Life)

An assessment of durability must consider climatic conditions, terrain, and loading. A basic trade-off decision must be made when buying small vehicles for paratransit service between low-cost, short-lived vehicles and higher cost, more durable vehicles. If the minimum standards of comfort and safety can be met, it may be less costly to buy a low-initial-cost vehicle and write it off before it falls apart. Public operators tend to buy more durable vehicles because they have learned that they are often forced to keep their vehicles beyond a normal lifetime. Here again, as with maintenance costs, insufficient data are available for objective evaluation among models.

Legislative Constraints

At times, the operator does not have much choice because of constraints attached to government funding or because of very high safety or environmental standards. Examples of this are the government policy of buying locally made products and problems in meeting environmental standards with certain types of engines.

Special Body or Equipment Options

Certain models—e.g., low-profile buses and vehicles having good wheelchair lifts—may be selected because of their accessibility for handicapped persons.

Reliability

The reliability of a vehicle is measured negatively in terms of lost travel or length of time the vehicle is out of service because of a need for maintenance. This factor affects the number of spare vehicles that must be purchased.

Availability

The best designed vehicle is not an appropriate selection if it cannot be obtained (e.g., if the plant making it is on strike or cannot deliver by the due date).

APPLICATION OF SELECTION FACTORS (LIFE-CYCLE COSTING)

The use of the factors discussed above in the vehicle selection process can be illustrated as follows. From an offering of several small buses for a paratransit service, three models have been selected that meet the required delivery date, satisfy the funding regulations, and are generally acceptable in terms of durability, ease of operation, and availability of parts and service. The key considerations remaining are initial cost, reliability, cost of maintenance, and fuel consumption (4): Assume that the vehicles are operated 80 000 km/year (50 000 miles/year), fuel costs are $0.16/L ($0.60/U.S. gal) for gasoline and $0.13/L ($0.50/U.S. gal) for diesel, and there is a net average finance rate of 10 percent.

1. Vehicle A is a high-quality, integrally designed, diesel-powered bus with a 10-year lifetime. Its proven reliability indicates a need for 5 percent of the fleet as spare vehicles. Its average maintenance costs are $0.12/km ($0.20/mile). Fuel consumption is 6.4 km/L (15 miles/gal).
2. Vehicle B is a good-quality bus body attached to a truck chassis. It has a gasoline engine and a 5-year lifetime. Its record of reliability in other services indicates a need for 12 percent of the fleet as spares. Its maintenance costs are $0.20/km ($0.32/mile). Fuel consumption is high—2.1 km/L (5 miles/gal)—because of the mass of the vehicle.
3. Vehicle C is a low-cost, small school bus with a 4-year anticipated lifetime. It has a gasoline engine and a slightly better record of reliability than vehicle B, requiring 10 percent of the fleet as spares. Its maintenance costs are also lower—$0.17/km ($0.28/mile) and its fuel consumption is 3.2 km/L (7.5 miles/gal).
4. Vehicle D is a 14-passenger van with a 3-year anticipated lifetime. It has a gasoline engine with a reasonably good record of reliability for light automotive equipment. Because it has a relatively short maintenance cycle for brake and drive-component servicing, 10 percent of the fleet are needed for spares. Its maintenance cost is the same as that of vehicle A—$0.12/km ($0.20/mile)—and its fuel consumption is the same as that of vehicle C—3.2 km/L (7.5 miles/gal).

The cost analysis given in Table 1 shows that vehicles A and D are the lowest cost options. In spite of its high initial cost, vehicle A is the best bus option. If the requirements of the system can be met with vans, then vehicle D is a good option.

CURRENT TRENDS AND FUTURE VEHICLES: NEXT TEN YEARS

To properly assess the future maintenance requirements of, the demand for, and the supply of paratransit vehicles, it is necessary to look at current trends in both North

America and elsewhere. At present, the following observations can be made:

1. There is a trend toward smaller, lighter automotive vehicles (using substantial amounts of plastics) to reduce fuel consumption.
2. The interest in reducing fuel consumption is encouraging the use of more expensive diesel engines in passenger automobiles and light vans.
3. Some transit systems (e.g., Ottawa and Calgary) are replacing the gasoline engines in their small (30-passenger) buses with diesel engines to improve fuel consumption.
4. There is a trend toward the use of larger capacity vehicles by all types of operators (i.e., transit systems are using articulated buses and taxi operators are using vans and buses) to improve labor productivity.
5. Federal governments in both Canada and the United States are encouraging investment in less capital-intensive public transportation.
6. There is a trend toward more leasing of vehicles by public operators in Canada and by private operators in both Canada and the United States.
7. Battery-powered buses are being tested (5, 6).
8. Transit managers are more willing to buy higher quality, higher cost buses because of numerous problems with lower quality vehicles.

Other factors affecting the future development of vehicles include

1. The continuing pressure for public transportation for the disadvantaged,
2. The cost of new technology (which often increases at a faster rate than the labor cost of public transportation),
3. The decrease in the number of companies developing a new technology as the technology matures (e.g., downtown people-mover manufacturers and small bus manufacturers),
4. The consolidation of taxi operations by brokers who finance the vehicles only and supply the communication system for a fee, and
5. Deregulation of taxis [which could result in faster replacement of vehicles (7)].

These observations lead to the following predictions:

1. The paratransit vehicle of the future will probably be a multipurpose, small, diesel-powered bus with a nominal seating capacity of about 24 persons.
2. This vehicle will offer an optional package to accommodate wheelchair passengers mixed with semiambulatory and ambulatory passengers.
3. The market for paratransit vehicles is small but growing; other uses (such as recreational and limousine service) will continue to affect the production of vehicles during the next 10 years.
4. The production of third-generation vehicles by fewer companies will reduce maintenance problems.

Table 1. Cost analysis.

Vehicle	Capital ($)			Operating ($)		Total ($)
	Initial	Financing	Spare Allowance	Fuel	Maintenance	
A	5000	2500	400	1700	10 000	19 600
B	5000	1250	750	6000	16 000	29 000
C	4000	800	650	4000	14 000	23 450
D	3500	525	425	4000	10 000	18 450

5. The cost of vehicles will continue to increase because of more expensive power plants and specialized hardware for handicapped persons.

ACTION REQUIRED

Maintenance Data Base

A standardized data base of paratransit vehicle performance is needed. The difficulty with the excellent vehicle-appraisal system described by Chaput (4) is that the vehicles are compared within the operators' own fleets only. Because of the multiplicity of vehicles in paratransit service today, often in very small fleets, it is rarely possible to make valid comparisons. It would therefore be useful to have a national review of vehicle experience by type and model, similar to that done by the state of Michigan (2).

Taxi Regulations

Another area requiring attention is the trend toward the use of smaller taxi vehicles. Some cities are already controlling the minimum size by using bylaws, but as automobile sizes continue to decrease, it would seem reasonable to open the size limitation to permit microbuses or vans to operate as taxis. A standardization of regulations is desirable (8).

New Vehicle Designs

An assessment of the potential for the development of a high-quality small vehicle is not encouraging. In Canada, Flyer Industries of Winnipeg, Manitoba, received funding from the province and the Canadian federal government to develop a prototype small bus about 4 years ago. The design was completed and the bus about 90 percent developed when the project was abandoned. Other large-vehicle manufacturers have expressed little or no interest in the small bus market.

In contrast, the variety and quality of vans available for paratransit services is steadily increasing. This is due to the increasing volume market for personal use.

There may be greater potential for the development of a better taxi. The International Taxicab Association has advised the Urban Mass Transportation Administration of the need for a standard specification for taxi vehicles, and prototype vehicles have been built (9). Such a specification could encourage industry to build a larger, more accessible taxi vehicle that would serve a high-volume market including many paratransit applications.

The role of the taxicab is changing (10). Several applications of taxis for organized paratransit services have already been tested (11, 12); several systems have been designed and approved for implementation in Canada (13, 14, 15); and the use of taxis for the transportation of handicapped persons has been closely examined (16).

What is required now is the implementation, monitoring, and dissemination of experience to improve the credibility of paratransit services (17). Otherwise, a high-volume vehicle market will not develop. It is a paradox that system implementation is inhibited by bad experiences with the vehicles, and the limited application inhibits vehicle development (18).

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Information and Control Systems for Paratransit Services

Nigel H. M. Wilson and Neil J. Colvin, Center for Transportation Studies, Massachusetts Institute of Technology

The current uses of information and control systems in paratransit services are reviewed, and new applications that are currently being developed are discussed. Thus far, the greatest use has been by the conventional transit and taxi industries for accounting, payroll, and limited management information. In both of these industries, the larger operators have recognized that the costs of automating these clerical functions are readily justified by the benefits. However, for many other functions, the questions of whether automation will produce benefits and whether the costs can be justified are still open. In several functional areas, most strikingly brokerage and pooling services, advances in computer technology and reductions in computer costs are already making a stronger economic argument for automation. At present, however, the ability of many of the more innovative applications of computer technology to paratransit to provide real economic advantages is unproven.

Information and control systems are central to most forms of paratransit because of the importance of managing, organizing, and assigning the vehicles that provide the transportation. Each type of service has different characteristics, and the appropriate type of information and control system also varies considerably. However, there are several important questions that must be addressed independently of the specific service being studied. These include

1. What are the benefits of using information and control systems?
2. Do these benefits justify the costs of implementation?
3. What are the major problems in using these systems?
4. What role should the federal government play in furthering appropriate uses?

This paper explores these issues by drawing on experience obtained from information and control systems already implemented or currently being developed.

The paper is structured around the following functions that might be performed by the information and control system of a paratransit service:

1. Customer information—responding to service enquiries from the public and service inventory;
2. Operations planning—planning the transportation system;
3. Operations control—monitoring and controlling the operation of the system;
4. Maintenance support—parts inventory, planning fleet maintenance, and monitoring vehicle performance;
5. Management information—monitoring and reporting on system performance; and
6. Accounting—including payrolls and general ledgers.

In general, any information and control system will perform only a small subset of these possible functions; indeed, for most services some of them are not even required. Table 1 presents a matrix of these functions, indicating past, current, or planned use for each type of

paratransit service, and the following sections of this paper review various experiences with information and control systems in different types of transportation services.

CONVENTIONAL TRANSIT

Not surprisingly, thus far, the transit industry has made heavier use of information and control systems than any of the other services being considered here. This is partly because of the size and longevity of most transit properties, factors that tend to make management and control more difficult, and partly because the federal government has funded and encouraged the development and installation of several of these systems. Although it is quite easy to determine the extent of use of information and control systems by the transit industry, it is much harder to assess the cost-effectiveness of these systems. Here, only a brief review is possible, but any available evidence of benefits is included.

Customer information is still typically provided by telephone operators, who rely principally on their knowledge of the system and supplement this with printed information. The principal problems with this approach are the length of time before an operator can be fully trained and useful and the difficulty of organizing printed material for fast access. Two levels of automation have been implemented or are currently being planned in attempts to overcome these problems. The first level involves the use of microfiche to store the route information, and the second level uses a computer data base. In the fiche-based systems, retrieval of the correct information may be either mechanical [e.g., the Chicago Transit Authority (CTA)] or computer aided [e.g., the Southeastern Pennsylvania Transportation Authority (SEPTA)]. The principal advantages of the mechanical-fiche approach are its low cost (about $30 000 for the CTA system) and the reduction in operator training time (90 percent for CTA). With automated-fiche systems, access time is reduced to less than 10 s, and significant gains in operator productivity can be achieved. A Stanford University study (1) indicated that a 15 to 20 percent time saving is possible with a microfiche system. Such productivity increases could well justify costs much greater than those of the CTA system.

It is interesting that in this type of use, as well as in several others, Canada is slightly ahead of the United States in implementing information and control systems. In a demonstration project in Mississauga, Ontario, a bus-passenger information system has begun to use an automated-voice response after a 2-year manual test. The computer system informs the person requesting information the times of arrival of the next two buses serving the route and stop number specified. Washington, D.C., and Los Angeles are currently planning fully computerized, customer transit information systems without automatic voice response.

At least in concept, a computer data base can be easily edited if the services change and can also organize and present different, and more generally useful, information than the traditional single route. However, there is still considerable disagreement in the industry on the benefits of any type of automation of customer information services and no strong movement toward its general application.

Operations planning for fixed-route bus service focuses on scheduling buses to routes and drivers to buses. The run cutting and scheduling (RUCUS) package that was developed with Urban Mass Transportation Administration (UMTA) funding is now being used by a variety of transit properties, again, typically with UMTA financial assistance. RUCUS builds a set of driver runs to meet a specified set of headways on each route so as to minimize operating cost given the existing labor agreement. Traditionally, for an even moderately sized property, this run cutting process has been laborious and time-consuming and required considerable skill on the part of the schedule makers. New runs are typically generated 3 or 4 times/year and, because of the cumbersome nature of the manual process, only minor changes are made from the previous year's schedule. But once the RUCUS package and necessary data files are established for a property, alternative schedules can be tested quite quickly. In some instances, RUCUS-generated schedules have been able to reduce the cost of operation slightly (by 1 or 2 percent), but the major benefits realized thus far have been through its use as a management aid and easier access to data. For example, management can readily estimate the cost of a particular change in the labor agreement and thus be more effective in union negotiations. Similarly, schedule makers can now concentrate on the service being provided to the public rather than on the mechanics of run cutting. Perhaps more significant, a computer data base describing the service being provided can be a key to the integration of a wide range of information and control system functions. On the cost side, a one-time RUCUS software installation cost of $50 000 to $100 000 is typical for a moderately sized operation, and there is perhaps a similar annual cost for running the program if time is purchased on a large machine.

San Diego Transit, probably one of the leaders in the transit industry in using information systems, has carried their use in planning one step further by an on-line verification of each driver's run selection. This software, developed in-house, is credited with the prevention of costly mistakes in the shake-up that could result in having to repeat the pick. The program is tied into the system accounting and payroll programs so that the driver pay for the next period is automatically determined on the basis of his or her run selection. Los Angeles is experimenting with using the computer as an aid to driver training and new-route study through on-line simulation, a technique that could significantly reduce the cost of driver training and improve the effectiveness of drivers on the extra board.

Operations control for fixed-route buses focuses on the maintenance of on-time service and the correction

Table 1. Application of information and control systems to paratransit services.

Function	Conventional Transit	Conventional Taxi	Dial-a-Ride	Shared-Ride Taxi	Transportation Brokerage	Van and Car Pooling
Customer information	x		x		x	x
Operations planning	x				x	x
Operations control	x	x	x	x		
Maintenance support	x	x				
Management information	x	x			x	
Accounting	x	x				

of deviations from schedule as they occur. At present, this process is a manual one in which on-street supervisors and central dispatchers attempt to identify problems and reallocate buses through radio instructions. In the future, bus-location systems may become part of computer control systems that could provide the dispatcher with a coherent picture of operations on a route and, perhaps, suggest alternative corrective actions when problems develop.

Central to this concept is an automatic vehicle-monitoring capability for fixed-route bus service. Such systems have been tested in Chicago, Philadelphia, Vancouver, and Toronto, and further tests are planned for Los Angeles. Sudbury, Ontario, has recently implemented a signpost-based, manually monitored, bus control system. Chicago, which earlier experimented on a limited scale with a similar bus-location system, is planning an expanded system that will eventually incorporate an on-line computer. Again, however, there is no real evidence that this type of use justifies the costs and very few operators have strong active interest in it.

The final three areas of maintenance support, accounting, and general management information are, perhaps, the most amenable to computerization, and computers are, in fact, widely used for these functions in the transit industry. A major focus of current work in this area is the development of a uniform system of accounts and a records and reporting system, which is required under section 15 of the 1974 Amendments to the Urban Mass Transportation Act of 1964. To be eligible for grants under section 5 of the act after July 1, 1978, all applicants must be using this uniform system of accounts and records. UMTA is assisting transit operators in converting to this new system by making the conversion cost eligible for funding under the section 5 grant program as either a capital or an operating expense. A 1976 American Public Transit Association (APTA) project report estimated that the industrywide cost of this conversion would require a federal contribution of more than $40 million (2). This indicates both the importance of federal assistance in such a standardization and how difficult it is to achieve uniformity in a large industry once diverse information systems are already in general use.

Vehicle maintenance systems beyond parts inventory are now being implemented by some of the larger transit properties with the principal objectives of increasing maintenance-employee productivity, reducing clerical requirements, and reducing the number of on-the-road breakdowns. As an example of one such system, CTA this year implemented a vehicle maintenance system that is designed to increase maintenance-employee productivity by 10 percent over a 3-year period. This system involves recording the type of task and bus number of each employee's current activity so that standards can be developed for each type of job. The data base can also be used to determine the current status of the buses and the labor force. Whenever a dispatcher receives notification of a bus breakdown, the information is keyed into the computer, and a complete maintenance history of the vehicle is available at the appropriate garage. To aid in scheduling preventive maintenance, a computer record of travel since the last inspection is maintained so that a list of buses close to their scheduled inspection time is always available.

To summarize, there are great differences in the uses of information systems among transit properties. Most properties use computers for the clerical aspects of maintenance support, management information, and accounting. Beyond these functions, some properties are moving into other areas—even toward an integrated information-system approach that would cover all the suggested functions. Two properties in this category are San Diego Transit and the Santa Clara Transit District. In Santa Clara, California, which is in the process of expanding its fleet by a factor of two to about 500 buses, an integrated system is being developed that will include a driver-actuated, computer-assisted bus monitoring system, an on-line customer information system having address lookup, RUCUS, and an on-line maintenance program. This is clearly an innovative and imaginative system and will require an annual operating budget of at least $250 000. It remains to be seen what tangible benefits will result and whether other properties will be persuaded that such applications are cost-effective. A potential role for government exists here in the monitoring of these systems both to assess their effectiveness and to publicize the results.

CONVENTIONAL TAXI

The taxi industry represents a sharp and interesting contrast with the transit industry. Of particular relevance to the subject at hand are

1. The lack of federal funding for, or regulation of (or, until recently, interest in), the industry;
2. The private enterprise nature of taxi operations that necessitates profitable operations; and
3. The fragmented nature of the industry, which is composed principally of small operators.

For all of these reasons, one might expect the taxicab industry to make much less use of information and control systems than the transit industry. Furthermore, since their use of automated systems is not affected by federal funding, a lasting use must be cost-effective on the basis of full costs and internal benefits—a much harsher standard than in the transit industry. In practice, although there has been less experimentation with unusual applications of computers in the taxi industry, the use of computers for routine tasks is already widespread among medium and large operators. For example, a 1976 International Taxicab Association (ITA) survey of a small sample of taxi companies operating more than 25 cabs each showed that more than 75 percent of them used computers routinely. About half of these had an in-house computer, and the remainder used an outside service bureau. The most common functions that the computers perform are accounting, payroll, maintenance support, and evaluation of driver performance. Significantly, none of the companies surveyed currently use a computer to assist in the dispatching process (operations control), although some expressed an interest in the possibility of doing so in the future.

At present, there is much diversity among the computers and software being used in the taxi industry; each system is to a great extent a custom product. However, as in the transit industry, an effort is now under way to standardize the statistics that each firm produces. This project (Taxistats 2) has resulted in a software package that will be run by ITA to generate industry and firm reports. The proposed uniform statistics have been gathered on a test basis from approximately 20 companies, and the system is now ready to be used nationally. It is designed to be compatible with the corresponding transit system and can include shared-ride as well as exclusive-ride systems. Taxistats 2 will soon be required for subsidized systems, but will be voluntary for other systems. Given the small number of required participants and the lack of the financial incentive of federal assistance, what impact the system will have on the taxi industry is questionable.

It is striking how sparingly computers have been used

for dispatching operations; only the Los Angeles Yellow Cab Company and the Diamond Association of Montreal have done so on a large scale. In Los Angeles, a computer system was installed in the winter of 1971-1972. As a request for taxicab service was received, it was entered into the system, which validated the order, assigned the request to the appropriate dispatcher along with the number of the appropriate cab stand for use in servicing the order and, if a cab was available at that stand, its number. Drivers were to report their locations when available for service. However, the system was oversold to the drivers in terms of possible increased revenue and, when the radio frequencies available for driver input could not handle the volume, the drivers lost faith in the system. The driver-location phase of the loop was dropped and the system continued to function without it.

By the fall of 1973, it was evident that this system had a number of deficiencies that required correction—limited capacity to handle standing advance orders, inadequate handling of call-backs, inconvenient search for alternative stands, and slow response times when the system was handling more than 300 orders/h. By the summer of 1974, a new minicomputer system was installed with improved software that operated satisfactorily until the company ceased operation in December 1976.

In Montreal, Diamond, which provides dispatching services to 1000 cabs and processes about 4000 orders/d, has been using a computer since 1973 to control communications between the dispatchers and the drivers. The major problems to overcome were favoritism and call piracy, but these have been solved and at the same time, driver earnings have increased by 20 percent as a result of the greater operating efficiency (3). New computer dispatching systems are currently being implemented in Mississauga (Intercab Taxi Company), Ottawa (Blue Line Taxi), and Detroit (Checker). Both of the new Canadian systems involve computer matching of calls with cabs waiting at stands and mobile displays that provide the drivers with their assignments. It is still too early to evaluate the effectiveness of these new systems.

All of these uses are by very large taxi companies, and it is not yet clear to what extent, and how quickly, other large- and medium-sized companies will follow. The principal potential benefits appear to be greater efficiency in the use of vehicles through the elimination of dispatcher favoritism and call piracy, but there will be a capital investment required and operators will have to be shown that computers can in fact produce these benefits. It is probable that these systems will diffuse only very slowly without active participation of the federal government in demonstration projects and, possibly, financing. At present, there is neither a demand for automated dispatch systems on the part of taxi operators nor a supply in terms of dispatch systems with proven ability to deliver the potential benefits.

Given the poor financial conditions of many taxi companies, the use of computers must be based on compelling economic arguments. The reduction in total system cost through automation of clerical functions is accepted, and the road to more significant uses will almost certainly be based on a low marginal cost for these additional functions. The efficacy of this argument remains to be seen.

DIAL-A-RIDE

Dial-a-ride is still in the earliest stage of development; no more than 100 or so systems are yet operating, and none of them have existed for more than 7 years. The use of information and control systems by dial-a-ride operations has focused on the control of operations, as does this discussion.

Dial-a-ride represents an extreme form of paratransit service and relies most heavily on a complex, real-time control function. In the pure many-to-many (or unstructured) form, the activities of each vehicle are decided on the basis of the current state of the system and must be continually relayed to the driver. Although this is by no means the only form of dial-a-ride operating today, the discussion below will begin by concentrating on this and then note how other configurations alter the control system requirements.

Automated operations control for dial-a-ride can take the form of computer decision making, computer information storage and retrieval (this will be referred to as computer assisted), digital communication with the vehicles, and combinations of these. Automated control has the following potential benefits: improved service quality (particularly reliability), controlled service quality, simultaneous provision of different types of service, improved vehicle speeds, reduction of the knowledge of the area required of dispatchers, increased vehicle productivity, and increased size of systems. The principal penalty associated with automated control systems is increased control cost, and its justification depends on the existence and extent of these supposed benefits and their importance.

Thus far, automated control systems have been used by unstructured dial-a-ride operations at only three sites: Haddonfield, New Jersey; Santa Clara, California; and Rochester, New York. The Haddonfield control system was used in the latter stages of the UMTA-sponsored demonstration project that operated from 1972 to 1975. Dial-a-ride service was provided by a 10-vehicle fleet serving a 2800-ha area. The computer control system used a 32K-word general purpose machine that was responsible for assigning customers to vehicles (4). When fully operational, the system succeeded in improving service quality, in particular reducing passenger wait time by about 17 percent, but did not achieve any of the other benefits suggested above (5). Part of the reason for this was the short time (less than 6 months) that the system functioned to full effect. The computer control system was removed at the scheduled end of the demonstration project and has not been used since then. Although its cost is not available, this particular control system could not be justified by the benefits demonstrated in Haddonfield.

In contrast, the Santa Clara system was not a federally funded demonstration, and its computer control system was developed without UMTA support. Thus, a complete assessment of its performance is harder to make because of incomplete documentation (6). Furthermore, the Santa Clara system operated for fewer than 6 months (November 1974 to May 1975) and only under computer control, which makes it more difficult to draw any conclusions and impossible to compare manual and computer dispatching. Santa Clara was by far the most ambitious dial-a-ride system implemented at that time, having about 75 buses operating in a 50 000-ha area that has a population of 1.1 million. The control system used in Santa Clara was loosely based on that used in Haddonfield, although the computer was used to assist the dispatcher rather than to make the assignments directly. It is probable that such a large system would not have been undertaken without an automated control system, but no other benefits can be attributed to it. Once again, the control system cannot be justified on the basis of any demonstrated benefits. Since the termination of the Santa Clara system, the control system has not been used anywhere else.

Dial-a-ride has been operating in Rochester for 4 years, the last two of which have been under the auspices of the UMTA Service and Methods Demonstration Program. Currently, two separate but connected areas of

about 4600 ha and 100 000 population are being served with a fleet of 10 to 15 vehicles. As part of the demonstration project, an automated control system was installed and has been functioning for almost 2 years. This control system is also based on Haddonfield's, but has significantly greater capabilities, in particular direct two-way digital communication between the drivers and the control center and computer. In addition, the computer assignment algorithm has been enhanced to allow multiple types of service and to effectively control service quality. This computer decision making is performed on a large remote time-sharing computer with local computers to handle communications and the controller terminals.

A comparison between manual dispatching and the automated control system in the smaller area (Irondequoit) has shown that in some respects, service quality has improved significantly with computer dispatching (Table 2) (7). For example, the mean total service time for immediate requests decreased from about 40 to 28 min, with much lower variability. All of the benefits suggested above have been demonstrated in Rochester except the ability to increase vehicle productivity through the use of computer control. Unfortunately, this is the most important anticipated benefit, and the failure to demonstrate it is a serious disappointment. There are several reasons for the unchanged vehicle productivity. Probably the most important is that vehicle unreliability over the past 2 years has so alienated potential users that dial-a-ride is now viewed very much as a last resort; service has been bad for so long that improvements make no difference to a skeptical public. A second reason is that, because of budgetary pressure, the service has been gradually reduced over the past year in terms of area served, the number of vehicles operating, and the hours of service and demand is considerably decreased, making higher vehicle productivities still harder to achieve.

The control system used in Rochester, although effective from many points of view, still cannot be justified economically for such a small system. It is possible that a similar automated control system could be implemented at a hardware rental cost of $5000/month and a lifetime communication hardware capital and operating cost of $4500/vehicle (i.e., about $100/month/vehicle). Let us examine the economics of such a control system by asking the question, How large a vehicle productivity increase is required to offset the increased control cost? The Rochester system has also shown that an automated control system will neither increase nor decrease control staff requirements. The monthly cost of operating a 20-vehicle system (at a cost of $15/vehicle-h for 12 h/d, 5 d/week) will be about $76 000. Thus, an increase in vehicle productivity of only 10 percent would justify the installation of such a control system. Although no increased productivities have yet been observed, it is easy to justify continuing the search; the rewards are potentially large.

Turning to more structured forms of dial-a-ride, the greater the degree of structure imposed, the less likely is any role for the automated control system or the simpler the system will be if it is implemented. The most common type of structuring is the zonal-loop type of service in which the service area is divided into mutually exclusive zones that have one vehicle operating a loop on a fixed-time cycle in each zone. Ann Arbor, Michigan; Bay Ridges, Ontario; Regina, Saskatchewan; and other Canadian operators provide this type of service with the focus of each zone being a transfer stop on a line-haul transit facility. Decision making in this type of system is considerably easier than in the unstructured form, and the control requirements are also somewhat simpler. Thus far, Regina with 15 buses and Ann Arbor with 32 vans (operating in dial-a-ride service at a single time) have implemented some form of computer assistance for this type of service, and Calgary with 6 vans is in the process of doing so. In Regina, the computer lists the regular riders on files that are organized into trip sheets and printed daily for the use of drivers, and using the computer to store and organize requests for immediate service is being considered.

The Ann Arbor control system is considerably more complex than the Regina one, representing a fully computer-assisted dispatching system (8). In this system, the computer, which has a 48K-word core, makes almost no decisions, but rather accepts the booking of requests, displays information for the dispatcher, and stores the assignments made by the dispatcher. One of the implications of this system is that dispatchers are still the prime determinant of service quality and so must be highly skilled and reliable. This control system has been operating for almost 2 years, and although the resulting benefits have not been evaluated, it is thought that without the system only about half the current number of vehicles could be effectively controlled. Ann Arbor is not an UMTA-sponsored demonstration project, but received a capital grant that covered most of the $498 000 cost of the information and control system. Recently, digital communication has also been introduced between the control center and the vehicles.

The control system being implemented in Calgary is essentially the same as that in Ann Arbor except that in Calgary the computer will send the information to land-based printers at the transfer points rather than to

Table 2. Comparison of manual and computer dispatching in Irondequoit.

Measure of Service	Manual (min)	Computer (min)	Preferred	Improvement (%)	Statistically Significant Difference at 95 Percent Level
Immediate passenger requests					
Mean wait time	29.69	17.44	Computer	41	Yes
SD of mean wait time	20.42	10.23	Computer	50	Yes
SD of mean daily wait time	5.93	4.12	Computer	30	—
Mean pickup time deviation	5.51	6.25	Manual	-13	—
SD of mean pickup time deviation	16.24	8.53	Computer	47	Yes
SD of mean daily pickup time deviation	3.94	2.49	Computer	37	—
Mean ride time	10.41	10.72	Manual	-3	—
SD of mean ride time	5.49	7.19	Manual	-31	Yes
SD of mean daily ride time	1.35	1.28	Computer	5	—
Advance passenger requests					
Mean pickup time deviation	7.12	4.24	Computer	40	Yes
SD of mean pickup time deviation	15.29	10.87	Computer	29	Yes
SD of mean daily pickup time deviation	5.99	2.32	Computer	61	Yes
Mean ride time	10.60	13.05	Manual	-23	Yes
SD of mean ride time	7.11	7.27	Manual	-2	—
SD of mean daily ride time	1.61	1.83	Manual	-14	—

mobile displays on the vehicles.

In summary, the future role of automated control systems in dial-a-ride is not yet decided. There have been several such systems implemented in the past 3 years, but no two have been the same and no economic benefits have been observed to offset the implementation expense. It is anticipated that as the latest experiences in Ann Arbor and Rochester are evaluated, increasing attention will be paid to demonstrating economic feasibility. It is clear that small dial-a-ride systems can be operated without computer control and that large systems cannot. What is less clear is whether large systems will play an important role in urban transportation over the next few years.

SHARED-RIDE TAXI

Shared-ride taxi is very similar to dial-a-ride from a technical point of view, the only difference in the control problem being a more binding vehicle capacity. However, the distinction between conventional transit and taxi is also true between dial-a-ride and shared-ride taxi. Although shared-ride taxi is now included in the UMTA definition of transit services, operators of shared-ride systems have not yet received anything like the federal funding or technical assistance from which dial-a-ride operators have benefited. It is not surprising then that there has been much less innovation in shared-ride taxi services than in dial-a-ride. All the potential benefits to dial-a-ride would also apply to shared-ride taxi. In systems in which drivers are paid on an incentive or commission basis, the potential benefits include (as for conventional taxi) the reduction or elimination of dispatcher favoritism and the stealing of passengers by cabs other than the one assigned.

Despite these potential benefits, the only known use of automated control by a shared-ride taxi system was that in Davenport in 1972. In this case, the Royal Cab Company reported an increase in revenue from 20¢/km (32¢/mile) with manual dispatching to 27¢/km (44¢/mile) with computer dispatching (9). Despite this favorable result, the computer was quickly withdrawn from service because it was unable to keep up with the volume of requests. Furthermore, despite some publicity for the Davenport results, no other shared-ride taxi operator has followed suit—either the costs and risks are too high or the benefits are not credible.

A quite different development is the work at Carnegie-Mellon University on improved taxi meters. One new meter would have the fare for a trip determined by computer, communicated to the taxi, and displayed on the meter—all at the start of the passenger's trip. This would remove uncertainty in the passenger's mind about the ultimate cost of the trip and also allow promulgation of more complex and equitable fare structures for both exclusive-ride and shared-ride operations.

Automated control may well be an important issue in the future expansion of shared-ride taxi service; one oft-cited obstacle is the difficulty of manually dispatching large shared-ride fleets. However, if shared-ride taxi service is to expand significantly, two prerequisites would seem to be the demonstration of effective control systems for large fleets and a means for private operators to acquire these systems at reasonable cost. A good illustration of the capabilities and limitations of manual dispatching is provided by the Black and White Cab Company of Little Rock, which currently provides shared-ride service with 75 taxis controlled by two dispatchers without computer assistance. This operation, which is far larger than any existing dial-a-ride service, has a severe dispatching problem that is one of the factors preventing further expansion. This experience tends to confirm the importance of proven cost-effective computer-dispatching systems for the expansion of existing shared-ride taxi services and the creation of large new systems. It also indicates that there is no product currently on the market that is cost-effective for the unsubsidized private operator.

TRANSPORTATION BROKERAGE

A transportation broker provides a clearinghouse between those needing transportation and those providing it. In most cases, the transportation being brokered runs on a fixed schedule (such as line-haul bus or commuter rail) or is already scheduled (such as van pools or car pools). A person needing transportation enters the brokerage with trip origin and destination locations and desired trip start and end times. The broker then attempts to match the transportation request with the available transportation and informs the customer of all reasonable transportation alternatives. This matching can also recognize the requirements of the elderly and handicapped and identify transportation services suited to their special needs. The customer then selects the desired alternative and places a reservation either with the broker or directly with the provider.

The information and control requirements of this type of paratransit service are obviously quite different from the real-time scheduling requirements of dial-a-ride or taxi operations. The broker integrates the services of many different transportation providers and hence must be able to maintain a large data base including capacities, schedules, and fares for each type of service. Many of the customers in such a system are permanent, using the same transportation service on a regular basis. The broker must be able to maintain records of these customers and the resources they use.

In addition to this fairly static information base, the transportation broker must also handle a number of dynamic data flows. For example, if a transportation service is temporarily unavailable (e.g., the van-pool driver is sick or there is a bus strike), the broker must record the unavailability, notify the customers affected, and inform them of alternative services. Conversely, the schedule of a regular customer may temporarily change (e.g., overtime, vacation, or illness), and the broker must both provide different transportation service and attempt to use the transportation resource suddenly made available. Finally, the broker should be able to handle the walk-in customer who needs single-trip transportation. With all of the transportation requests being channeled through a single information center, the broker can also provide nontransportation services such as customer accounting, vehicle maintenance scheduling, and other management information.

Although it is obviously possible to operate such a transportation brokerage manually on a small scale, the benefits to be gained from the use of an automated system are significant:

1. The ability to include more transportation providers in the system,
2. The ability to include a larger number of customers in the system,
3. The ability to locate more customer-provider matches in real time, and
4. The ability to provide support services such as accounting and maintenance scheduling without additional clerical assistance.

Although such an information system could easily be implemented on a minicomputer or a time-sharing computer, it is unlikely that this would be cost-effective for

a small community brokerage. Knoxville, Tennessee, for example, is currently using a large-scale (DEC system 10) time-sharing system to provide on-line inquiry capability into available transportation resources, but has found that the cost prohibits expanding the on-line services to include resource allocation or scheduling. Within the last year, however, a new computer technology has arisen that makes such a system much more cost-effective.

Microcomputers have brought general purpose computing power into a new cost-performance range. A complete computer hardware system capable of providing all of the above functions can now be purchased for less than $10 000. The software for such a system, once developed, could be used by many different transportation brokers.

The first attempt to introduce this new technology is currently under way in Knoxville, where UMTA is sponsoring a project to develop the software and hardware required to support a microcomputer-based information system with all of the capabilities described above. In addition, it will provide some of the van- and car-pool matching capabilities discussed below.

VAN AND CAR POOLS

Van and car pools are perhaps the simplest transportation systems from an information and control standpoint. With the exception of unplanned changes in rider schedules (overtime, medical appointments, and such) and vehicle failures, they are basically static systems. Once a set of riders is firmly established in a given pool, there is normally little interpool movement. The only planned changes are the addition or deletion of riders from the system as a whole or the permanent schedule change of a rider who requires a reassignment to a compatible pool.

The static nature of the system allows the use of well-established information-system techniques with minimal real-time capabilities. A data base consisting of all potential riders and their schedules, preferences (driver versus rider), and other specific requirements, such as smoking versus nonsmoking, must be established first. Then, by using this data base, an initial set of matches can be generated, leaving all unmatched riders in the pool for later comparison with new pool entries. As new riders enter the system and others leave or request revised arrangements, additional scheduling runs are made to generate new matches.

The potential real-time benefits of such an information system are similar to those described above for a transportation brokerage. When short-term schedule changes, vehicle failures, or other disruptions occur, it is desirable for the system to be able to locate an alternative pool with available space. In addition, a real-time capability would allow the immediate entry of requests for new service, service deletions, and reassignments.

There are many available programs, services, and systems for car- and van-pool scheduling. Most of these use medium- to large-scale computer systems, with their associated cost and accessibility characteristics. These programs are normally run periodically in a batch environment and have no capability for revising the matches in response to short-term fluctuations in ridership or schedules. Knoxville and Commuter Computer in California both currently schedule their van pools in this way.

The nature of the computer requirements makes microcomputer technology extremely useful for small-scale operation. Computational requirements for the assignment process are well within the capabilities of the microcomputer, and because the scheduling need not be done in real time, speed is not a central issue. In addition, the availability of a dedicated computer system at such a low cost would allow for the inclusion of additional real-time capabilities.

It is apparent that there is a potential overlap between the transportation brokerage and the van- and car-pool organizer. The pools are potential sources of transportation service for the broker to draw on, and the broker has the capability to provide backup transportation to the pool riders. This overlap indicates the desirability of developing integrated systems that can provide both services. The system being developed for Knoxville is attempting to do just that. It will record pool requests in real time for later scheduling in an off-line mode. It will also use the pools as resources for the provision of transportation service to customers who require a nonscheduled trip.

SUMMARY

The discussion above shows that fairly extensive use of information and control systems is already being made in existing urban transportation systems. The greatest use is in conventional transit and taxi industries for accounting, payroll, and limited management information. In each of these industries, there has thus far been little commonality among the systems of individual operators, but because of legislative requirements, there are now plans to standardize the accounts, records, and reports of those operators receiving federal assistance. This will include most transit operators, but exclude many taxi operators, and underlines the differences in the traditional positions of these industries vis-à-vis the federal government: Transit is subject to extensive federal regulation but also receives substantial federal money for the development and implementation of new techniques; taxis are relatively unaffected by direct federal actions.

In both industries, medium- and large-scale operators recognize that the costs of information systems for these clerical functions are readily justified by the benefits. For many other functions, however, it is still unclear to what extent benefits exist and whether they justify the costs of information systems. In the taxi industry, where the problem of control is important, the cost of implementing an automated system without outside financial assistance and the lack of demonstrated benefits are major reasons for the lack of these systems. A cautious approach is very undestandable for any large taxi company. The traditional manual approach to control of conventional taxi operations certainly keeps control costs to a minimum, and the possible adverse employee reaction to an automated system could well destroy a company whose financial condition was precarious. Why make a major financial commitment for unknown and disputed financial benefits? If computer dispatching is to have any significant impact on the taxi industry, it will more likely come initially through shared-ride services. For shared ride, a stronger federal role can be seen emerging in terms of both technical and financial assistance. Thus, the taxi operator might be shielded from many of the risks during experimentation when the credibility of computer dispatching is being established. After that, its use by conventional taxi operations may seem worthwhile. In terms of encouraging shared-ride operations, funding research and development, and providing financial assistance, federal participation will be the key to wider use of information systems by the taxi industry. Equally clearly, computer control, with its large fixed costs, will be most readily justified for the largest operators. For some of these larger operators, who already use computers for clerical tasks, the marginal

costs of additional computer functions may be low enough to justify the risks of experimentation even though the costs of failure are high.

In the transit industry, which has a special position with respect to federal research and development and the availability of capital assistance and demonstration projects, information systems are being used experimentally in a number of ways. However, the benefits and cost-effectiveness of most of these—passenger information systems, RUCUS, bus control systems, and maintenance control systems—are still in dispute. Full evaluation of these is often very difficult and unsatisfactory because of uncontrollable events in the operating environment, but the UMTA Project Evaluation Program is designed to maximize the information obtained from the experiments, and the inclusion of innovative applications of information systems in the evaluation program would be most valuable.

For dial-a-ride, control technology has been developed and demonstrated with UMTA support, but definite economic benefits have not yet been shown. The economic justification for automated control is, however, being overshadowed by the concern about the economic feasibility of dial-a-ride itself. Actions to improve productivity, such as imposing spatial and temporal constraints on services, are becoming increasingly important, and these actions tend to simplify the control problem, thus decreasing the need for automated control. For small dial-a-ride systems (perhaps fewer than 15 vehicles), manual control is quite effective (with good training), and for much larger systems, either zonal structured service (as in Ann Arbor) or shared-ride taxi service may well be preferred.

In several of these types of use, most strikingly in the area of brokerage and pooling, advances in computer technology and reductions in computer costs are already making a stronger economic argument for automation. However, at present, it has not been proved that many of the more innovative uses of computer technology can provide paratransit with a real economic advantage.

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Management and Organization for Promoting the Use of Paratransit

Frank W. Davis, Jr., Department of Marketing and Transportation, University of Tennessee
Robert P. Aex, Knoxville Department of Public Transportation Services

Before paratransit organizations can develop, it is necessary to demonstrate their capabilities to the community. This paper presents a strategy for implementing various paratransit services and integrating these services into the community. It also presents some of the philosophical issues on which paratransit programs may be structured. Finally, it suggests an organizational structure that can be used to promote these concepts and appropriate funding levels.

HISTORICAL REVIEW OF PUBLIC TRANSPORTATION

The conditions under which public transportation operates today are entirely different from those under which it operated a century ago. Then, the railroads and trolleys were a quantum jump ahead of their competition (walking, horseback, and carriage) in terms of travel time, comfort, and convenience. In fact, railroads and trolleys were so superior that, even if a rider had to take a longer route or wait for the next train to take advantage of the service, he or she was better off.

At first, the railroad and trolley lines were very profitable and governments used regulation as a taxing device to force the companies to provide street lighting, maintain roads, and give service to low-density nonprofitable areas.

The automobile changed all that. It provided an additional quantum jump ahead in flexibility, time saving, and routing alternatives. Although the automobile was more expensive, it did not have to be driven by a professional driver. It was a do-it-yourself dream. It was not restricted to a single route, and the vehicles were small enough so that they could be adapted to

the needs of the individual.

This second quantum jump in technology was readily embraced by an ever-growing segment of society while the former technology (the fixed-route railroad, the fixed-route trolley, and later the fixed-route bus) hauled ever-decreasing numbers of passengers. Now, rail passenger service, interurban railroads, intercity buses, fixed-route transit, trolleys, subways, and commuter rail systems have all declined until

1. They are either extinct or carry only a small fraction of the passengers carried 30 years ago or
2. They are dependent on rapidly increasing subsidies to sustain a given level of service.

Today, government is no longer hopeful of using traditional public transportation as a tax source or even as a provider of street lights and maintenance. Today, government is increasingly concerned about providing a minimal level of service for the transit dependent and attempting to control the rapidly growing deficits of fixed-route services.

Unfortunately, the cities set about resolving their transportation problems by preserving the traditional public transportation companies, not realizing that public transportation had such a fixed-route, fixed-schedule structure only during a short period from the middle 1800s to World War II. During all other periods of history, public transportation has been provided by individuals or small companies that had a vehicle, a horse, or both available. The highly competitive approach to public transportation by using privately owned vehicles began during World War I, and it probably would have grown rapidly had not government legislatively prohibited the operation of jitneys to protect a perceived tax base among the trolley transit companies. This legislation artificially created two classes of vehicles:

1. A small group of taxis, buses, railcars, trolleys, and subways that legally can be used to haul people when money changes hands (this group is less than 0.2 percent of the nation's vehicles and hauls a smaller market share each year and that primarily in the cities and areas that were built before or during the years of the technological supremacy of the rail systems) and
2. A very large and growing fleet of privately owned vehicles (99.8 percent of the nation's vehicle fleet) that cannot be used legally to haul people if money changes hands.

EVOLUTION OF CHANGING ORGANIZATIONS AND MANAGERIAL PHILOSOPHIES

Paratransit is the term used to describe the use of small groups of privately owned fleets as public transportation or the operation of for-hire fleets in a slightly different manner. Actually, paratransit is a misleading term. Paratransit is not a mode; rather it is the concept that public transportation offers far greater options and possibilities than the managerial and operational practices that developed when the railroad and trolley systems were technologically superior.

Ironically, it will not be decreases in ridership or the disappearance of the tax base that forces the rethinking of the railroad-trolley model; rather it will be the energy crisis and the increased concern over the transit dependent. The energy crisis has focused national attention on decreasing the gasoline consumption of automobiles. Preliminary data suggest that by 1985, there will be a 25 to 50 percent increase in vehicle distances traveled, but that fuel consumption by private automobiles will decrease between 10 and 20 percent. As the cities (today's staunchest promoters of the railroad-trolley model of public transportation) continue to restrict other more flexible options, individuals simply shift their residential, work, and shopping preferences to keep highway congestion at an acceptable level. This process is known as decentralization, urban sprawl, and suburbanization. The cities must realize that the railroad-trolley model of public transportation serves only a small group along the rights-of-way and that the use of a full-time system is the most expensive and inefficient way to satisfy peak-hour commuter demand. Only then can a more efficient option be developed. Once this is realized, however, the cities will have to address their attention toward solving the congestion problem, curbing the resulting decentralization, discovering ways to use the other 99.8 percent of the available vehicle fleet (both public and private), and better coordination of all transportation resources.

The second incentive for paratransit is the needs of the transit dependent. This is the group for whom government feels it must preserve the railroad-trolley model of public transportation, regardless of cost. Interestingly, social service agencies have begun to claim that traditional transportation was designed for commuters and not for the transit dependent. Some of their arguments are as follows:

1. Traditional transit vehicles are not able to accommodate wheelchairs.
2. Traditional vehicles are too crowded for riders who have had a colostomy.
3. Traditional transit does not serve neighborhood meal centers for the elderly.
4. Traditional transit is too costly for suburban and rural areas.
5. Doctors' offices and other needed facilities are often located in suburban areas that are not served.
6. Very young children cannot use traditional services.
7. Many people cannot get to the bus stop.

The special needs are endless.

The first break in government-controlled franchise regulations based on the railroad-trolley model of public transportation came when, because only the railroad-trolley model of public transportation was available legally for implementation, social service agencies petitioned government for vehicles and then routed and scheduled the vehicles to serve the needs of their particular clients. It is obvious that the proliferation of social-service-agency transportation systems has been due to the inability of traditional transit to meet the needs of the agencies. The regulatory structure was not ready to deny the social service agencies the right to haul these worthy people with government vehicles.

The second break came with employer van-pool and employee car-pool programs to cope with the energy shortage; the Portland, Oregon, type of transit tax; and efforts to serve nonbus areas. These programs offered to identify additional possibilities and served to give greater freedom to operate without the prohibiting barriers of regulation. Individuals such as Bob Cherry of Davenport, Iowa, proved that they could use the best of the taxi models and the best of the railroad-trolley models to provide lower cost, more productive transportation options (at least until the city of Davenport became so eager for federal funds that municipal regulation and other factors put the service out of business).

Gradually, it became obvious that public transportation has always been a small business activity carried out in many different ways by diverse operators, each catering to a specific clientele. The only exception was

during the period from 1870 to 1917 when the railroads and trolleys had a technological advantage. By 1917, the model had begun to crumble with the growth of jitneys.

By 1938, the model changed again. Airline regulation, for example, does not adhere strictly to the railroad-trolley model. Historically, there have been major trunk-line airlines, regional airlines, commuter airlines, charter airlines, and air taxis. The Civil Aeronautics Board generally has granted much flexibility in abandonment and operating authority. The major and regional airlines have abandoned 164 communities in the last 15 years, but the number of commuter airlines has grown from 5 to 150.

EVOLUTION OF THE KNOXVILLE TRANSPORTATION BROKER

The Knoxville brokerage system was designed to facilitate the development of new options. Many approaches are part of the broker's activities—car pools, van pools, company work buses, private bus operators, subscription commuter bus services, employer incentive programs, contract services for social service agencies, contract tour bus services, shared-ride taxis, computer trip-aggregation services, regulatory reforms, new insurance programs, parking-pooling coordination, driver training programs, small business counseling, social service transportation audits, suggested shared-expense programs, loan guarantees, technical support, how-to-do-it handbooks, traffic management programs, user-side subsidies, automobile-free zones, signing and information programs, and free-fare bus zones.

Perhaps the coming of age of the Knoxville transportation broker is the move currently being considered to replace the transit authority (which has responsibility only for the routes, schedules, and fares of fixed-route transit) by a transportation board that will have broad authority and responsibility to serve the total local transportation needs. This transportation board will seek

1. To provide the transportation needed by social service agencies and those who do not own or cannot operate automobiles;
2. To reduce automobile-related problems, especially in the downtown areas and on the most congested highways; and
3. To operate within budgets and ensure that the city receives the maximum benefit for the money spent.

It is probable that, when created, this board will use fixed-route buses on the major routes and improve service to promote the highest ridership and maximum efficiency of staff and equipment. Standby, taxi feeder service probably will be implemented in the low-density suburban areas where fixed-route service is too costly. Car pools, van pools, and private buses will be used to complete a comprehensive transportation system. Trip aggregation will be done with a small microprocessor ($13 000 to $15 000 purchase price). Only the specific transportation needed will be provided, rather than running empty fixed-route vehicles in hopes that people will ride the service because it is there.

PHILOSOPHY OF TRANSPORTATION BROKERAGE

The next question is, What can be done to assist other communities to duplicate the Knoxville successes and to improve on its weaknesses? Before this can be done, the following philosophical concepts should be understood.

1. The railroad-trolley model must be put into perspective: The large, public transportation company operating under a franchise to provide fixed-route, fixed-schedule service by using hired professional drivers and charging regulated nondiscriminatory rates is a model designed around rail technology. The model has persisted beyond the railroad era because of artificial legal barriers. It should be realized that a wide range of flexible services provided by many different groups (including part-time owners and operators) would be the norm if allowed by government.
2. There is no one best form of public transportation: The railroad-trolley model has its place in high-ridership corridors. Casual transportation and volunteers are indispensable in rural communities. Cooperative pools (such as van pools, car pools, company work buses, and union pools) are the backbone of commuter activity. All alternatives must be used wisely.
3. Paratransit alternatives can provide real benefits to traditional transit: Traditional transit costs and the resulting deficits are caused primarily by attempting to provide (a) more peak-hour service than is economical and (b) service in low-density suburban areas where ridership is extremely low. The traditional transit systems have been unable to abandon this extremely costly service because no other alternatives were considered. By allowing other options, traditional transit can abandon these runs and concentrate on providing the service that it performs best.
4. Many community groups fear paratransit: Traditional-transit operators fear that they cannot compete with other forms of transportation. Traditional-transit promoters fear to admit the role of paratransit because these services might receive some funding that "rightfully belongs to the transit companies." (Ironically, transit assumes the opposite position when arguing with highway proponents on the issue of the highway trust fund.) Transit unions fear that competition from paratransit will prove so successful that they will lose their jobs.
5. Many community groups fear that paratransit will not be successful: Captive riders fear that paratransit will give traditional public transportation systems justification for removing unprofitable service and then not be able to meet the needs. Regulatory agencies, city councils, and others who are able to closely control one public transportation company fear that paratransit will be successful enough so that the transit system will be able to justify abandoning money-losing services, but not successful enough to eliminate public complaints.
6. It is easier to solve an individual's specific travel needs by using all the resources in the community: It is virtually impossible to develop a transit system that can serve all needs. Although the consideration of all the potential resources can be difficult, it is much easier than developing a single system that is accepted by all groups.
7. Institutions have developed under the railroad-trolley philosophy and must be changed to allow more flexible levels of service: These institutions include insurance, liability standards, regulation, labor contracts, tax law, zoning, social service budgeting, and leasing procedures.

STEPS IN IMPLEMENTING BROKERAGE CONCEPTS

Once these philosophical concepts are understood, a community can develop an effective program of action for implementing the brokerage concept. This program should include

1. Locating an area where existing public transportation does not currently operate to serve as a pilot project (this should probably concentrate heavily on a commuter service by using van pools, car pools, and possibly express buses),
2. Working with social service agencies to help them locate options to show that the brokerage concept works for more than one type of need,
3. Sensitizing the community to the limitations of fixed-route transit by showing that fixed-route transit deficits are caused primarily by heavy peak-hour commuter service and low-density feeder service in suburban and rural areas,
4. Developing programs to show how paratransit can help reduce the fixed-route transit deficit and improve service to those for whom fixed-route transit cannot serve, and
5. Shifting public attention from the promotion of a single mode to the solving of particular public transportation problems (once the organization has been designed to focus on particular transportation needs, many options will become available).

BROKERAGE RELATIONS

Although the brokerage philosophy is developed independently, it is important that the broker soon establish relations with other organizations in the community. The Knoxville broker has had to educate each of the following types of community organizations on the potential of paratransit options and develop working relationships with them.

Traffic Engineering

Traffic engineers are traditionally highway oriented, and most of their work involves automobile-related problems. Why then should traffic engineers lend their professional support to the use of paratransit? And why is this support important if paratransit is to be developed? The principal motive for a traffic engineer to support paratransit is that paratransit can be the safety valve between the demand and the supply sides of highway transportation. This is to say that pooling options can give the traffic engineer the time needed to increase the supply of highways. This support is important because a team composed of the transportation broker and the traffic engineer can be very persuasive.

Metropolitan Planning Organization

Second perhaps to that with the traffic engineers, the relation between the transportation broker and the metropolitan planning organization (MPO) will determine the extent to which paratransit options will be explored. Membership on the technical staff of the MPO can give the transportation broker a forum in which paratransit proposals can be suggested and evaluated and the opportunity to teach other members about paratransit options. In most communities, the MPO will, of necessity, consider paratransit the only feasible way to meet the Urban Mass Transportation Administration regulations for providing transportation for the semiambulatory and wheelchair handicapped. This gives the proponents of paratransit an ideal opportunity to advance proposals for other purposes as well and make paratransit an integral part of the transportation system management plan adopted by the MPO.

Master Planning Agency

Most cities and counties have a planning agency that includes transportation among its concerns. These planning agencies are generally also members of the MPO. When the transportation broker can join forces with a sympathetic traffic engineer and a member of the master planning agency staff, it will almost guarantee consideration of paratransit at a meeting of the MPO.

Transit Authority

Here is where paratransit often fails to get fair consideration. Notwithstanding the American Public Transportation Association position paper in which paratransit is acknowledged to be a member of the family of services, many transit authorities are still fearful that paratransit will take riders away from traditional transit. However, the advent of the MPO has tended to minimize the impact of unjustifiable concern by transit authorities. Increasingly, transit authorities are being confronted with uncontrollable and mounting deficits. This tends to soften some of the opposition when paratransit is suggested as a way to provide transportation for social agencies or remove the pressure from fixed-route transit to serve high-cost commuter runs and low-density neighborhoods.

Transit Operator

Transit operators are, of course, influenced by the attitudes of the transit authorities for whom they work. But, by the same token, they can influence members of the authority. Therefore, if a proponent of paratransit can convince a transit operator that paratransit can be integrated with traditional transit to the advantage of both, there will be many times when a united front consisting of the transportation broker, the traffic engineer, and the fixed-route transit operator can be presented before an MPO.

A-95 Review Agency

When a paratransit proposal has been approved by the MPO for inclusion in the transportation system management plan, it is referred to the A-95 review agency for comment. At this point, the support of a member of the review agency staff can be of great help.

State Department of Transportation

State departments of transportation are concerned with both transportation modes and highways. However, because initially highways were the only concern of these departments, they still tend to be more concerned with highways than with transportation modes, and their funds are directed more heavily toward highways. Highway engineers, however, are not necessarily adversaries of paratransit. In fact, highway engineers often look on paratransit in the same way as does the local traffic engineer, namely, as the safety valve between the demand and the supply sides of the highway problem. Highway engineers at the federal and state levels, were among the first proponents of car pooling.

Social Service Agencies

Although some social-service-agency administrators are inclined to build up transportation systems to protect their turf, many are more interested in the social services their agency performs. These administrators tend to regard the transportation of clients as a secondary activity to support the primary function. Transportation brokerage managers should seek out those social-service-agency administrators with whom they can develop a relationship directed toward removing the social service

agency from the business of transportation. An organized transportation audit procedure can be very effective, especially if it can show the benefits of a lower cost option.

United Way

For many years, United Way has allocated funds without much consideration of expenditures by agencies for transportation. Now, however, audit committees are asking questions about the duplication of transportation services—duplication among agencies and duplication of existing services by private providers. A transportation broker should open up communications with officials of the local United Way and seek opportunities to assist the United Way in developing more efficient transportation through the use of paratransit and the coordination of transportation volunteers.

Taxicab Industry

Because the taxicab is an important element of paratransit options, a good working relation with the taxicab industry is essential. Many fixed-route transit operators regard taxicabs as competitors to be feared. Some regard the industry with disdain because they do not consider taxicabs to be a part of the local transportation system. But taxicabs meet a large portion of the needs of the very young, the elderly, and the handicapped, and they should not and cannot be ignored. Furthermore, the use of taxis to provide feeder services to the terminal ends of fixed bus routes will benefit both in terms of ridership.

Private Bus Operators

Private bus operators usually perform many paratransit services in an independent and uncoordinated manner. They provide transportation in the form of charters and services for the elderly, the handicapped, and other special groups. Even though these operators may be understandably suspicious of the motives behind attempts to coordinate their services with those of others, they will respond to opportunities to make a profit. A relationship should be developed with these operators to take advantage of their operating and maintenance abilities.

Private Limousine Operators

The limousine is another element of the local paratransit scene. The old stretched-out 11-passenger vehicle is a thing of the past. One now finds the alert operator using vans and other equipment. Limousine operators are active in many transportation markets. As in the case of other private paratransit operators, they usually operate in an uncoordinated manner. If limousine operators can see opportunities for profit, they will be receptive to paratransit services such as feeder services to fixed-route buses or transportation for the elderly and the handicapped.

Business Community

The business community can be very helpful in attempts to use paratransit if it is aware of the options that are available. Therefore, the transportation broker must involve the business community at the beginning when a comprehensive transportation plan is being formulated. The local chamber of commerce usually offers a forum for such purposes.

DEVELOPMENT STAGES OF BROKERAGE

Stage 1

Stage 1 consists of the initial attempts to coordinate a particular approach to paratransit (a van-pool program, a car-pool program, a dial-a-bus program, or a social-service-coordinator program). The particular area does not matter. The main point is that the manager learns to focus on client needs and supply coordination rather than on operation.

Stage 2

A successful stage 1 program generally leads to an expansion of activities to include all areas not already covered by strongly organized existing groups (stage 2). In Knoxville, a department of public transportation services was organized to coordinate all surface public transportation, including fixed-route transit. The brokerage function is performed in Knoxville by the Knoxville commuter pool (KCP).

Stage 3

It appears that Knoxville is now at stage 3 not by design, but as a result of outside circumstances. The Knoxville Transit Authority was unable to maintain its base of service within its existing budget. Because the city was pressed financially and could not raise enough additional money to maintain operations, it was suggested that the broker could use its tools to help maintain service. The following conditions were considered to be essential for success:

1. A problem-solving mission having its major emphases on reducing automobile-related problems (such as congestion) and providing service to those to whom the community feels a moral obligation (such as the elderly, the handicapped, the poor, and the young);
2. A multimodal emphasis that used the most cost-effective options, including both nonsubsidized privately operated services and the publicly owned transit company;
3. Full responsibility and authority to make decisions that previously had pitted city council, mayor, and transit authority against each other;
4. Emphasis on the development of a competent transportation manager who can visualize the potential of all modes and serve as transportation spokesman in the community; and
5. The development of a professional, well-informed board that is interested in truly understanding transportation.

KNOXVILLE BROKER (KCP)

Figure 1 shows the relations between the broker, the city, the user, and the transportation supplier. KCP, a section of the Knoxville Department of Public Transportation Services, performs the functions of the transportation broker. KCP has a staff of six: an administrator, a computer systems supervisor, three marketing technicians, and an information coordinator. The 1977-1978 budget is as follows:

Item	Amount ($)
Personnel	60 211
Services	35 700
Materials and supplies	4 000
Equipment	5 000
Total	104 911

Functions of the Transportation Broker

To understand why the second stage Knoxville organizational structure was adopted, it is necessary to review the functions of the Knoxville transportation broker in at least a summary manner. They include, but are not limited to,

1. Reduction or elimination or both of institutional barriers to paratransit,
2. Determination of the transportation needs of users,
3. Determination of transportation abilities of private and public providers, and
4. Matching of the needs of users with the abilities of providers.

Institutional Barriers

The transportation broker must first address the institutional barriers that prevent or restrict the use of paratransit. In Knoxville, those issues included the difficulty of obtaining insurance and the excessive cost thereof for car pools and van pools. The problem in Tennessee was two-fold: past legislation that placed car pools and van pools under the jurisdiction of the Tennessee Public Service Commission and the attitude of the insurance industry toward ride-sharing vehicles. Both of those barriers were overcome as a result of research and lobbying by the transportation broker.

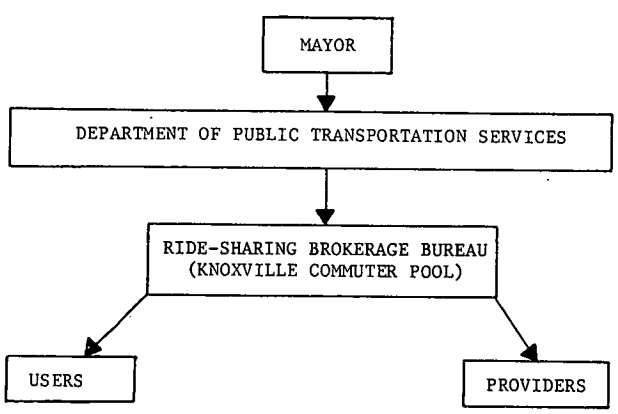
Another barrier was the requirements of section 13c of the Urban Mass Transportation Act of 1964. By working cooperatively with labor, the transportation broker was able to bring about two section 13c agreements that satisfied both fixed-route management and labor.

Still another barrier was at the local government level. Traditionally, the city of Knoxville has prohibited taxicab ride sharing, and the local taxicab ordinance made no provision for taxicab feeder services to fixed-route transit. These barriers were overcome by a new taxicab ordinance that was designed by the transportation broker and approved by the city council.

Determination of User Needs

To avoid promoting any single transportation mode merely to perpetuate its use, the transportation broker must determine the needs of users and then seek out the mode best suited to meeting those needs. In Knoxville, the transportation broker determined the needs of workers by making in-plant surveys. These surveys provided the input to a computer-based data file that now contains about 20 000 names of workers with their home addresses, work addresses, start work times, and quit times. The data file also indicates those who wish to drive and those who wish to be passengers. With a total work force of about 100 000, it is possible to obtain five or more matches for approximately 90 percent of those who inquire. Distances of not more than 0.4 km (0.25 mile) and times of not more than 15 min are used as matching criteria. The ability of the Knoxville transportation broker to quickly and effectively match the needs of potential users with each other depends on an on-line computer-matching system that has been developed with the assistance of UMTA.

Figure 1. Community relations of the Knoxville broker.



Determination of Abilities of Private and Public Providers

While determining the needs of potential users, the transportation broker must also inventory the various transportation providers and determine their abilities to meet the needs of users. The Knoxville broker surveyed the private providers and analyzed the services of the public system. These data were fed into the computer-based data file so as to be available on an on-line basis. Thus the data base includes

1. Publicly owned fixed-route systems,
2. Publicly owned commuter express systems,
3. Privately owned commuter services,
4. Privately owned services for the elderly and handicapped,
5. Privately operated car pools, and
6. Privately operated van pools.

Other provider services that will be added in the future include taxicabs and limousines.

Matching Needs of Users With Abilities of Providers

This is the final step in the brokerage function. The Knoxville matching technique depends on computer matching of poolers and users with providers. It is this matching that has enabled the Knoxville transportation broker to develop a comprehensive transportation system of all available public and private modes.

Transferability of Brokerage Concept to Larger Cities

The reason why the brokerage concept is so difficult for the traditionalist to understand is that the traditionalist thinks of brokerage as a replacement for traditional service. On the contrary, brokerage is simply a process of making more efficient use of all services (including fixed-route transit) through improved management techniques.

The roles of the different modes used by a transportation broker can be compared with the roles of various types of airlines in the airline regulation model:

1. Trunk airlines such as United and American focus on high-density corridors and use large planes. Similarly, fixed-route, fixed-schedule rail services should concentrate on high-density urban corridors and use large vehicles to quickly transport more people longer distances.
2. Regional air carriers such as North Central,

Allegheny, and Mohawk airlines use smaller planes (e.g., the Boeing 737) to serve regional markets. Similarly, transit buses can be used to operate on major arteries and provide service between major activity centers, such as the downtown and suburban shopping centers.

3. Commuter airlines use small planes (4 to 10 passengers) to provide frequent feeder service to airports from low-density ridership areas. Similarly, shared-ride taxis, casual transportation, contract services, and jitneys could provide local neighborhood circulatory services and feeder service to the larger buses.
4. Charter airlines provide service wherever large groups of travelers make the same trip. Similarly, car pools, van pools, subscription express bus services, company work buses, and others could serve the needs of large groups of commuters.
5. Air taxis provide specialized service to groups with special needs just as the Easter Seal Society, contract services, volunteers, and ambulances, and other services meet specialized needs in the community.

In large cities, the brokerage concept will be most important for neighborhood circulatory service and feeder service to main-line transit routes. The major contribution of the broker will be to commuter groups and in meeting the special service needs of local neighborhood groups. Undoubtedly, the major step in implementing the brokerage concept in either large or small cities is to begin to think of people and their specific transportation needs rather than to dwell on vehicles and their operational problems.

Discussion

Patricia Van Matre, Southern California Rapid Transit District, Los Angeles

The transportation brokerage concept, as developed and implemented by Aex and Davis, has been much discussed in the past year. Groups responsible for transportation planning in Los Angeles have studied the model as a possible solution to some of the transportation ills of Los Angeles County. The paratransit advisory committee of the Southern California Rapid Transit District (SCRTD) has suggested that a type of brokerage may be the only solution to the proliferation of social-service-agency transportation services.

There is no question that the transportation brokerage concept has merit and can work well in certain small geographic areas. Therefore, rather than discuss the merit (or lack thereof) of the concept, I will address questions the paper has raised in the areas of its premises, its processes, its application to larger cities, and the requirements for the broker.

PREMISES OF BROKERAGE CONCEPT

The basic premises that merit clarification are (a) paratransit as a solution to the energy crisis, (b) paratransit as a way to deal with urban sprawl, and (c) benefits of paratransit to traditional transit.

Paratransit, the Energy Crisis, and Urban Sprawl

SCRTD has conducted a study of energy efficiency for its energy shortage contingency plan (1). This study concluded, as did Davis and Aex, that the energy crisis will force the reconsideration of the railroad-trolley model. However, SCRTD's reasons for coming to this conclusion differed from those given by Davis and Aex. In an energy crisis, the maximum available fixed-route system will be able to haul only 8.8 percent of total person trips (12 percent of work trips) in Los Angeles County. An energy crisis solution will, of necessity, include increased car pooling and van pooling as well as fixed-route buses. Demand-responsive transportation, because of its negative energy impacts (2), will not be a part of this solution.

Urban sprawl, a major contributor to energy consumption, is not caused primarily by urban congestion. Most commuters are forced to move to outlying areas by spiraling land prices in central areas. Businesses move out for similar reasons. We have found that when a business moves, employees continue their employment and simply modify their travel patterns (make longer trips). SCRTD's most successful subscription service came into being when an employer built a new facility in an outlying area where land prices were lower.

Benefits to Traditional Transit

As Davis and Aex have pointed out, demand-responsive transportation, van pools, and car pools can provide great benefits to traditional transit. Demand-responsive transportation is especially useful in low-density and hillside areas; however, the SCRTD Paratransit Advisory Committee found (3) that most demand-responsive services do not locate in such areas of need. These services, whose placement is uncontrolled, gravitate toward high-density areas where some ridership is guaranteed by sheer population density. SCRTD does not object to demand-responsive service as a supplementary service. Rather, the district objects to demand-responsive service carrying one passenger at an average subsidy of $3.50 when, at the SCRTD subsidy of $0.45/passenger, conventional transit could carry more than seven passengers (4).

We have found that demand-responsive transportation and conventional transit serve different markets. It is not the erosion of ridership that transit authorities such as SCRTD object to; it is the forced cutback of high-ridership lines to serving a limited number of passengers in a restricted area.

BROKERAGE PROCESS

Davis and Aex state that the area chosen for coordination in stage 1 is immaterial. On the contrary, the type of transportation, its nature, and its client characteristics all affect the ability to coordinate that transportation. For example, van pools and car pools are self-operated. Direct client demand determines the numbers and types of services offered. These modes serve relatively singular trip needs (work trips) and meet two simple goals: getting people to and from work and saving energy. Accordingly, these services are relatively easy to coordinate.

As the paratransit advisory committee found, demand-responsive and social service transportation are much more complex. These serve multiple trip needs (work, shopping, medical, and recreational) and different agency goals and methods of meeting those goals. Each agency or provider has different answers to the questions of how to order priorities of needs and what service is appropriate.

In addition, the larger the service area, the larger the variety of clients, the larger the number of services, and the greater the coordination problem.

Knoxville has done quite well in stage 1—coordination of van pools, car pools, and subscription buses. A pri-

vate, nonprofit corporation in Los Angeles, Commuter Computer, has also done well in organizing car pools, establishing van pools, and developing a data base. Atlantic Richfield, one of the parent companies of Commuter Computer, has been a leader in organizing its employees for SCRTD-provided subscription bus services.

The test of success for the brokerage concept will be when it enters the more difficult stage 3 and attempts to fully coordinate all transit and paratransit services.

APPLICABILITY TO LARGER CITIES

The use of the airline model to explain the application of the Knoxville experience to larger cities is of interest. There are severe limitations, however, in the use of the airline model (a private-industry model) to describe the ideal situation for transit (a public industry).

1. In transportation, a full range of services is needed in both high-demand-density and low-demand-density areas. The airline model works because the low-density services (air charters) can charge fares high enough to make low-density runs economically feasible, but low-density transit cannot.
2. Those wishing long-distance transportation in low-demand areas have low-cost alternatives available (buses or trains). Transit has only the automobile as a low-cost option and lack of automobile availability is the usual reason for using transit in the first place.

An obvious problem with transferability to larger cities, unrelated to the airline model, is that the larger the population and area, the larger the number of specialized services that must be coordinated. In areas such as Los Angeles County [which has 10 577 km^2 (4083 $mile^2$) and and 7 million people], the coordination problem is much more complex than in Knoxville [which has 1367 km^2 (528 $mile^2$) and 310 000 people]. Because of the proliferation of services in Los Angeles County (there are 760 providers of specialized transportation), substantial changes in state and national legislation would be necessary before a brokerage concept could be implemented.

REQUIREMENTS FOR THE BROKER

Finally, Davis and Aex do not approach the question of the requirements for the broker. Obviously, because the broker has the power to decide on service allocation, it should be nonpartisan. Ties to city council persons, county supervisors, and other politicians should be avoided. The broker should also be careful to avoid increasing service to one specialized group while decreasing service to the population as a whole, and system integrity should be maintained.

Other areas have discovered, as has Los Angeles County, that the problem of turfism is serious, especially among the 760 social-service-agency operators of paratransit. A broker modeled after that in Knoxville treads a thin line in dealing with individual agency turf. The broker plan stresses cooperation, but the actions required to coordinate agencies and eliminate turf may eventually require coercion.

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Involving the Private Operator

Eugene R. Leyval, California Taxicab Owners Association, Sacramento

Issues related to the use of the excess capacity in paratransit resources provided by taxicab operators are discussed, and recommendations are made. The local nature of the daily surface transportation of people is stressed. The decisions regarding options available under federal and state public transportation programs that most directly affect efforts to more effectively use existing public transportation resources, including private operators, are local. The states should provide technical assistance to those local governmental entities that lack the staff and economic resources to support permanent public transportation research and planning. The states should also exercise leadership in harmonizing public transportation planning and optimizing state and local programs and funding mechanisms to supplement federal efforts. Before additional paratransit funding sources are approved, the states should identify and understand the use of the paratransit funds already available in their jurisdictions through federally funded categorical programs. They should seek to reallocate these existing monies to purchase paratransit services more effectively than is possible under present circumstances of fragmentation, duplication, and waste. Reforms at the federal level are ultimately necessary to achieve this. More must be done at the regional level to identify existing public and private paratransit services and resources. Advisory committees to metropolitan planning organizations are recommended composed of public transportation decision makers, users, and public and private providers. The need for local regulation to implement innovations in meeting paratransit demand is addressed. The roles of independent owner drivers and lease drivers, shared-ride taxi services, and fuel-tax relief equal to that granted transit are discussed as reforms required to enable the private operator to gain control over operating costs and provide for easier entry into the taxi market for entrepreneurial drivers. Labor considerations under section 13c of the Urban Mass Transportation Act of 1964 need not have only negative connotations in the use of private operators for paratransit service. As taxicab operators move into shared-ride services and function as mass transportation companies, with or without Urban Mass Transportation Administration monies, their employees may qualify for section 13c protection whether or not they are unionized.

BACKGROUND

Paratransit, by its very nature, is responsive to local demands, socioeconomic conditions, and geographic configurations. These types of services are constantly evolving, changing, and adapting to market demand. The pace of paratransit activity has quickened dramatically in recent years because of public policy developments at

the federal and state levels, and there are now a bewildering number and variety of paratransit services throughout the country. It is a constant challenge to keep up with all that is going on. Both private operators and public officials, therefore, are often unaware of or inadequately informed about the options available to them for mutually beneficial relations that could lead to more effective delivery of paratransit services in their communities.

There is a traditional parochialism in the public and private sectors with regard to one another. For years, the private automobile has been (as it is likely to remain) the primary surface mode for personal mobility in the United States. The impact of the automobile on land use and development and the concurrent decline or lack of development of public transportation in most areas have fostered a climate of benign neglect of each other by the public and private sectors in public transportation. Until the recent increases in inflation and development of environmental considerations, public interest and political pressure favored the private automobile. Public officials, accustomed to private providers of public transportation surviving as best they could in the marketplace, merely collected licensing revenues and maintained a supervisory role over the provision of a reasonable level of service at appropriate and accountable rates.

At the same time, taxi operators were pleased to have as little as possible to do with public officials because their firms were often diversified and pursued a variety of markets, providing services far beyond the stereotypical exclusive ride. It is quite common for a medium-sized taxi firm with a fleet of 40 to 50 vehicles to provide transportation services for specialized markets such as clients of social service agencies, school children, employees on the job, the elderly, and package, message, and mail delivery. Taxi firms often operate airport limousines, charter limousines and buses, automobile rentals, ambulances, and even tow trucks. This diversity and experience, which constitutes an in-place paratransit resource in most communities, was developed in spite of the dominance of the private automobile and before the era of federal and state subsidies for paratransit services. It has produced private operators who, as small businesses, take pride in their ability to operate on a narrow margin of profit, survive, and remain independent.

Increasingly, public policies are supporting public transportation programs and attempts to diminish the degree of reliance on the private automobile for surface transportation. Government monies are now available for paratransit services under contract with private operators that will offer transportation officials a range of new choices and arrangements for the delivery of these services. Many operators, however, have neither the time, economic resources, nor information to pursue these new opportunities. And where aggressive taxi operators have attempted to develop proposals in accord with the new subsidy programs, they have often been rebuffed at the local level by public officials who are unaware of the possibilities for paratransit services or, because of attitudes conditioned by restrictive local taxi ordinances, are unable to imagine taxis providing any transportation service other than exclusive ride. Moreover, the natural conservatism of public administrative officials often makes them reluctant to change the way things are done.

There remains a general unwillingness on the part of both the private and the public sectors in transportation to deal with each other at the local level. This is aggravated by a persistent lack of awareness on both sides of continuing developments in federal and state programs for paratransit and the various approaches and combinations of approaches available to imaginative decision makers. Both sides need leadership and the motivation to take the first steps toward joint efforts to deliver paratransit services more economically and effectively in their communities.

THE STATES

For the public and private sectors to effectively contract for the delivery of paratransit services, the various sources of government funds should be minimized and unified so that they can be identified and pursued in an accountable and orderly manner by local public and private transportation officials. The present situation has been described by Brooks (1).

> The disaggregated nature of human service delivery structures at the local level is most profoundly evident in the transportation minisystems that carry human services clients to primary program services. The U.S. Department of Health, Education and Welfare, the U.S. Department of Labor, the Community Service Administration, and others expend funds for client transportation services in more than 50 federally funded programs.

State transportation agencies have long had a strong role in decisions related to the private automobile. This role has ranged from allocation of financial resources to providing technical assistance where local jurisdictions find it unrealistic to maintain large professional staffs. In this new era of multimodal transportation, these agencies should also exercise leadership and initiative in making information and consulting services available to the public and private sectors at the local level. For example, model paratransit ordinances should be developed and promulgated.

There is a great need for state transportation agencies to work with other governmental agencies to coordinate and unify the categorical fragmentation that characterizes public financing of paratransit. Agencies that administer health and welfare programs and programs for the elderly and handicapped, as well as agencies that regulate and license transportation services, should all be involved in securing changes in federal and state legislation and departmental regulations so as to harmonize and rationalize the sources of funding for paratransit. This would free paratransit funds from the categorical programs in which they are now buried so that they could take their place with the transit and highway funds.

Saltzman (2) has indicated that it is impossible to know with precision the annual amount of federal funds being spent on paratransit programs through such agencies as the Urban Mass Transportation Administration (UMTA), the Federal Highway Administration, the Federal Energy Administration, the U.S. Department of Health, Education, and Welfare, and the U.S. Department of Housing and Urban Development. His estimate places the amount between a conservative $500 million/year and a liberal $1 billion/year.

To illustrate, California, which has approximately 10 percent of the nation's population, may receive about 10 percent of these funds. It is therefore possible that $50 to $100 million/year in federal funds alone are being expended for paratransit in California, a sharp contrast to the supposed shortfall in meeting paratransit needs in the state.

According to the California Taxicab Owners Association (CTOA), in 1973, taxi operations in California transported 32.6 million unsubsidized passengers, producing a revenue of $59.6 million. Coordinated, competent purchase of paratransit services with the $50 to $100 million of federal funds currently being expended, but

unaccounted for, would substantially expand and improve the delivery of these services. The most conservative reallocation of the smaller estimate for purchase of paratransit service from taxi operators would approximately double the size of the current market of 32.6 million unsubsidized exclusive-ride taxi passengers. The economies of shared-ride taxi could result in the purchase and delivery of paratransit services in a market more than double the current one served by taxi operators.

METROPOLITAN PLANNING ORGANIZATIONS

The involvement of the private operator is meaningless unless it can include involvement in the transportation planning process, and this is also true of users, public providers, and local and state government representatives. There should be regional and local task forces, or at least advisory committees, to provide a forum for contact, communication, and involvement in transportation decision making by all the affected parties. This type of contact and participation would generate mutual education and commitment to improved delivery of paratransit services.

Planning procedures should include an inventory of the available resources—a task that should come early in the procedure. Metropolitan planning organizations are in a position to aid federal, state, and local transportation officials by engaging in essential research on the taxicab resources within the area under their jurisdiction. The inventory should also include the social-service-agency transportation services being offered. This would identify the paratransit resources and funds available in the area and document the inefficient allocation of funds, the duplication of service, the waste, and the excess capacity. These are the initial steps required before developing alternative approaches involving private operators.

Regulatory restraints to service delivery soon become apparent in any inquiry into paratransit services. Metropolitan planning organizations can assist in the improvement of private-operator involvement by inventorying the local regulatory ordinances and analyzing them to identify changes that will foster broader and more flexible participation of taxi operators.

Those involved in the transportation system, from the federal government at one end to the users of services at the other, must become active on the issue of paratransit. State, regional, and local governments and private providers, as well as users, require a framework of communication and interaction that is oriented toward more effective and cost-efficient delivery of paratransit services. Without the involvement and commitment of these intermediate elements, there will be more of the same fragmentation and scattered demonstration projects, but no ongoing funding or implementation of a recognizable paratransit program.

APPROACHES TO INVOLVING THE PRIVATE OPERATOR

A diversity of services has been successfully provided in various forms and under various names by the taxi industry for many years (3).

Taxicabs perform a wide variety of paratransit functions. The taxicab company is a many-faceted service. Shared riding, jitney, multiple load, limousine, livery, school service, contract service, subscription service, dial-a-ride and package delivery have and continue to be an important part of taxicab operations for many companies.

With the probable exceptions of limousine and livery services and package delivery, these services have all been the subjects of recent studies and demonstration projects. The persistent cost-efficient performance of taxi operators in the delivery of these services offers a sound basis for involving the private operator in publicly subsidized paratransit programs.

The design of paratransit programs involving the private operator is affected by local physical, geographical, demographic, economic, and political conditions and mainly limited by the imagination of public transportation decision makers. Basically, however, there are two approaches to subsidizing paratransit services pursuant to contract with private operators: the userside subsidy and the serviceside subsidy.

Userside Subsidy

Many communities have found that a desirable, efficient method of matching transportation services to transportation users is to provide the subsidy directly to the user. This places the buying power in the hands of the user, who can purchase the service at a time and in a manner suited to personal convenience. The advantage to the subsidizer is that the funding is on a service-performed basis. The public sector does not assume the capital outlay and administrative burden of going into the transportation business, and service is paid for only when it is used. The problem of using a private enterprise and yet not subsidizing it is resolved by providing the subsidy directly to the user.

Accounting and administrative procedures are relatively simple in this approach. Normally, a coupon or charge-slip system is used to pay for the trip. Such questions as discounts, subsidies, and eligibility are determined and administered as a matter of local public policy. Many communities provide userside subsidies for paratransit to groups ranging from the entire population to narrow segments determined by such factors as age, income, or handicaps.

Taxi operators are accustomed to this type of system and find it easily adaptable to their services. System design and rates are pursuant to agreement between the private operator and the public sector. The coupons or charge slips are submitted by the provider for payment on a regular basis.

In El Cajon, California, a city having an area of 31 km^2 (12 $mile^2$) revenue-sharing funds are used to subsidize tickets that all residents can purchase at $0.50 each. The local taxi company provides communications equipment, vehicles, and drivers for the El Cajon Express, which operates as a dial-a-ride. The tickets will purchase a ride anywhere within the city limits; the average trip length is approximately 4 km (2.5 miles). The taxi operator keeps logs of the number of passengers, the distances they travel, and the tickets used. The city only has to monitor this data to ensure its accuracy, issue the tickets, and pay the proper subsidy to the provider on a weekly basis. The August 1977 data are typical: In that month the system carried 19 962 passengers, and the city paid a subsidy of $1.05/passenger.

Oklahoma City has embarked on an interesting demonstration project funded under section 5 of the Urban Mass Transportation Act of 1964 called share-a-fare that uses shared-ride taxi service provided by four taxi companies between 9 a.m. and 5 p.m. to meet the transit needs of the elderly and handicapped. Handicapped or elderly persons qualifying for share-a-fare can buy a book of coupons for $5.00. The initial purchase must be made in person, but renewals can be ordered by mail. When participants need transportation, they call a special share-a-fare number at least 1 h before the service is

needed. This allows the grouping together of riders who are traveling in the same general direction. A solo rider pays the fare shown on the meter. If there are two or more riders, each pays a proportional share of the fare, which is calculated from the first rider's starting point to the last rider's destination with a $0.50 charge for each additional person. The total fare is divided by the number of riders in the taxi. For example, if the fare from a beginning point to an end point is $2.00 and there are four people in the taxi, the total charge will be $1.50 for the three extra people plus the $2.00 fare charge (i.e., $3.50), and this is divided among the four passengers. When rides are shared, the rider is given the approximate cost of the trip when the call is made to order the ride (4).

Danville, Illinois, is using an UMTA Service and Methods Demonstration grant to fund a userside subsidy, taxi discount on a shared-ride taxi service. Taxi Transit in Danville operates 24 h/d, 7 d/week. Under the taxi discount feature of this project, the operator charges the normal fare, but the passenger pays only a portion of this in cash on the spot. The difference is paid to the operator with project funds. The group eligible for the service includes all persons 65 years old and over and handicapped persons under 65 years of age.

The Danville Planning Department certifies the riders and provides them with identification cards. The average fare is $1.37/passenger. The average share paid by the rider is $0.34; thus, $1.03 is charged to the project. The riders also pay an average $0.05 in tip. Hidden administrative and start-up costs, not seen by the operator or rider, have been about $0.25/trip, a cost absorbed by the project. Thus, the total real cost per trip (not counting tip) is $1.62, of which $0.34 is paid by the rider and $1.28 by the project (5).

Serviceside Subsidy

A serviceside subsidy goes directly to the private operator pursuant to a contractual arrangement that usually specifies an hourly rate of compensation for the time the transportation service is provided. In some of these arrangements, the operators are allowed to keep the fares as an incentive to increase the ridership. In others, the operators must return all fares to the public authority. The hourly operating costs and subsidies are arranged by negotiation or in response to terms and specifications for service issued by the public authority calling for bids to provide the service.

Long Beach, California, implemented a specialized system for the elderly and handicapped in February 1976, following recommendations of a committee that included members of the handicapped community. Handicapped persons in Long Beach did not want to use hydraulic lifts on regular transit buses because of the danger and inconvenience of rolling their wheelchairs down the street at night or in bad weather. In addition, the local curbs were not built for wheelchairs, which would have had to travel down the streets in a lane of traffic. The handicapped community unanimously requested that the Long Beach Public Transportation Company (LBPTC) use special small buses with hydraulic lifts and operated on a dial-a-ride basis limited to the elderly and handicapped.

The LBPTC now owns six hydraulic-lift-equipped small buses, and the Diamond Cab Company has a contract to operate the service. LBPTC maintains control of the quality of service and the approval of applications and also subsidizes the operation at an average rate of $10.05/service h/vehicle. Eligible riders obtain special identification cards that permit them to ride at a cost of $0.50/trip or by using 10-ride books that cost $3.50. As an incentive, the taxi operator is allowed to keep the fares. This arrangement is not only a more economical method of operation, but also more practical, because the cab company can use its fully experienced dispatchers. The buses are running to capacity. In 1976, it cost about $4.00/passenger to operate the service, and ridership averaged 3000 to 3200/month (6).

The contractual arrangement enables LBPTC to provide the service at a saving of approximately one-third the cost by the public sector. The private operator's cost for drivers is 40 percent less than that of the public operator, his dispatching cost is 30 percent less, and his maintenance cost is 40 percent less. The private operator's drivers are represented by a labor union whose members and leadership are receptive and accustomed to the innovative approaches that characterize paratransit operations. This allows for flexibility and personalized attention to the individual needs of the handicapped users of the service.

Fullerton, California, provides an example of a unique relationship—that between the Orange County Transit District (OCTD) and the Yellow Cab Company of North Orange County. Dial-a-ride service is provided by using five 19-passenger buses leased to the cab company by OCTD and five cab company sedans. The buses and the sedans are dedicated to the dial-a-ride service and bear the OCTD colors and identification symbols as well as the Fullerton dial-a-ride seal and telephone number.

The cab company keeps all the fares it receives as an incentive to increase ridership and receives an OCTD subsidy of $9.65/service·h/vehicle. The cab company operates and maintains the vehicles and is responsible for hiring and supervising all personnel, including drivers, dispatchers, supervisors, and maintenance employees.

OCTD vehicles in fixed-route transit service operate at a cost of $25.00/service·h. The transit district has no experience with or data for demand-responsive services provided by the district itself. The total cost to OCTD for implementing and monitoring the dial-a-ride service is $470 000/year. The funds are derived from existing budgeted allocations; no capital investment was required. The service operates Monday through Saturday from 6 a.m. to 7 p.m. The small buses are used during peak travel periods.

The Fullerton dial-a-ride meets community needs beyond the fixed-route service and offers transfers to the fixed-route service and neighboring dial-a-ride services. Regular fares are $0.50; fares for the elderly are $0.25; handicapped persons and students pay $0.15; and handicapped persons with a special pass, riders with transfers, and children under 6 years of age ride free. Ridership for August 1977 was 11 500.

Peterborough, Ontario, withdrew its fixed-route bus service from a suburban area west of the city in May 1974 and instituted a taxi-feeder service instead. The Peterborough Trans-Cab service is provided by one taxi company under contract with the city. Passengers are transported between the bus stops at the eastern boundary of the transfer area and points within the area. Bus riders pay $0.10 more than regular bus fare for this transfer service. The taxi operator is subsidized by the city at the normal meter rate. The contract provides no incentives for shared rides and the resulting reduced costs.

During the first 9 months of service, monthly ridership averaged 3894, with a deficit of $0.60/passenger. The former fixed-route bus service in the area had had a deficit of $2.34/passenger. Trans-Cab tripled ridership; therefore, the total deficit faced by the city for transportation in this area stayed almost constant (7).

PROBLEMS AND ISSUES

Paratransit programs involving taxi operators usually reflect unorthodox and innovative approaches on the part of both the public and the private sectors. The programs cited above to illustrate userside and serviceside subsidies are not examples of taxi service in the traditional sense. Many local regulations limit taxicabs to exclusive-ride service in vehicles driven by the employees of the taxi operator. Exclusive-ride service may be defined as a taxi ride in which a single passenger is normally in charge of the trip and the time of pickup, point of origin, intermediate stops, route, destination, and even, at times, speed, are specified by the passenger. The result is low vehicle productivity and high operating costs and fares. Exclusive ride is an expensive service, beyond the purchasing power of a large portion of the population. A transportation resource that is already available in most communities is underused and left with excess capacity because of local regulatory restrictions.

Regulatory Reform

The need for regulatory reform is expressed in the UMTA statement on Proposed Policy for Paratransit Services [41 Federal Register, 46 412 (1976)].

Outmoded local laws, regulations, and ordinances often constitute a barrier to paratransit implementation. Local and state agencies are encouraged to review existing laws, regulations, and ordinances pertaining to paratransit operation, and eliminate or revise obsolete requirements or prohibitions that constrain or inhibit the introduction of paratransit services.

There appears to be a need at the municipal level for more knowledge and understanding of public transportation policy and the developments taking place at national and state levels as well as of the response developing within the private sector. Taxi operators who attempt to secure ordinance changes and obtain a greater share of the growing public transportation market often find that local officials are unwilling to view taxi service in other than stereotypical exclusive-ride terms. Local officials are seldom aware of the untapped potential offered by taxicabs as a public transportation resource already present in most communities. Restrictive points of view and restrictive regulations at the local level often preclude the delivery of innovative demand-responsive services by professional taxicab-industry managers.

Federal and state transportation administrators are increasingly sensitive to the crisis in transportation financing that promises to persist for the foreseeable future. These people are recognizing that taxicabs offer significant advantages for cost-effective delivery of a variety of paratransit services. The time has come for municipal officials to reevaluate local regulations toward the goals of increasing taxi productivity, reducing taxi operating costs, pursuing innovative contractual arrangements with taxi operators, and thereby purchasing the optimum paratransit services possible for their communities under public financing programs.

A case in California offers an example of a failure on the part of the public and private sectors to work cooperatively with each other in providing an innovative public transportation service.

In the early 1970s, the Yellow Cab Company of Merced, California, pioneered a reduced-rate tariff on a shared-ride basis, and by 1973, these tariffs accounted for more than 50 percent of its revenue. In 1973, the city of Merced instituted a publicly funded demand-responsive system with lower subsidized fares than those offered by the unsubsidized shared-ride taxicab service. The city service charged a fare of $0.25/passenger for any destination in the city while the taxicab service charged $1.00/passenger, except that 2 or more passengers going from a common origin to a common destination could ride for $0.50 each. The publicly funded system operated, for the most part, during weekday daylight hours. The taxicab shared-ride and exclusive-ride service was available 24 h/d, 7 d/week.

The public system diluted both the shared-ride and the exclusive-ride revenues of the private operator, which led to a reduction in the number of private-operator vehicles from 25 to 10 by the summer of 1976. In the fall of 1976, the city announced plans to expand the public system. The private operator then terminated his taxicab operations in an atmosphere of personality clashes and misunderstandings with city employees and officials, and the matter continues in a costly litigation process.

The lack of effective communication and understanding between the private operator and the city precluded a mutually informed approach to the question of providing low-cost transportation for the transit-dependent of the area. If both parties had attempted to approach the matter rationally and with knowledge of each other's purposes and capabilities, the unfortunate ill will, attendant publicity, and loss of an existing transportation resource might have been avoided. The public sector and the private operator in this community could have provided an example of a joint public transportation effort by city transportation officials and private enterprise at a cost and service level that benefited the users, the public, and the private operator.

Shared Ride

The federal requirement that shared-ride services be included to qualify for financial assistance is a principal element of UMTA policy. Municipal authorities will be faced with this in their continuing attempts to obtain increased public transportation from existing community resources. The demand for paratransit service is already strong, and it will grow as inflationary pressures and the economic effects of environmental protection policies increasingly affect the dependence on the private automobile.

Shared ride is a recognized priority with the taxicab industry. The International Taxicab Association (ITA) has developed an official industry description of this service.

The purpose of shared riding (other than exclusive-use taxi service) is to increase productivity of taxi service and lower customer charges by encouraging concurrent use of a taxi vehicle. It is a taxi trip where passengers enter at one or more origins and depart at one or more destinations, paying individual fares. Such service is typified by advance arrangement and has been designated dial-a-ride or plan-a-ride, among other names. The rate is usually fixed in advance and is reduced from exclusive-use charges for each passenger. It may be calculated by taximeter or zone maps or be a predetermined flat rate.

Greater vehicle productivity will mean greater use of currently unused capacity in the taxicab industry and more economical delivery of paratransit service to passengers. To increase the involvement of taxi operators in paratransit delivery systems, it is important that local authorities review this matter and enact regulatory provisions that provide for both shared-ride and exclusive-use taxicab services.

Independent Contractor Drivers

Many local ordinances restrict taxi operators and their drivers to an employer-employee relationship. Contrac-

tual relationships between operators and independent owner drivers or lease drivers are often explicitly forbidden by local regulations. However, labor costs account for as much as 70 percent of taxicab operating costs and have become an important factor in the rising rates that are pricing taxi service out of the reach of significant numbers of people. When ridership decreases, an operator's driver force must be reduced. The upward movement of labor costs is motivating taxi operators to look for alternative types of arrangements with drivers beyond the employer-employee relationship.

Taxicab ordinances should allow a variety of driver relationships so that operators and drivers can choose the one that best suits their needs. Ordinance changes in this area would benefit all concerned: taxi drivers, taxi operators, and the general public.

Independent contracting in the taxi industry offers an entry into the market for independent driver business persons. Recent experiences in Los Angeles, San Francisco, and San Diego have shown that many drivers are eager to seek independent contractor status. Becoming an owner driver or a lease driver, functioning under the authority of a licensed taxi organization, can be the entry into the market for a small entrepreneur as well as providing him or her economical access to important support services such as volume purchasing, maintenance, insurance, marketing, and, above all, radio dispatching. Most paratransit services require skillful dispatching of vehicles pursuant to telephone orders so that equipment can be allocated efficiently and services matched to demand.

Benefits to Drivers

Taxi drivers would benefit from contractor status by enjoying the independence of a small business entity. Employee status brings with it employer-mandated work rules regarding such matters as hours and location of trip orders. Many drivers would be attracted to the incentives and options open to an independent entrepreneur in the marketplace and under the tax laws. Independent contractor drivers, prompted by the profit motive, tend to develop a spirit of competitiveness and satisfaction by promoting business for themselves through personal contacts in the community or by providing business cards to passengers.

Independent contracting in the taxicab industry can provide business opportunities for the disadvantaged and unskilled unemployed by offering entry into the market for a relatively modest capital investment and avoidance of costly overhead and support service by purchasing these from authorized operators for reasonable fees.

Benefits to Operators

Taxi operators are giving high priority to curbing the rising operating costs that have resulted in unprecedented rate increases since 1973. Taxis, like transit, suffer a loss of ridership whenever a rate increase goes into effect. Unfortunately, demand in the taxicab market is elastic, and many passengers who leave it do not return. ITA reports that more than 60 percent of taxicab trips are by housewives, students, the unemployed, the elderly, or the handicapped. When taxicab transportation is priced out of their reach, comparable mobility—in terms of accessibility, comfort, safety, and convenience—is simply not available to them.

Independent contracting with drivers would relieve taxi operators of the burden of inflated labor costs by eliminating driver payrolls, legally mandated payroll taxes, and the overhead costs associated with the administration of payrolls and supervision.

Fuel is a critical cost factor for operators. Drivers who contract independently commonly purchase their own fuel. They are consequently much more concerned with its consumption as a cost of doing business and tend to use less.

Benefits to General Public

The general public should find an improved level of taxi service with independent contractor drivers. Drivers who are independent entrepreneurs are directly responsible for their own success. Competition and incentive require a clean and attractive vehicle and courteous and personalized service. More cabs can be expected to be at the public's disposal because the capital investment required for vehicles will be spread among many drivers, rather than concentrated among a few authorized operators. More economic resources can be devoted to marketing by authorized operators who would be in the position of selling their services to independent contractors. Marketing would, therefore, be an important service and an attraction for contractors to purchase.

The lower labor costs and increased taxicab productivity that would result from business promotion by independent contractor drivers and marketing by authorized operators would be an effective economic defense against the pace of rate increases. In communities where taxi service is threatened by costs (and, therefore, rates) that are too high for a significant portion of the market to pay, the option of independent contracting could maintain service in the community at more affordable rates. And the survival of the taxi resource will make it available for subsidized paratransit service to the transit-dependent at a reasonable cost.

Enforcement

Taxi operators cannot control the manner in which independent contractor drivers perform their work. This, of course, is not the case with employee drivers. The exercise of such control over independent contractor drivers would result in the loss of the nonemployer status and the benefits accruing to that status.

Local regulators must be aware that independent contractor drivers are not required to follow the rules and regulations of the taxi operator. This problem can be solved by writing into the local taxi ordinance specific rules and regulations regarding levels of service to be maintained by independent contractor drivers (e.g., response to duly dispatched telephone orders for service, even in unattractive outlying areas). The local ordinance should provide for the revocation or nonrenewal of the public-vehicle-driver permit of a taxi driver who violates service levels. The franchised operator could then refuse to enter into or maintain a contractual relationship with drivers who had rendered themselves legally incapable of performing the contract.

Finally, and most important from the public point of view, independent contracting under the umbrella of authorized operators provides regulatory authorities with a centralized point of access to mandated information collection and records. This allows them to monitor the operation for enforcement purposes and ensures service levels for the protection of the public interest.

Regulatory reform in the area of shared-ride and independent contractor drivers will enable transportation decision makers to more fully involve taxi operators in paratransit service.

Fuel Tax Relief for Taxicabs

The taxicab industry operates under particularly inequi-

table provisions in the laws relating to fuel taxes. Since 1964, the federal government has granted rebates to local transit systems for the federal tax on fuel. Revenues from federal fuel taxes have been used to aid local transit systems with capital grants and operating funds pursuant to the Federal-Aid Highway Act of 1974. Many states also provide fuel-tax relief and financial aid to local transit systems. The proposed Energy Tax Act of 1977 would extend fuel-tax exemption to intercity, local, and school bus operations.

In many areas, taxicabs compete for paratransit business directly with these tax-favored systems. Should taxicabs continue to face imposition of fuel taxes, the industry will be forced to subsidize its competition.

Whenever the taxicab industry has been allowed to bid on services to the elderly and handicapped, it has consistently been a low bidder despite its subsidized competition. The stereotypes of the expense-account taxi passenger and exclusive-use taxicabs are not supported by reality. More than 60 percent of taxi riders are transit dependent. In many cities, shared-ride taxi services are operating that, when used efficiently, can be as cost-effective and energy efficient as other forms of public transportation.

The scale of taxi operations is comparable with those of other forms of public transportation. In 1975, the taxicab industry transported 3.4 billion passengers as compared with 5.6 billion by transit. There were 5387 taxicab companies, 947 transit authorities and companies, and 950 intercity bus companies. Taxicab operations employ more than 0.5 million workers, transit employs 200 000, and intercity bus employs 46 000.

The taxicab industry is composed of small businesses; ITA data indicate that the average company fleet has 55 vehicles, and more than 1300 companies have fewer than 10. Glassman (8) has described the situation.

> It would appear ... that the taxicab industry is aggressively servicing existing and new markets and therefore should be a profitable industry. Unfortunately, the industry has not been able to keep pace with inflation, particularly in the areas of insurance and fuel. The taxicab industry has had its fuel costs increased from approximately 6 to 12 percent of the total operating costs. A similar increase has occurred in insurance in 3 years. In this year alone, we have seen an additional increase in the cost of gasoline of approximately 4.5 cents nationally.
>
> A study by Control Data Corporation and Wells Research Company, Taxicab Operating Characteristics (March 1977, page S-4) states, "Taxicab fleet operators have evidently experienced profit decline from 1970 to 1974. In 1975, the revenues of nearly 50 percent of the companies did not cover total costs (including capital costs). Revenues of 25 percent of the companies did not cover out of pocket costs. This tends to verify observed conditions in the industry resulting from drastic increases in fuel, insurance, and labor costs."
>
> Simply stated, this means 25 percent of the companies will not be able to remain in business.
>
> In a 1973 survey there were 6467 taxicab operators and the 1975 survey listed 5387. Some went bankrupt; others merged; many small companies simply closed their doors.

Virginia, Michigan, and Wisconsin have granted taxicab operations a full rebate on state gasoline taxes. Similar legislation is being considered in a number of other states. Considerations of equity lead to the conclusion that taxicabs should receive fuel-tax relief comparable with that given to other forms of public transportation.

Cost-efficient demand-responsive paratransit is a vital element in making public transportation competitive with the private automobile. Relief from fuel taxes for taxicabs would assist in controlling the cost of fares and provide another opportunity for the integration of taxicabs, transit, and intercity buses into effective public transportation systems.

Fuel-tax relief at the federal and state levels is a major requirement for continued investment of capital, time, and effort by private operators of taxicabs. In the absence of equity in this critical area of operating costs, taxicabs will continue to cease operations in their communities, and a valuable transportation resource will be lost.

LABOR PROTECTION CONSIDERATIONS

Section 13c of the Urban Mass Transportation Act of 1964 provides protection of the interests of employees affected by assistance under the act. It is not clear from a reading of this section which employees are affected. No mention is made, however, of union or nonunion employees, and it would appear reasonable that the provisions of section 3e of the act would require interpretation in favor of employees of mass transportation companies.

The paratransit-services policy statement proposed by UMTA [41 Federal Register 46 413 (1976)] requires that to be eligible for assistance, a private operator must provide shared-ride transportation on a regularly available basis to the public. The policy further states that the paratransit service must be more than an incidental adjunct to its main business for the private operation to be considered a mass transportation company within the meaning of section 3e, or a system with employees entitled to protection under section 13c.

If shared-ride, taxi-operated transportation services are eligible for subsidies from UMTA funds, it would follow that the employees of such services are covered by section 13c protection. This would be particularly true if UMTA funds were used for demand-responsive programs in competition with taxi-operated services.

In jurisdictions where shared-ride taxi operations exist pursuant to appropriate local ordinance provisions or where taxi-operated paratransit systems have come into existence with local, state, or federal sources other than UMTA funds (e.g., user-side subsidies from categorical social-service-program funds), claims for section 13c protection might be made by taxi employees.

Ideally, labor protection issues that arise in the course of planning and developing integrated paratransit and transit systems should be resolved in a climate of cooperation. The goal is to meet the growing public transportation demands within the buying power of increasingly scarce public funds. Efficiently operated paratransit services are an essential element in building ridership for transit services. As additional passengers are attracted from the private automobile, additional employment opportunities will become available in all public transportation modes. The alternative is declining transit service and jobs because of inability to deliver riders from their homes to fixed routes within the limits of available funds.

CONCLUSIONS

Most of the daily surface transportation of people takes place at the local level. The decision to exercise the options available under federal and state public transportation programs rests ultimately with local and regional decision makers. Their task is to analyze the existing transportation resources and relate the alternative transportation modes to each other and to the private automobile and avoid duplication; in short, to use existing resources, both public and private, more effectively.

These decisions can be assisted if the states assume leadership comparable with that which they exercise in decision making and allocation of financial resources relating to the private automobile. The primary decisions for public transportation are appropriately made at the local level. The states, however, can fill the need for

technical assistance in research and planning in local communities that lack the economic resources to support local full-time staffs. The states can work cooperatively with regional and local governments to harmonize public transportation planning and develop programs and funding mechanisms to supplement federal and local efforts.

The states should become directly involved in identifying and understanding the use of the paratransit funds already present in their jurisdictions through federally funded categorical programs. Before responding to demands for additional funding, the states may be able to reallocate existing monies so as to purchase more paratransit service than is possible under the present circumstances of fragmentation, duplication, and waste. Reforms at the federal level are necessary to achieve this, but leadership from the states could bring significant progress.

A unified approach to paratransit funding at the federal and state levels would bring the missing elements of oversight and accountability to this area of public transportation. Allocation of funds should bear some relation to productivity and efficiency as well as effectiveness in terms of user population and ridership.

Metropolitan planning organizations and councils of government are potential intermediate levels of influence in developing sound approaches to the delivery of public transportation services. The needs at these levels are research and planning oriented and catalytic in nature. Little is being done at the regional level to identify the existing public and private paratransit services and resources. Public decision makers, users, and public and private providers should be brought together to evaluate the present conditions of funding, demands, and actual delivery of paratransit services. A mechanism such as an advisory committee can assist in reshaping the bits and pieces of paratransit funding and resources into a more identifiable program that delivers service in better relation to demand.

A possible scenario might involve the establishment of a regional agency with transportation and funding brokering authority only. This would avoid the typical conflict of interest in which both planning and fund-disbursal authorities rest with a public provider. The responsibility of the agency would be to disburse paratransit (and transit) funds based on considerations of competition, efficiency, and effectiveness consistent with the appropriate local transportation planning goals and policies.

Regulatory reform, particularly at the local level, is necessary to enable the private operator to implement the innovations required to serve paratransit demands. Paratransit regulations and ordinances should allow authorized taxi operators to contract with independent owner drivers and lease drivers. Shared-ride taxi service should be allowed in addition to exclusive-ride. Fuel-tax relief comparable with that granted to public transit should apply to taxicabs. These reforms are essential to enable the private operator to gain some control over operating costs and provide for easier entry into the taxi market for entrepreneurial drivers.

The involvement of private operators raises labor considerations. Section 13c of the Urban Mass Transportation Act need not have only negative connotations. As taxicab operators move into shared-ride service and function as mass transportation companies with or without UMTA monies, their employees may qualify for 13c protection whether or not they are unionized. Paratransit, particularly demand-responsive service, is distinct from transit. The responsibilities and functions of workers and the rules governing them are related to the characteristics of the respective modes. These differences should be recognized from the point of view that, although paratransit and transit are distinct, they are also supplemental. Paratransit operations and funding are not competitive with those of transit. Indeed, paratransit, which can operate as a feeder service and can relieve transit of the high cost of serving the transportation dependent, can be vitally important to the future of transit and transit jobs.

Several of the approaches to involving the private operator are short-range in nature and can be implemented at appropriate levels of government without delay. Others are longer range because of political complexities. Private operator involvement can have a positive effect on the delivery of paratransit services within the limits of realistic costs. Whether short- or long-range action is in question, it is now necessary to move beyond the current state of institutional and economic factors affecting the delivery of effective multimodal public transportation service.

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Implementation and Evaluation

Perspectives on the Evaluation of Urban Transportation Systems

Jerry D. Ward,* Department of Civil Engineering, Massachusetts Institute of Technology

The term evaluation is very broad and has different implications for different people: An evaluation can be designed only after it is specified who is evaluating for what purpose against what criteria. The different perspectives of some of the more important actors are discussed here. There is a difference between comprehensive evaluation and functional evaluation. Comprehensive evaluation is concerned with external effects, e.g., pollution, energy consumption, evolution of land-use patterns, and other contributions to the quality of life. Functional evaluation is concerned with system performance parameters, e.g., wait times, coverage, productivity, ridership, and the other variables that characterize the supply characteristics and their appropriateness to the markets served. Two primary conclusions are developed. The first is that intelligent interpretation of an observed set of system descriptors requires a knowledge of the ridership pattern being served. Both potential productivity and service level are sensitive to ridership pattern, and without a knowledge of its nature, other comparisons are uncertain. The second is that the equilibrium between supply and demand is unstable. This implies that an observed trend in ridership will, in the absence of external change, probably continue. Thus, the rate and direction of change in ridership is the single most important evaluative measure, because it portends the future of the system and can be an early warning signal of a need for change.

NATURE OF THE PROBLEM

Evaluation of transportation systems is not a simple problem. First, the persons who are the evaluators are a diverse set of actors who have different perspectives, entertain different objectives, and therefore evaluate the transportation system (or the subelements thereof) by using different, often unarticulated, and changing criteria.

Second, the system being evaluated is often complex and exhibits strong characteristics of scale; i.e., as ridership patterns change, so do costs and levels of service, inducing future change. These interactions between supply and demand and their implications are generally not well understood, but they are crucially important.

Figure 1 illustrates the general framework of the problem. Although there are wide variations in both the degree of interest and the degree of potential impact of the multiple evaluators, it is clear that no single perspective can be taken in arriving at a total evaluation. And the various perspectives change with time and circumstances. A walk to an unsheltered bus stop on a beautiful spring day may be evaluated by riders as perfectly acceptable; it is evaluated in a very different way during a winter rain. A heretofore acceptable cost for installing shelters may be called into question by city officials the day after the sewage treatment plant breaks down.

In the analysts' parlance, we have a multiplicity of different objective functions that cannot be represented explicitly and that change over time.

The analysis and discussion of this is made somewhat easier by differentiating between two not independent, but essentially different, kinds of evaluation. From the definitions given by Hoffman and Goldsmith (1), comprehensive evaluation is that concerned with the impacts the transportation system is supposed to have, and functional evaluation is that concerned with the relations among ridership, service, and costs. These problems and the processes of their evaluation are sufficiently different that they will be discussed separately.

COMPREHENSIVE EVALUATION

The criteria for evaluation should be derivable from the objective(s) that the transportation system in question is intended to serve—e.g., to make the city a nicer place to live, to revitalize the economy of the city center, to reduce the air pollution to a given level, to induce a land-use pattern that is more energy efficient. The problems are that (a) it is often difficult to translate such broad objectives into measurable attainment criteria, (b) the achievement of these objectives almost always concommitantly depends on other conditions that are not functions of transportation performance, and (c) we seldom understand the causal mechanisms well enough to relate these broad impacts to measurable transportation performance characteristics.

Of these three problems, the third is the most limiting; we do not understand in sufficient depth the interactions between transportation system performance and the performance or behavior of economic and societal systems. Gomez-Ibanez (2) points out, for example, how limited is our current ability to relate transportation characteristics to land-use patterns. The wide differences of opinion about the ultimate worth and impact of the Bay Area Rapid Transit in San Francisco and Metro in Washington, D.C., are testimonial to this point.

Even when we can estimate the different impacts of transportation alternatives, they are seldom in a format that allows us to relate them to quality-of-life type objectives easily. The following paragraphs about Metro from the Washington Post (3) illustrate this.

> If there is no subway line from Gallery Place to Greenbelt, $766 million in construction costs will be saved but 21 300 more automobile trips will be taken every day in 1990.
>
> If the subway line to Vienna is halted at Parkington in Arlington County and remaining service replaced with express bus service, $244 million in construction will be saved but Metro will have to buy 540 new buses that will annually consume 10 million gallons of fuel more than the subway would.
>
> Those kinds of choices are spelled out in a new, 5.5-in thick study that was generated to help area politicians decide whether buses, trolleys, or more freeway lanes might be better than subways for some parts of the region.

Another complicating factor is the time horizon. In general, we are dealing with phenomena that change slowly and have long-term impacts that can be very different from their short-term anticipations. In a sense, this is derived from the problem of causal mechanisms. Confidence in long-run predictions is tantamount to confidence in the model on which they are based. However, although models are being improved as our understanding of the underlying phenomena grows, we still have a way to go. With the present state of the art in dynamic, long-run models, we should at least be cautious. Furthermore, people are impatient, and the politician is acutely aware that the political time cycle is short. Long-run promises carry a heavy discount rate.

This discussion of broader objectives is primarily relevant to subsidized, publicly owned systems. For them, the real evaluation is a public budget decision. In this arena, the costs and benefits are assessed through

the collective opinion of the political actors and their constituencies using a decision calculus that is much more complex and less traceable than the private sector discipline of profit.

In this discussion, the key distinction between comprehensive and functional is the difference between benefit (or impact) of ridership and ridership itself. Even for a simple, publicly supported, neighborhood system serving the handicapped or elderly, the question of whether the system is being operated efficiently can be answered through functional evaluation. But whether the benefit of that system is worth the cost involves comprehensive evaluation and typically is decided politically. Passenger travel is easy to measure; the worth of a particular collection of passenger travel is not.

Functional evaluation, to which we now turn, is much more amenable to measurement and analysis, but it too presents some difficult judgmental problems.

FUNCTIONAL EVALUATION

Figure 2 shows the hierarchy of interactions we are discussing. Comprehensive evaluation is at the top of the figure, and functional is at the bottom. The linkage variable is ridership: At the top, it is related to its effects on other objectives, and at the bottom, it is related to the supply characteristics of the transportation system.

At this level of evaluation, the perspectives that are of primary importance are limited. There are those of the riders and potential riders as they evaluate the service and price characteristics offered them and compare these to their alternatives and then decide whether or not to use the system. Thus, exogenous actions that affect the alternatives should also be considered in the total picture. For example, increasing the price of downtown parking affects the decision on whether to use transit or, alternatively, to join a car pool.

The second important perspective here is that of the system operator or planner who controls the trade-offs between service and cost characteristics. Ideally, the planner makes these trades with sensitivity to the perspectives of system users and potential users as well as to those of the political bodies that oversee the planner's actions and typically approve budgets.

Thus, the third perspective, looking over the shoulder of the operator, is that of the funder of the system. For a private-sector system, this is the owner (who may also be the operator and planner) and, for a public system, it is the polity. The perspective of the polity includes the social, environmental, and economic impacts of the system (comprehensive criteria), but the primary proxy variable is ridership. A well-patronized system garners more support than a sparsely patronized one.

In the following section, the primary perspective assumed is that of the operator or planner, because a good one will be sensitive to the other perspectives also. The planner's objective is improvement in some sense; the possibilities are considered below.

Figure 1. Evaluation framework.

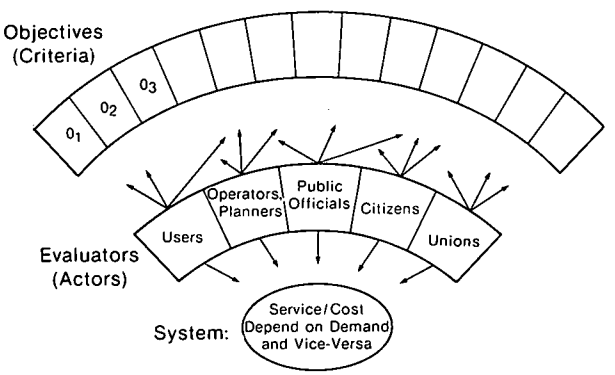
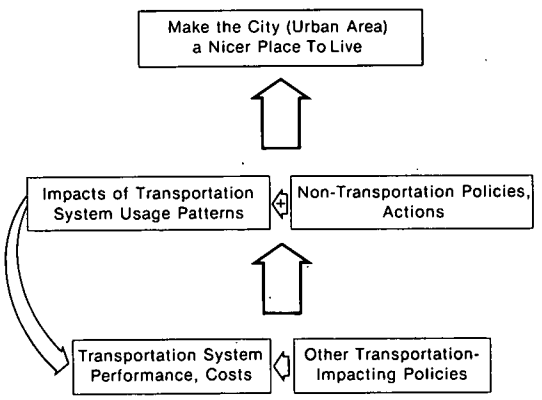


Figure 2. Hierarchy of interactions.



FUNCTIONAL EVALUATION: CONCEPTUAL FRAMEWORK

Most evaluations of transportation systems appear to be largely devoted to descriptions of the system, along with a collection of whatever numbers can be accumulated. There is usually very little (if any) interpretation of the numbers and their significance and almost never any prescription of what changes might be desirable and why. Evaluations tend to be largely descriptive, seldom analytic, and almost never prescriptive. This is understandable; we are dealing with a complex, many-faceted problem.

There are two fundamental kinds of interrelated trade-offs that characterize a transportation system. Evaluating the system really involves assessing how well these trades have been selected. The first are the market-sensitive trades—ridership versus service versus price. The second is the system-efficiency trade—service versus cost.

In developing a framework for the problem of functional evaluation, it is convenient to use the concept of a pattern of desired travel from the point of view of the potential user of public transportation. This is intended to represent the best one could do with public transportation and current technology in attracting ridership, given the competing alternative of the automobile and the extant rules and prices affecting its use. For example, the pattern of desired travel might be the travel pattern that would result if single-ride taxi service were available within 5 min of everyone. Clearly, the price at which it was offered would affect the resultant use; because the purpose here is conceptual, it can be considered free.

Obviously, this hypothetical system would generate a much higher level of ridership than any real system, but it would also involve prohibitively large subsidy. In real life, it would also compound congestion and use energy prodigally. In short, it is not a realistic alternative for a medium-to-large city; it is merely an expository device intended to crudely represent the maximum potential market for public transportation.

The primary technique in all transportation systems for lowering costs, reducing energy consumption, and improving space efficiency is aggregation. Aggregation permits the cargo, whether passengers or freight, to be

moved in fewer, higher capacity vehicles that are, ceteris paribus, cheaper and more efficient per unit of capacity than small vehicles. Aggregation is the principle behind car and van pooling, behind shared-ride rather than single-ride taxi service, behind dial-a-ride, and above all behind mass transit. Higher levels of aggregation are the primary reason that full buses are cheaper than full taxis, and full 747s cheaper than full DC-9s.

But there are also costs that must be paid to achieve aggregation. These are usually manifested in some kind of forced distortion in the desired pattern of travel, either spatial or temporal. That is, the users of the system are required to either travel at a different time than they really want, or follow a more circuitous route (that may include their own walking to and from a pick-up point) than they really want, or both. This is the essence of the problem: achieving a reasonable trade-off between the benefits of aggregation and the penalties of service distortion.

Figure 3 illustrates these ideas of temporal and spatial distortion: Figure 3a illustrates a hypothetical pattern of desired travel during three 5-min intervals. But if service is offered only every 15 min, rather than every 5, then all of that travel is aggregated into one set of trips (Figure 3b). Thus, some people either forego the trip or take it at a different time than they prefer. But if they do take the trip, more people travel at the same time and the aggregation is higher.

If the system does not offer origin-to-destination service and therefore requires walking to a pick-up point, then the ideal pattern will be distorted spatially, as illustrated in Figure 3c, in which a bus route that does not go to all origin and destination points was assumed. By choosing the simple route from A to B, the circuity is minimized for the vehicle and for the A and B passengers, but forced on the potential passengers from points C and D. But if the bus route goes through all four points, then the trip for passengers from A and B is more circuitous and therefore takes more time, but the walking for the C and D passengers is eliminated. The operator sees such circuity as extra costs (the price) incurred to achieve the economies of aggregation. Everything involves trade-offs; one attribute is traded for another; what helps one person hurts another.

Figure 3. Pattern of desired transportation.

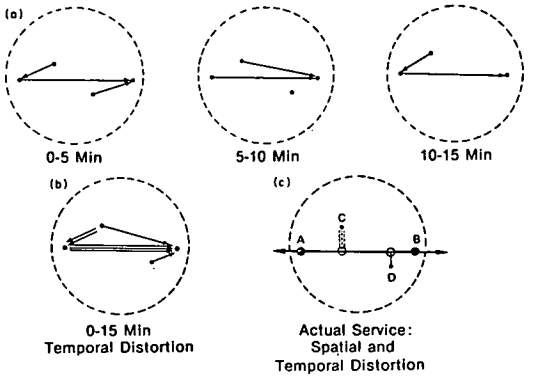


Figure 4 summarizes the way the actions to reduce operator costs impose walk-wait-circuity distortions on the ideal movement pattern as perceived by potential riders. If potential riders can readjust their travel times to smooth the peaks and valleys in demand, then drivers and vehicles can be used more steadily and avoid idle times, and the system is better utilized. If riders can wait for less frequent service, then more can ride at one time, and the aggregation is higher. If there are fewer pick-up points, then riders must walk more, which makes their total trip more circuitous for them but, for the operator, increases aggregation and reduces vehicle-path circuity.

Figure 4. Cost reduction distorts desired pattern.

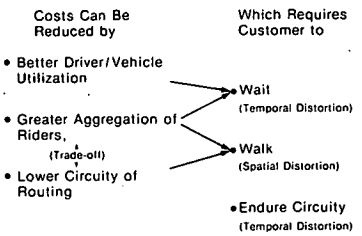
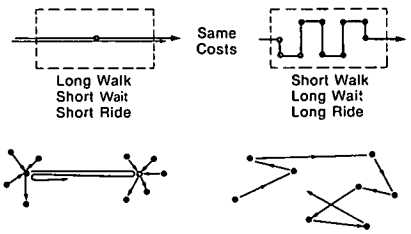


Figure 5 shows two more examples of how in real systems wait time is traded for walking, or spatial distortion is traded for time distortion. The system shown on the top left has a higher frequency of service and less circuity for the vehicle so that the rider has less in-vehicle time, but the price is more walking to the pick-up point. In the system shown on the top right, the rider trades less walking for longer waits and more in-vehicle time. The market decides which is preferred.

The system shown at the bottom left of Figure 5 offers shuttle service between two collector points rather than individual door-to-door service. If the actual origins and destinations are closely clustered about the chosen collector points, the riders may prefer the shuttle service to door-to-door service because it provides (at the same cost) more frequent service and shorter ride times. But if actual origins and destinations are more randomly located, then door-to-door service may be preferred; circuity and wait time will be traded for walking. An example of this type of trade occurred in the early days of the Batavia, New York, system. Because the ridership patterns observed in providing origin-to-destination dial-a-ride service suggested that using one vehicle as a point-to-point shuttle would be preferred to continuing with dial-a-ride only, mixed service was instituted.

Figure 5. Trading wait time for walking.



The more general problem of evaluating whether flexible-route service; fixed-route, fixed-schedule service; or some combination is preferred in a given market situation is more complex than simply calculating relative productivities. Some people apparently just will not ride without door-to-door service; others would prefer to walk to a pick-up point rather than make the implied commitment of calling a vehicle to come to their door. The managers of the Teltrans System in Ann Arbor, Michigan, encountered this problem when they were contemplating the substitution of fixed-route service for dial-a-ride service in a neighborhood where ridership was outgrowing the existing service. None of these trades are simple.

Thus, the quest for an absolute scale or set of standards with which to evaluate urban transportation systems is not likely to succeed unless the schema reflect the fact that one attribute must be traded for another. Furthermore, these trades are both market and site specific. A system operator or planner must simultaneously make two kinds of judgments. The first is a market judgment in which he or she must estimate how ridership will re-

spond to various combinations of service (walk-wait-circuity) and price; i.e., what combinations of temporal and spatial distortion of the ideal travel pattern are likely to be the most tolerable to potential riders at a given price. The second is an operating-efficiency judgment in which he or she must estimate how costs will vary as a function of the service (walk-wait-circuity-coverage) offered. Typically, these trades must be decided in the context of a constrained maximum capital-and-operating-subsidy budget. It is not an easy set of decisions. Furthermore, there are numerous pragmatic considerations. Complex operational schemes are confusing to both system operators and system customers, so that there is a premium on simplicity. Changes are slow and usually difficult to bring about, so that frequent experimentation is not usually possible.

The criterion for making these trades is usually some ambiguous version of maximizing the ridership of the target market per unit of subsidy. The qualification "of the target market" is important. For example, a service aimed at helping the elderly that becomes so popular with teenagers that no elderly person wants to ride has missed its objective.

The first of these trades, the ridership versus service versus price relation, is illustrated in Figure 6a. The evaluative question here is whether the spatial and temporal distortions imposed by actual service on the pattern of desired travel are reasonably appropriate to the service propensities of the target market(s); i.e., would offer a different type and pattern of service to attract a higher ridership? This is clearly difficult to answer because we can only deduce desired travel patterns and service propensities from questioning and observed behavior. Both can be very misleading; people often do not know what they want until they experience it, and short-run behavior is often not the same as long-run behavior.

This market-match question entails two different ground rules. The first governs whether more ridership can be attracted by offering a different combination of service and price under the restriction that total deficits do not increase. The second relaxes the constraint on costs. The addition of these dimensions to the original market-match question is illustrated in Figure 6b.

Obviously intertwined in these market questions are the issues of efficiency in choice of modes and utilization of the factors of production. The principal clues to a need for improvement are low load factors, low utilization of equipment and personnel, or a combination of these. Some are unavoidable; transportation, like almost all other forms of human endeavor, has its peaks and valleys of activity. The problem is to minimize their impacts; strategies to do so will be discussed below.

This discussion of a conceptual framework for functional evaluation has not introduced any unfamiliar thoughts; its usefulness depends largely on whether one's personal way of thinking about such problems agrees with the perspective chosen here for exposition. There is, however, one more element of the conceptual problem that is important to the way the market-match and efficiency questions are viewed. This is an aspect of the problem that may be more important than the attention that has been accorded it: the nature of the supply versus demand equilibrium and its implications for system evaluation.

Figure 6. Market-match framework.

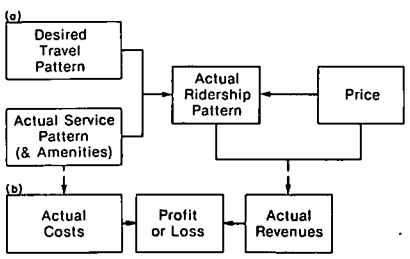
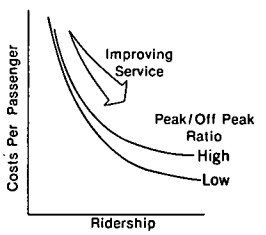


Figure 7. Transportation system costs.



CONCEPTUAL FRAMEWORK: DYNAMIC SUPPLY VERSUS DEMAND INTERACTIONS

The basic determinant of the productivity a transportation system can achieve depends on the pattern of movement being served. A high productivity is possible only if a high level of aggregation of riders is possible. High aggregation is possible only if the number of origins and destinations is relatively limited in comparison with the density of ridership. High utilization is possible only if there is no markedly varying temporal pattern that produces high peak-off-peak ratios. These points are summarized below.

1. Greater aggregation of flows permits larger vehicles and higher service frequency or both, and
2. Flat temporal patterns permit better vehicle and driver use and simpler management.

Figure 7 shows how costs of operation vary with level of ridership. The curves are intended to be illustrative but are based on an actual calculation for a medium-sized city (4, 5). Increased ridership represents higher levels of aggregation, thus lower costs and better service. In general, service improves with ridership for three reasons: (a) once the ridership exceeds that associated with some minimum service threshold, frequency of service can be increased; (b) higher ridership increases the opportunity for more direct routing; and (c) at higher ridership, more infrastructure amenities such as shelters and information systems can be afforded.

The important point is that when ridership is growing and peak-off-peak ratios are improving (or both), then service and productivity should also be improving. This, in turn, may induce still greater ridership. (There is a caveat; if labor or other costs are growing, then productivity improvements can alleviate the growth in total costs, but may not completely offset it.)

Conversely, if the ridership is decreasing, the portents are for further worsening as costs increase and service decreases. Decreasing ridership and increasing peak-off-peak ratios are the early warning signals of deteriorating systems.

An important part of an evaluation, then, is to observe and analyze the direction of change of ridership patterns, so that if the system is deteriorating, corrective actions can be taken and the disequilibrium between demand and supply characteristics reshaped. This should be done on a market-by-market and individual route or neighborhood basis: Aggregate averages hide too much.

To summarize, transportation systems typically operate where marginal costs are falling, and the quality-of-service changes that come with increased service frequency and more direct routing are shifting the de-

Figure 8. Leading indicator: direction of change of ridership patterns.

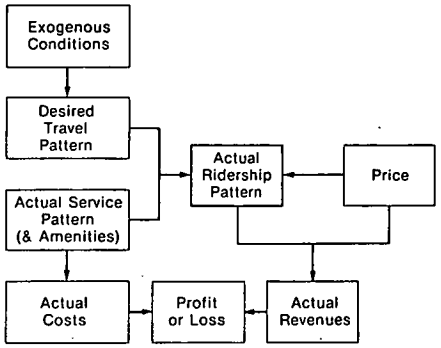
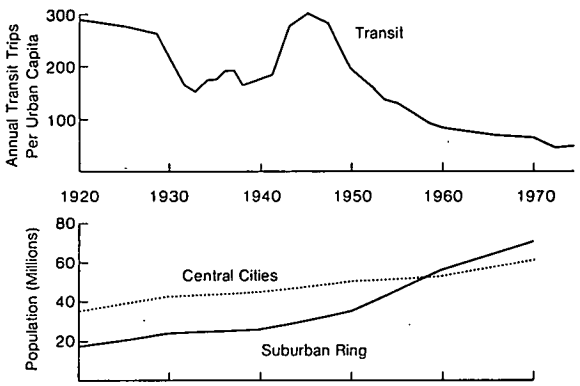


Figure 9. Urban passenger travel.



mand curve. Thus, the equilibrium between demand and supply is unstable. On the one hand, the lower limit is system failure, and on the other, a steady-state is reached as the marginal costs flatten and the market is saturated; no further shifts in the demand curve appear. (External subsidy also shifts operating points.)

STRATEGY ALTERNATIVES FOR FUNCTIONAL IMPROVEMENT

This section completes the general picture and illustrates how specific kinds of actions fit into it.

The most important factors affecting transit—the exogenous factors—which are not shown in the logic structure (Figure 6b), are shown in Figure 8. The evidence is very strong that what has happened to public transportation has not been caused by anything that has happened to transit itself but is the response to one primary exogenous factor: the automobile, first as it has offered competing transportation and second as it has contributed to changing urban spatial form.

If we view the system in the framework of Figure 8, there are three blocks over which the transportation authority potentially has some control. It can influence the patterns of desired travel—the size and nature of the potential market—through changes in the exogenous conditions; it can change prices; and it can change the pattern and amenities of the actual service offered.

There are three classes of exogenous actions that can affect the desired pattern of travel by public mode. The first is the set of actions that can alter the relative attractiveness of the automobile (e.g., changes in parking arrangements and changing prices). These are potentially very powerful because a small shift in the use of automobiles is a large percentage shift in the use of alternative modes. But changes that are very restrictive of automobile use are usually not feasible politically. It does appear, however, that our resistance to such restrictions is slowly decreasing.

The second class are actions (e.g., flextime and other work-hour-staggering schemes) that can change peaking patterns. Car pooling and van pooling also change peak demands on public transit.

The third are actions that could influence spatial organization. Whether this is even possible is controversial, and in any event, it is clearly not a short-term measure.

These classes of actions, with the exception of the borderline case of car pooling, do not involve changes to the public transportation system itself. They are changes that are exogenous to it, aimed at affecting the desired pattern of travel. Changes to the system itself do not change the desired pattern—the basic potential market—but do change the actual pattern because they affect the choices offered to potential users.

The many approaches to changing services and prices have been widely discussed in other places [e.g., by Keyani and Putnam (6) and by Ward (7)]. It is beyond the scope of this paper to further analyze or even enumerate them, except to note that there is still a tendency to evaluate alternatives singly rather than in combination, although the interactions between specific techniques make the latter the preferred approach. But we are still impeded by inadequate analytical tools for synthesis and evaluation of integrated, multielement systems.

If the general decline in public transit has largely been due to a declining market, a shrinking pattern of desired travel, and the service-cost deterioration that followed and an observed decline on a route or in a system portends further decline, what, then, can be done when a deteriorating situation is observed? If it seems reasonably clear that the problem is a declining basic market due to exogenous factors and not simply an ineptly supplied transportation service (and the option of modifying exogenous factors is not possible), then there appear to be only two options. The first is to increase the subsidy, gambling that a greatly improved service will expand market capture and improve the service-cost ratio (and therefore partially absorb the need for continued high subsidy), i.e., move to the right on Figure 7.

The second option is to reexamine the goals of the system, sharpen the definition of the market it is directed toward, and then structure the service to that specific market. For example, if general purpose service is being offered, but the real concern is one small disadvantaged group, then subsidized taxi might be more appropriate. Rethinking goals may become more and more important in the years ahead.

DEMOGRAPHIC INFLUENCES

The magnitude of the ascendency of the automobile has been described elsewhere (8). Between 1950 and 1970, the automobile cut passenger travel by public transportation approximately in half, but created 30 times that amount of new travel.

Although the automobile alone did not cause suburbanization, it has been a major factor in the decreasing densities of both downtowns and suburbs. However, the efficiency of transportation depends on aggregation, and the ability to aggregate depends on the density of potential riders. As densities have decreased, modes that depend on aggregation have increasingly suffered.

Conventional transit seems to require about 17 dwelling units/ha (7/acre) to permit the levels of aggregation for adequate service. This is a fairly high density, cor-

responding to about 4600 persons/km^2 (12 000 persons/mile^2). Overall average densities in American cities are less than half of that.

The impact of declining urban densities on transit is illustrated in Figure 9. The number of automobiles in the United States began to increase after World War I, reached a plateau of about 0.2 automobile/person in 1930, remained constant during World War II, and is now approximately 0.5 automobile/person. And, as the suburbs grew after World War II, transit use steadily declined. This does not prove causality, but it is not hard to believe that the changing spatial form is a contributing factor.

Thus, the rapid increase in transit unit costs that has been observed is consistent with the idea that, on the average, we are reversing the trend shown by the curve in Figure 7. Again, causality is only inferred, because the unit costs of labor and other inputs have also been increasing. It would take a more careful and disaggregate analysis to establish the relative importances of the various influences. But the general observations developed above about the behavior of transit systems are not inconsistent with the aggregate trends observed.

The evidence is persuasive that the size and density of the central business district, the residential density, and the general spatial arrangement of the city strongly affect transit use. Thus, the evaluation of transit in any of its forms must include these factors explicitly. In particular, comparisons between systems can be very misleading unless differences in demography are specifically considered.

SERVICE STANDARDS

A word on the role of service standards is appropriate. Service standards are primarily a device for operational control, because they provide a standard against which to compare actual operations. They are also a device for communication, because they describe the system. But they do not in any way evaluate whether the system is properly matched to the market conditions, i.e., whether the optimum trade-offs among walk, wait, circuity, price, and subsidy have been selected.

An operator might evaluate his or her own performance as excellent because all of the service standards selected were being achieved, while, at the same time, a potential user was avoiding the system because the standards selected were badly matched to the market.

CONCLUSIONS

The key conclusions are summarized below.

1. Overall cost-benefit and impact issues are largely in the political arena.
2. The key determinant of potential productivity for a given level of service is ridership pattern.
3. Supply-demand equilibria are unstable: The direction of change of ridership pattern is the most important evaluative measure.
4. The options for improvement include the following: (a) exogenously modify latent patterns (work-hour staggering, spatial development patterns, automobile management), (b) new service-characteristic trades to broaden the market, and (c) better service through higher costs.

Although it would be desirable to evaluate our public (and private) transportation systems as to how they contribute to larger objectives such as improving the quality of life, we are unable to do so except very generally because of our relative ignorance of the causal mechanisms. Perhaps one of the first prerequisites of rational evaluation is that one should understand reasonably well the relation between the observable properties of what one is evaluating and the objectives against which it is being evaluated.

The inability to trace causal mechanisms combined with the fact that different persons have different and multiple objectives means that the overall assessment of whether a service is worth its costs is a political decision.

We do have a much better understanding of how the potential service and cost characteristics of alternative transportation modes vary with patterns of ridership. As a first level of functional evaluation, this allows us to assess whether we have appropriately matched the mode and service level with the ridership pattern to be served. It is a reminder that in comparing systems, unless the differences in the types of ridership patterns served are taken into consideration, the comparison can be misleading.

Perhaps the most important conclusion is that the way the ridership pattern is changing is the real clue to the future of the system; if the change is unfavorable, then action to change the trend is required.

Let us think in terms of shaping the ridership to improve the use of public modes. The options are three—exogenous changes, different service characteristics, and better service purchased at the risk of larger subsidy. The functional evaluation then becomes the evaluation of a total strategy for improvement, a prescriptive evaluation rather than simply a judgment of current performance.

The central criterion is ridership response. If ridership can grow appreciably and the largest percentage growth is in the off-peak period, then the promise of reducing the deficit per rider is real. But it seems probable that this cannot be done with incentives alone. The automobile is very attractive, and disincentives or constraints on its use will probably be required, along with staggered work hours and car and van pooling to relieve the peak-hour pressures. However, for automobile restrictions to be acceptable to the public, the alternative offered must be very attractive.

The only way to learn what is possible is by experimentation. Even if pursued vigorously and expeditiously, the experimental process could take a decade, given the time required to bring integrated transportation systems into being and operate them long enough for automobile-use habits to change. To assume otherwise does not seem realistic. Functionally coordinated systems will introduce operational and institutional problems with which we have little or no experience; there is still much trial and error. The experiments now in progress should be continued.

Such experimentation should be managed so that there is continuous interplay with theoretical analyses and simulation modeling as well as with other experiments. The experimental results improve the quality and reality of the theoretical models, and the development of the models improves the ability to extrapolate the experimental results to different situations. The development and consolidation of generically useful tools and knowledge and their broad dissemination are clearly desirable.

Finally, our ability to evaluate performance and prescribe improvements depends on our ability to correctly interpret what we observe.

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Mr. Ward was with the Office of the Secretary, U.S. Department of Transportation when this paper was written.

Dial-a-Bus Implementation: A Living Example

Joseph S. Silien, Rochester-Genesee Regional Transportation Authority, New York

The process undertaken to transfer a demand-responsive dial-a-bus service from federally funded, experimental-demonstration status to permanent-operation status is described. The particular project described suffered from a local financial condition that was insufficient to support dial-a-bus services, technical difficulties, and problems in perceived attitudes toward the project. The strategy developed included an independent assessment of the program, consultant recommendations modified by local staff, expansion of the service to two additional areas, areawide service to the handicapped and elderly, attempts to negotiate the labor clearances necessary to permit competitive solicitation of service vendors, and approval of an extended demonstration by the Urban Mass Transportation Administration.

Implementation is the most difficult phase of any research, development, or demonstration project—perhaps that is why the term was, until recently, only rarely mentioned. To be sure, any particular project included implementation for the duration of the particular test or as long as the agreed-on combination of federal and local funding lasted. But discussions of permanent implementation are conspicuously absent from the voluminous texts of government contracts. Even when unwritten commitments to implement have been made, events and budgets have often altered even the best of intentions. Recently, acknowledging the problem, the Urban Mass Transportation Administration (UMTA) renamed its Research and Development Program the Technology Development and Deployment Program, in an attempt to establish the essential link between the development of a new concept and its delivery to the public as a permanent part of an improved transportation system.

An examination of the dial-a-bus project in the Rochester, New York, area illustrates the difficulties inherent in permanently implementing a project based on a new technology.

The project had its beginnings in October 1971, when three small buses were placed in demand-responsive service in Batavia. The Batavia Bus Service, or B-line, had been acquired by the Rochester-Genesee Regional Transportation Authority (R-GRTA) in June of that year. A very limited fixed-route service was operated until the transition to dial-a-bus. The dial-a-bus mode was adopted in an attempt to expand transit service to as many residents as possible by using the then-new and innovative technology of demand-responsive service.

R-GRTA had submitted an application to the Urban Mass Transportation Administration (UMTA) for demonstration funds to operate a dial-a-bus in the city of Rochester. But UMTA had determined, under Congressional pressure, that only one dial-a-bus project would be federally supported until such time as success was ascertained. The location of this project was Haddonfield, New Jersey, which was selected after the New Jersey State Department of Transportation committed itself to using its commuter operating authority to assist the project, as well as for reasons of size, density, and traffic potential.

In Rochester, a demand-responsive service was eventually established in the suburban community of Greece by using local resources. The service was named PERT (for PERsonal Transit) and offered door-to-door transportation within the service area and feeder service to fixed-route buses.

In 1974, R-GRTA commissioned a short-range improvement program study. A principal finding of the study report (1) was that PERT services should be expanded to include all suburban areas contiguous to the city of Rochester.

The report projected an annual operating cost, including rationalization of the fixed-route services, of $1.2 million for the entire suburban service. The substitution of PERT for the majority of the urban fixed routes on Sundays and at night was further projected to produce a saving in operating costs. The entire plan was based on the assumption that all of the operating assistance funds available under section 5 of the Urban Mass Transportation Act of 1964 could be drawn down by R-GRTA. Because of insufficient local share, this proved not to be the case.

In part because of the initiative Rochester had taken in implementing the dial-a-bus services in Batavia and Greece and developing an areawide dial-a-bus plan and in part because UMTA was seeking an expanded site for testing computer dispatching software, in March 1975, Rochester was awarded a demonstration grant to develop an integrated adaptable metropolitan transit service program. The Massachusetts Institute of Technology (MIT)

was designated as the principal subcontractor to R-GRTA and assumed a major role in the management of the project.

Among the stated objectives of the project were

1. To demonstrate the potential of dial-a-bus service in a major metropolitan area in which regular transit is available,
2. To provide an improved level of transit services for all members of the community and in particular to provide a more convenient service for the elderly and other special-need groups, and
3. To test the ability of a dial-a-bus service to augment and complement a transit system composed of fixed-route, express, and park-and-ride bus services, i.e., system integration.

Significantly absent were any stated objectives relating to cost of service (in terms of affordability by the community) or permanence beyond the conclusion of the demonstration.

By October 1976, the subject of dial-a-bus was touchy indeed at R-GRTA. The main computer (located in Waltham, Massachusetts) had suffered a serious fire, and thus the use of a manual dispatching system was required for more than 7 months. Despite earlier use of a manual dispatching system by R-GRTA personnel, after the project had begun to operate under federal auspices and MIT assumed a stronger role, the development of an improved manual dispatching system had been relegated to a secondary role, essentially for backup use only.

The other major service problem was caused by vehicles that proved to be unsatisfactory. The unsatisfactory nature of the mixed fleet of small buses may be due to design deficiencies in these vehicles, or it may be due to the difficulties inherent in having the operator of a large diesel fleet [Regional Transit Service (RTS), R-GRTA's main operating arm] also maintain a diversity of small gasoline-powered vehicles, or it may be due to a combination of these factors. One of the unwritten objectives of the project was to evaluate various small buses and determine the type or types best suited to demand-responsive service. Thus, 7 different types of vehicles were being operated in the 29-vehicle fleet. All of them were unsuitable—as many as 20 were unusable on certain especially bad winter days.

The restoration of the computer dispatching capability and a changeover to modified throwaway vans rather than small buses considerably improved the service, as well as public confidence in it. The passing of the worst winter in a century also eased service problems. However, as the service improved, the time for conclusion of the project approached.

Despite all of the technical problems, the major factor influencing R-GRTA toward discontinuing the service was its very high cost. Under the terms of the demonstration project, the dial-a-bus was being operated by RTS. The employees, as members of the Amalgamated Transit Union, were paid at the same rates as the fixed-route employees. Thus, the dial-a-bus and fixed-route services had nearly identical operating costs, i.e., $22/vehicle·h. That cost can be substantially offset for fixed routes, particularly during peak hours, but at a productivity of 5 passengers/vehicle·h and an average fare of $0.85, the recovery rate is much too low to sustain demand-responsive services.

R-GRTA's decision about what was obviously a high-cost and certainly experimental operation was definitely affected by a serious financial constraint. That constraint was the increasing inability to generate sufficient local matching funds within the community to draw available federal funds to support the basic fixed-route services. Both state and county appropriations had been frozen at 1974 levels, and the RTS operating costs had continued to climb. The inevitable result was the prospect of reduction of basic services, a situation totally incompatible with providing dial-a-bus subsidies.

Severe limitations on the R-GRTA staff resources and time prevented a thorough in-house exploration of the possible alternatives for the future of the dial-a-bus. The staff itself was not unanimously convinced that the service should be continued. Regardless of the degree of skepticism, however, a decision had to be reached quickly, and the basis for that decision had to be firm.

During the course of the project, a number of changes had been made in attempts to adapt to the rapidly changing conditions. As it became clear that the projected financial situation would not be realized, plans to add a new service in Henrietta were dropped. Services in Greece were restructured several times, as were the late evening urban services. However, the project, it seemed, was suffering from a number of potentially fatal illnesses, although there was a late improvement in service reliability. These illnesses included the lengthy computer malfunction and endless vehicle problems. There was also a notable lack of management attention from all quarters. The R-GRTA staff had been too thinly spread for some time, with primary reliance on MIT for management. R-GRTA had been operating without an executive director for nearly a year. The dial-a-bus had received a great deal of attention from him, and his departure had left a significant void, particularly in the the area of project management. MIT, while conscientious, was an absentee manager and should not have been expected to replace R-GRTA as primary manager. Although MIT did have personnel on site, additional resources were needed. RTS, never enthusiastic about the project, remained neutral, at best. UMTA, for its part, was a willing participant in frequent meetings, but did not insist that the participants rectify the management difficulties.

Thus, with UMTA encouragement and staff consensus, in January 1977, R-GRTA hired the California-based firm of Systan, Incorporated, to undertake an in-depth, albeit brief, assessment of the project to date with the objective of defining alternatives for permanent implementation.

Their report (2) validated the principal obstacle to dial-a-bus implementation, i.e., that

> the financial condition of the Rochester-Genesee Regional Transportation Authority (R-GRTA) has changed dramatically since the comprehensive program calling for an areawide system of demand-responsive PERsonalized Transit (PERT) services was developed. Unless cost-effective successors to the present PERT service can be found, demand-responsive services may be discontinued.... the far-reaching transit objectives called for in the comprehensive program of 1974 seem to be financially infeasible. Moreover, the experience of the demonstration project suggests that demand-responsive transit must play a more limited role than that originally foreseen.

R-GRTA had asked that Systan evaluate a number of specific alternatives including

1. Continuation of the demonstration program beyond its scheduled termination date if additional experimentation was required to enable an orderly changeover to permanent services;
2. Implementation of modified fixed-route services to replace the services available under the demonstration program;
3. Continuation of all or certain demonstration services under the auspices of RTS;
4. Continuation of all or certain demonstration ser-

vices by other vendors in coordination with RTS; and

5. The use of demonstration resources to provide an areawide special service to the elderly and handicapped, either by RTS or through another vendor.

The Systan evaluation identified 12 general conclusions. These were categorized as to demand (numbers 1 through 5), level of service (numbers 6 and 7), productivity and cost (numbers 8 and 9), system integration and route rationalization (numbers 10 and 11), and computerized dispatching (number 12).

1. Demand for most PERT services did not reach anticipated levels, yet PERT clearly served a market not otherwise served.
2. Although the dial-a-bus users were predominantly female and transit dependent in the sense that they do not drive, dial-a-bus also attracted a diversity of users in terms of age, employment status, and trip purpose.
3. A large part of the dial-a-bus demand could be served by a system of fixed routes at approximately equivalent service levels, productivities, and costs.
4. During the steady-state period, the dial-a-bus service achieved slightly lower, but not significantly different, market penetration than comparable many-to-many demand-responsive services in other cities.
5. Work subscription services attracted a market that would rarely use transit otherwise.
6. The travel reliability of the dial-a-bus service, as measured by the ability of users to predict the timing of their trips, was lower than that of the fixed-route service but improved after the computerized dispatching system was repaired and vehicle reliability increased.
7. As measured by demand and attitudes, dial-a-bus, group trips, and special services for the handicapped are of great value to the transit dependent.
8. The productivities of all the PERT services except group trips resulted in costs that were higher than those that would have resulted if the service had been offered by taxis at prevailing rates.
9. During the steady-state period, dial-a-bus productivities in Greece were slightly lower, but not statistically different, than the productivities of similar demand-responsive systems in other cities.
10. The strategy of route rationalization in Greece (i.e., the substitution of dial-a-bus for curtailed fixed routes) resulted in an increase in travel times, a decrease in transit ridership, a shift of trips to the peak period, an increase in the vehicle-hours of service required and, hence, a higher total cost of service. The dial-a-bus does not seem to be an adequate substitute for fixed routes that have been operating in a radial fashion for many years.
11. Efforts to coordinate dial-a-bus vehicles and fixed-route buses did not appreciably reduce transit times.
12. There are still insufficient data to determine whether computerized dispatching operates more cost-effectively, yields greater productivities, or offers higher service levels than manual dispatching.

Although many of these conclusions are negative, the continuation of several specific types of demand-responsive services might be worthwhile if they could be structured on an affordable basis.

Systan made eight recommendations—four short range and four long range.

The short-range recommendations all involved accounting changes and immediate service modifications intended to reduce operating costs. With the exception of some specific modifications, principally in the area of revised federal-local share ratio, the R-GRTA staff concurred with these, and they were implemented.

The long-range recommendations (summarized below) all dealt with preserving the many-to-many dial-a-bus service on a more economical basis.

1. Talks should be initiated with contract paratransit management firms, taxi companies, and union representatives concerning paratransit services to determine the possible terms under which they would offer these services.
2. On the basis of the information obtained in the discussions with possible suppliers, costs should be reestimated and terms of reference for bidding and negotiation should be determined.
3. Because the demonstration project is the least risky way to proceed to an areawide dial-a-bus service, it should be extended to September, 1978, provided that UMTA agrees to a 50/50 cost sharing through September, 1977, and an 80/20 cost sharing thereafter.
4. On the basis of the demand observed in Greece and Irondequoit (a community that had been added to the demonstration project in 1975), the original projection of a fleet of 100 vehicles should be scaled down to a fleet of 29 vehicles equipped with lifts. These can provide both service to the handicapped and elderly and general dial-a-bus service. [The local share of a 1-year demonstration extension on this scale was projected at $292 000, with an eventual annual cost to R-GRTA of $342 000 (these cost estimates were based on the ability either to establish lower wage-rate classifications with RTS and its union or to solicit private vendors on a competitive basis).]

However, the R-GRTA staff had serious reservations about these recommendations. The prospect of a 29-vehicle areawide dial-a-bus and service to the handicapped and elderly was undeniably appealing and also a bargain if the $342 000 annual local-share projection proved accurate. However, an overriding problem was the inability to finance the project on a continuing basis, even at the $342 000 level.

The staff also believed that, in keeping with the changes in UMTA policy regarding paratransit services and private operators and to ensure fairness in expanding the service, it was appropriate to introduce an element of competition. Finally, they questioned the technical feasibility of instituting an areawide general dial-a-bus service in a 1-year time frame.

Another factor had a strong effect on the staff modifications to the Systan recommendations. R-GRTA has always been proud of the active role it has played in providing transportation for the handicapped and elderly. In addition to reduced fares for the elderly and a commitment to purchase kneeling buses for the fixed-route service, the dial-a-bus project has pioneered in door-to-door transportation for handicapped and elderly passengers on lift-equipped vehicles. The Greece and Irondequoit services were seen as pilot projects that would lead to an eventual areawide service to the handicapped and elderly.

As with both the fixed-route service and expansion of the general dial-a-bus service, the constraint has been inadequate funding. Nevertheless, R-GRTA acted in part on the belief that some affirmative action was required by law and in part on the expectation that general dial-a-bus service would disappear. An appropriation of $150 000 of scarce local funds was made to be used as local matching for a $300 000 limited areawide service to the handicapped and elderly. This commitment was to exist whether or not general dial-a-bus service continued.

Thus, the R-GRTA staff modified the Systan recommendations for a 29-vehicle areawide service as follows:

1. Systan recommendations: (a) 29-vehicle areawide dial-a-bus service, including service to the handicapped and elderly; (b) private operation; (c) implement through UMTA demonstration until September 1978; (d) approximate local share for the demonstration of $292 000; and (e) approximate annual operating deficit after the demonstration of $342 000 versus
2. Staff recommendations: (a) continue federally assisted demonstration through March 1979; (b) maximum R-GRTA local share (matching funds for service to the elderly and handicapped) of $150 000 each in FY 1977/1978 and FY 1978/1979; (c) continue Greece and Irondequoit under RTS operation for the duration of the demonstration; (d) add two additional service areas (8 to 10 vehicles); (e) select operator by competitive bidding (private or RTS); (f) service-area selection criteria to include commitment by towns that, if demonstration meets agreed-on criteria, will pay 50 percent local-share (25 percent if New York State participates) subsidy for continued operation; and (g) no continuing financial burden on R-GRTA.

Intensive discussions with UMTA officials were encouraging regarding the new strategy.

The key features of the plan as it developed included a somewhat longer demonstration program structured to permit several months of preparation and 1 year of service, which would coincide with the R-GRTA fiscal year.

In addition, the maximum local-share commitment was to be the annual $150 000 appropriation made for service to handicapped and elderly persons and matched by funding under section 5 of the Urban Mass Transportation Act of 1964 (with UMTA's concurrence these funds were tentatively earmarked for services to the handicapped and elderly). The remainder of the approximately $1.2 million project was to be funded from the federal demonstration program.

It was agreed that services to Greece and Irondequoit would remain unchanged for the duration of the extended project and that RTS would continue to operate the services at applicable wage rates. Thus, residents of those communities would be assured of service continuity at least for the demonstration period.

In addition, two more service areas would be added to the project. Service to the two new areas would be sought competitively from private vendors or from RTS and its union at new wage scales along the lines established in other cities for community transit services. The two additional areas would be selected from among the towns, other than Greece and Irondequoit, that are contiguous to the city of Rochester. The principal criterion for selection was set as willingness to participate on the following basis: For the duration of the demonstration, there will be no cost to a participating town, but based on criteria of success to be defined mutually by the town and R-GRTA, the town must agree that if the project is successful, the town (rather than R-GRTA) will fund the local share of future operating deficits.

The opinion of the Monroe County Legislature with respect to the dial-a-bus question was a particularly sensitive issue. This sensitivity arose because initially, R-GRTA had been so enthusiastic about the concept, claiming dial-a-bus to be virtually economically self-sufficient. In the ensuing years, that enthusiasm had been tempered by the losses not only of the dial-a-bus service, but also of the fixed-route service. Some legislators believed that scarce dollars being used to fund the costly dial-a-bus service should have been channeled to reduce the increasing deficits of the fixed-route service.

Furthermore, there was a measure of support for expanding services to the handicapped and elderly but little public reaction either for or against general dial-a-bus service.

In an attempt to update and inform the legislators, as well as to assess their opinions, the R-GRTA staff met with key leaders of the legislature and explained the projected program. Their attitude could be characterized as receptive and neutral on the premise that, as long as the legislature was not being asked for additional funds, there would be no outright objection or opposition. Some legislators were enthusiastic about the possibilities of introducing a new basis for union operation and competition for service vendors.

Finally, at an R-GRTA meeting on April 26, 1977, resolutions (3) embodying the staff recommendations were approved by a vote of 10 to 6. The favorable vote, although not overwhelming, was certainly both gratifying and surprising to the staff. Many advocates of expansion of the dial-a-bus service were indeed surprised by the number of statements made by commissioners and county legislators in favor of this.

After a meeting with the editorial board of the Gannett newspapers, at which the program and its risks and benefits were explained, a lengthy and favorable editorial appeared in the Rochester Democrat and Chronicle of May 17, 1977 (4). The press has since taken an active interest in reporting new developments.

A draft application was prepared and submitted to UMTA in June.

The next step was a series of information meetings held with representatives of the eight suburban towns contiguous to the city. After those meetings and local presentations in some of the communities, two towns, Brighton and Henrietta, expressed by written resolutions a desire to participate in the project, two decline and, by fall, discussions were under way in two others.

The implementation process is complex, lengthy, and often frustrating. The pressure of time will determine a solution—perhaps permanently. In mid-1977, R-GRTA was facing a series of problems. The available funds would support the services only through October. By early October, approval of the grant application would have to be obtained from UMTA or discontinuance notices posted for the Greece and Irondequoit services. Similarly, if the demonstration would not be extended, a decision would have to be made and implemented about the areawide services to the handicapped and elderly.

There were many encouraging signs to indicate that perhaps the locally devised and tailored implementation strategy would ensure permanence to the dial-a-bus service, but there remained significant hurdles.

One hurdle was to obtain the certification required by section 13c of the Urban Mass Transportation Act from the transit union regarding project extension. Nationally, such certifications were being obtained, but the local situation was uncertain. It was difficult for the union to accept the concept of a private vendor performing transit services. On the other hand, the union employees were assured of not only the Greece and Irondequoit services but also the opportunity to compete for the two new service areas.

Another hurdle was the necessity for UMTA approval. Without that, R-GRTA would have no recourse but to terminate the services at the end of October 1977.

R-GRTA and the Rochester community had been living with the heritage of a program caught in an unstable world—a world of reality. The project suffered because of lack of leadership during a critical period. It suffered from the financial crisis that has affected the entire New York State transportation program (and virtually all other

aspects of state government). Similarly, the local financial conditions in Monroe County could not fill the gap created when state assistance was frozen at 1974 levels. Instead, the county, never enthusiastic about being mandated by the state to support transit, merely adhered to the unchanging match dictated by the state.

Thus, the situation in 1977 was quite different from that when the project was first proposed as a part of an overall transit expansion program. And it has not proved to be a simple matter to modify such a project in real time to meet changing goals in an unstable environment. Assumptions as to available subsidy funds, operating costs, demand, and technical readiness were inaccurate. Plans to cope with the institutional problems of transition from exhibit to permanent service were not made.

Nevertheless, significant accomplishments were made in a short time. Service was reliable when the computer was functioning and less temperamental vehicles were used. A detailed assessment of project status and alternatives was conducted. Superfluous services were trimmed to effect economies. Attitudes toward the program generally became positive. A commitment to areawide service to the handicapped and elderly was made. At least two communities indicated a willingness to participate even though they realize that R-GRTA cannot finance the local share of operating deficits at the conclusion of the program.

Only time will show whether the necessary section 13c certification and final UMTA approval can be obtained.

Is it worth it? Speaking for the R-GRTA staff, for MIT, and for our passengers, I must offer an unqualified "yes" response. Dial-a-bus service offers the only potential for transit in low-density suburban areas. The service affords a freedom from a second automobile for housewives and a new mobility for handicapped and elderly persons who have no real alternative. Other potential transit-oriented benefits of large-scale computer dispatching, competitively selected vendors, and fixed-route rationalization remain to be realized.

What have we learned that may be of interest to other communities regarding the relative roles of various public transit options?

Dial-a-bus—paratransit—is not a panacea. Where the volume of patronage is sufficient, obviously fixed-route operation is more economical. Dial-a-bus, on the other hand, is really the only option for low-density areas.

A community should be very sure of the role it wishes the paratransit service to perform. Is it the typical low-density many-to-many service? Is it a more limited service to the handicapped and elderly? Above all, how will such service be financed?

What are the criteria for determining whether an area should be served by fixed-route or paratransit service? The question is not an easy one. We have learned, for example, that if we could economically isolate the outer ends of many of our fixed-route services, their stand-alone economics would be no better than those of dial-a-bus, but methods of allocating costs and subsidies in our community cause such distinctions to become largely academic, at least at present.

Such may not be the case in the future. As transit employees have come to recognize the inherently high cost of such services, they have shown increasing willingness to negotiate less expensive wage and benefit packages and less restrictive work rules in exchange for the prospect of becoming part of the growing rather than the shrinking portion of the industry.

If we reach a point at which the marginal costs of extending fixed-route lines carrying few passengers can be traded off against the costs of implementing dial-a-bus services in those areas, then perhaps more rational integration of fixed-route and paratransit services will be possible and result in savings to the operator and better service to the customer.

Negotiating the agreements that are making some of these things happen in a few communities is but one of the early steps in the evolution of paratransit.

Van pools and shared-ride taxi services are other configurations of paratransit service that become possible as community and employee awareness of transit economics increases. Such services, however, should not be established to compete with or further drain the ridership of the basic fixed-route services.

Most of these services must be considered in the light of the particular institutional and financial framework in question. The proper planning for the management of these services is paramount—the technology is a secondary issue.

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Review of Paratransit Activities in Canada

S. Ling Suen and Agnès Lehuen, Canadian Surface Transportation Administration, Transport Canada

Canadian experiences with paratransit services—dial-a-bus services in 12 communities and five car- and van-pooling operations—are reviewed. In general, the Canadian operations have differed from those in the United States in the following ways. The Canadian operations are typically more productive and operate at lower costs per rider, and the demonstration projects have been more modest in scale and the use of new technologies. The introduction of computerized routing and scheduling techniques has usually been postponed until the operation has achieved stability. Dial-a-bus operations are usually treated as interim services to be replaced by fixed-route transit as soon as possible, and organized ride-sharing programs have been subordinate to dial-a-bus and mass transit services.

OVERVIEW

During the period between 1970 and 1974, there was a burst of paratransit activity in Canada that led to the implementation of dial-a-bus systems in 12 communities. But since 1974, no new systems have been implemented, some of the former ones have been phased into fixed-route bus systems, and others have been terminated.

The Canadian experience with paratransit differs from activities in the United States in several important ways: In Canada,

1. Dial-a-bus systems have typically achieved greater productivity and operated at a lower cost per rider,
2. Demonstration projects have been modest in both operational scale and the use of new technologies,
3. The introduction of computerized routing and scheduling techniques has been postponed until operations stabilize into known and established routines,
4. Dial-a-bus has been treated as an interim or transitional program that can be replaced by fixed-route transit as demand patterns are identified and a transit riding habit is established, and
5. Organized ride-sharing activities have been subordinate to dial-a-bus and conventional mass transit (however, the next generation of paratransit activity will probably place greater emphasis on shared-ride taxicab programs and van pooling).

The modest scaling of projects and the success of incremental service deployment recommends the Canadian approach as a model for paratransit development elsewhere.

INSTITUTIONAL SETTING OF CANADIAN PARATRANSIT OPERATIONS

Unlike that in the United States, the Canadian federal government plays a limited role in urban transportation financing and development. This role is confined to research and demonstration projects; the initiative in transit and paratransit financing has historically rested with local and provincial governments. Canadian paratransit activity has been focused in the province of Ontario where subsidies from the Ministry of Transport and Communication (MTC) have provided the financial base necessary to stimulate community-level service innovations. Lack of assured funding is one of the factors that has discouraged the same level of innovation in the other provinces. Table 1 (1) summarizes the transit and paratransit funding arrangements in each province.

In Canada, as in the United States, the responsibility for transit operations and financing lies primarily with local government. And as transit ridership declined during the postwar years, many local governments responded to the increasing costs by curtailing service. The cost-revenue constraints in transit financing discouraged many localities from experimenting with paratransit until provincial subsidies and federal demonstration funds became available. Even then, paratransit innovations were sometimes frustrated by the ingrained traditions and preferences of transit managers trained in the operations of conventional fixed-route services. Thus, paratransit suffered from what might be called the not-invented-here syndrome as well as from the budget problems of transit in general.

Tight budgets can argue for procuring service from private vendors, such as taxicab companies, by using competitive bidding. In Canada, this has occurred only infrequently. At the beginning of the paratransit era, the taxi industry was generally apprehensive of the new mode. Although taxi operators were given the chance to bid on paratransit contracts in some cities, none did so.

Today, however, the taxi industry is organizing itself to tap a share of the public transit market through the provision of paratransit services, realizing the necessity to broaden their market because of

1. Increasing costs of operation due to higher insurance rates and fuel costs and
2. Fear of competition from dial-a-bus services.

INVENTORY OF PARATRANSIT SERVICES IN CANADA

Four classes of paratransit have been experimented with in Canada—dial-a-bus, privately operated systems, pooling arrangements, and provision of services for the handicapped.

Dial-a-Bus

The dial-a-bus services in Canada have all been of the zonal many-to-one or many-to-few types and operated in one of three modes:

Mode of Operation	Location
Areawide municipal transit service	Pickering, Ontario Bramalea, Ontario
Off-peak service	Kingston, Ontario Stratford, Ontario Ottawa, Ontario
Feeder services to line-haul bus or local community shopping centers in low-density areas	Burlington, Ontario Cambridge, Ontario Kitchener, Ontario Ottawa, Ontario Toronto, Ontario Regina, Saskatchewan Calgary, Alberta Winnipeg, Manitoba

The chronological expansion and contraction of dial-a-bus systems is shown in Figure 1. The number of systems implemented reached its maximum in 1974/1975 and has gradually declined since then. No new systems have been implemented since 1974.

General Systems Characteristics

Table 2 presents some of the characteristics of the 13 dial-a-bus systems implemented thus far and information about their service areas. The populations served by these systems range from a low of about 8000 inhabitants (Burlington) to a high of 150 000 (York Mills in Toronto). The population densities vary from about 750 persons/km^2 (2000 persons/mile^2) to 3400 persons/km^2 (9000 persons/mile^2). All of the vehicle fleets are relatively small; the largest is that in Regina, which has 21 vehicles. All systems are operated by a city and subsidized by the provincial government.

Ridership

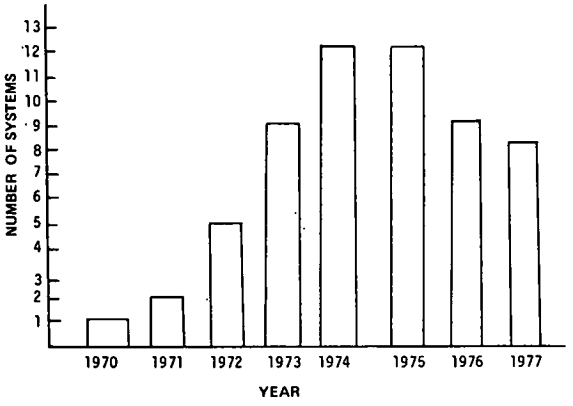
Table 3 (compiled from data supplied by the Canadian Urban Transit Association, the Ontario Ministry of Transportation and Communications, and various transit operators) gives the annual ridership of the dial-a-bus systems. From 43 000 riders in 1970, dial-a-bus systems expanded to carry almost 4 million passengers in 1976. The highest ridership was recorded in 1975.

In most cases, ridership has met expectations and the service has been continued or even expanded (e.g., Regina, Calgary, Kingston, and Pickering). In Regina,

Table 1. Provincial subsidy rates for transit.

Province	Capital Subsidy	Operating Subsidy	Studies and Demonstration Projects Subsidy
Newfoundland	None	$3/capita (in St. John's only)	None
Nova Scotia	50¢ of all costs	$3/capita	None
Prince Edward Island	None	None	None
New Brunswick	Varies inversely with strength of municipal tax base (part of provincial unconditional grant)		
Quebec	Vehicle costs (30¢ if made in Quebec and 10¢ if made elsewhere); 60¢ of servicing costs	45 to 55¢ of operating deficit (1¢ increase for each 1¢ ridership increase)	All studies conducted by province
Ontario	75¢ of vehicle costs; 100¢ of cost of inter-regional services in Toronto region; 75¢ of construction costs	Percentage of costs (25 for city of 0 to 100 000 population, 22.5 for city of 100 000 to 150 000, 20 for city of 150 000 to 200 000, 17.5 for city of 200 000 to 1 000 000, and 13.75 for city of more than 1 000 000)	75¢ of costs of studies; up to 100¢ of costs of demonstration projects
Manitoba	50¢ of vehicle costs if manufactured in Manitoba	50¢ of deficit	Variable aid for demonstrations
Saskatchewan	50¢ of vehicle costs; 75¢ of construction costs	$0.03/passenger; 50¢ of deficit for transit for handicapped	75¢ of costs of studies; 75¢ of costs of transit demonstration projects
Alberta	$7 500 000 each to Calgary and Edmonton; up to 100¢ of costs to smaller communities	50¢ of deficit up to $3.33/capita	66.7 to 100¢ of costs of planning studies; up to 100¢ of costs of transit demonstration projects
British Columbia	100¢ of vehicle costs; certain other costs	100¢ of deficits in Victoria and Vancouver; 50¢ of deficits in other municipalities	None

Figure 1. Operating dial-a-bus systems in Canada: 1970-1977.



the passenger volume on the public transit system has increased by 3 percent, and the Telebus is considered responsible for stemming the decline in transit use that was occurring. In two cases (Toronto and Sudbury), the dial-a-bus services were cancelled because of their high costs. In four cases (Burlington, Kitchener, Ottawa, and Stratford), the systems are continuing without major changes. In three cases (Bramalea, Cambridge, and Winnipeg), the heavy demand induced by the demand-responsive service has led to replacement of the dial-a-bus service by a fixed-route bus. In Winnipeg, however, this replacement has taken place only during peak hours, and the dial-a-bus service is maintained during the rest of the day.

The systems that have attracted the largest ridership are those having transfer points that are both major trip attractors and close to the dial-a-bus service area.

Productivity

Most Canadian dial-a-bus services have performed well in terms of vehicle productivity, which has varied from 8.1 to 19 passengers/vehicle·h and for most of the services been greater than 10. These are considerably higher than those of U.S. systems (e.g., the 25 dial-a-bus systems in Michigan had vehicle productivities ranging from 4.8 to 9.6 passengers/vehicle·h).

System	Productivity (passengers/vehicle·h)	System	Productivity (passengers/vehicle·h)
Bramalea	11.5	Ottawa	10.0
Burlington	8.1	Pickering (Bay Ridges)	11.8
Calgary	13.5	Regina	19.0
Cambridge	9.0	Stratford	13.1
Kingston	15.8	Toronto	11.0
Kitchener	8.5		

One explanation for these relatively high productivities is that Canadian dial-a-bus systems have not yet evolved into the true many-to-many, taxi-like operation that is characterized by areawide coverage, real-time response to client requests for service, and full door-to-door service without transfer.

Economics

All dial-a-bus systems implemented thus far in Canada have been costly; the deficits per passenger trip range from $0.52 to $1.51 (for comparison, the deficits per passenger trip on fixed-route systems range from $0.10 in large cities to $0.70 in smaller ones).

System	Deficit per Passenger Trip ($)	System	Deficit per Passenger Trip ($)
Bramalea	0.64	Ottawa	1.22
Burlington	1.51	Pickering	0.67
Calgary	1.45	Regina	0.52
Cambridge	1.09	Stratford	0.75
Kingston	0.69	Toronto	1.34
Kitchener	0.97	Winnipeg	1.38

This explains why the dial-a-bus experiment has been cancelled in Toronto and Sudbury—a combination of low patronage and high costs.

Although Canadian paratransit systems are considered to have achieved reasonable financial results when compared with some of their U.S. counterparts, all of them still require heavy subsidies. For the majority, the average rate of recovery of operating costs from the fare-box is still about 30 percent (with the exception of the Whitehorse Minibus Service described below, which has a fare-box recovery of 43.9 percent). In addition to labor and dispatching costs, the high costs are due to the facts that

1. The quality of service offered is higher than that

Table 2. Characteristics of dial-a-bus systems.

System	Start Date	Population of Area	Population Density (persons/km²)	Type of Service	No. of Vehicles: Peak	No. of Vehicles: Off Peak	Adult Fare (¢)	Initial Sponsor	Status
Bramalea	1973	52 000	2880	Many to one	9	7	35	MTC Ontario	Replaced by fixed-route service because of heavy demand (1976)
Burlington	1974	7 670	1230	Many to one	4	4	35 + 15 premium	MTC Ontario	Replaced by fixed-route service because of high ridership (July 1977)
Calgary	1973	15 000	1880	Many to one	6	3	45	Ministry of Transport, Canada; Ministry of Highways and Transportation, Alberta	Ongoing computerization of dispatching being tested
Cambridge	1974	24 346	1870	Many to few	5	5	Regular + 15 premium	MTC Ontario	Replaced by fixed-route service because of high ridership (1976)
Kingston	1972	64 320	3020	Many to one[a]	—	7	35 + 15 premium	MTC Ontario	Ongoing
Kitchener	1974	11 000	985	Many to one	3	3	45	MTC Ontario	Ongoing
Ottawa	1973	54 250	2580	Many to one	16	14	45 + 15 premium	MTC Ontario	Ongoing
Pickering (Bay Ridges)	1970	23 650	760	Many to few	9	5	50	MTC Ontario	Expanded to cover most of city (1973)
Regina	1971	151 000	2130	Many to few	21	21	40 + 15 premium	Ministry of Transport, Canada; Department of Highways and Transportation, Saskatchewan	Expanding
Stratford	1972	23 650	1600	Many to few	4	4	Regular + 10 premium	MTC Ontario	Ongoing
Sudbury	1972	—	—	Many to few (subscription)	2	2	Regular	MTC Ontario	Abandoned because of high costs and poor patronage (1974)
York Mills (final version of Toronto)	1973	150 300	3360	Many to few; many to one	8	8	Regular + 10 premium	MTC Ontario	Abandoned because of high costs (1976)
Winnipeg	1974	15 505	1970	Many to one	8	8	25 + 25 premium	Ministry of Highways and Transportation, Manitoba	Replaced by express fixed-route bus in peak hours; demand-responsive service retained in off-peak hours (November 1978)

Note: 1 km² = 0.386 mile².
[a]Service between 6 and 11 p.m. only.

Table 3. Annual dial-a-ride bus ridership: 1970-1976.

System	1970	1971	1972	1973	1974	1975	1976
Bramalea				131 450[a]	490 450	600 000	375 000[b]
Burlington					66 287[c]	143 795	154 045
Calgary				3 200[d]	199 587[e]	304 285	343 161
Cambridge					88 433[c]	161 889	81 492[f]
Kingston			11 426[g,h]	66 849	136 700	175 385[i]	181 780
Kitchener					27 614[g]	82 982[j]	138 228
Ottawa				164 333[k]	717 604	923 408	749 145
Pickering (Bay Ridges)	42 900[k]	132 418	143 256	188 461	320 990	374 128	389 660
Regina		8 970[l,m]	369 030[n]	577 350[n]	819 552	804 882	762 340
Stratford			15 705[k]	60 084	73 849	75 401	74 820
Sudbury			314[o]	8 593	10 031[o]		
Toronto				38 134[g]	270 221	336 679	173 770[p]
Winnipeg					34 100[n]	347 078	349 560
Total	42 900	141 388	539 731	1 238 454	3 255 418	4 329 912	3 773 001

[a] Service initiated in August.
[b] Service terminated in May.
[c] Service initiated in May.
[d] Service initiated in December.
[e] Service changed to full-day service in March.
[f] Service terminated in June.
[g] Service initiated in October.
[h] Service covered only two zones and included transfers.
[i] Service increased from four to five zones.
[j] Service interrupted by 3-month transit strike.
[k] Service initiated in July.
[l] Service initiated in September.
[m] Estimated data.
[n] Service initiated in November.
[o] Service terminated in December.
[p] Service terminated in July.

of other kinds of public transit operation and

2. Service is provided at very low premium prices ($0.10 to $0.15 above regular bus fare) for marketing and political reasons.

However, all the dial-a-bus services still existing in Canada have been considered less expensive to operate than alternative fixed-route buses because of the low densities of the areas where they have been implemented.

When savings have been achieved, as in Whitehorse, it has often been the result of dynamic management, use of nonunion parttime labor, and a good balance of peak versus off-peak ridership.

Obviously, high cost is a relative assessment: In all cases where dial-a-bus service has been maintained, it has proved more economical than a comparable fixed-route service, given low demand density.

In Calgary, if a fixed-route system were to replace

the dial-a-bus system, the operating cost would be 3 percent greater and lower revenues would result in an 8 percent greater deficit. Similarly, in Regina, after 8 months of operation, the Telebus system was estimated to have reduced the subsidy that would have been required to operate the previously available fixed route service by $45 000. In Stratford, the DART system is estimated to have saved $24 000/year over what it would have cost to operate the fixed-route service it replaced.

Privately Operated Systems

Thus far, very few paratransit systems have been operated privately in Canada—there is one shared-ride taxi service in Ontario and one fixed-route minibus service in the Yukon Territory.

Shared-Ride Taxi

The only shared-ride taxi service in operation in Canada is Transcab in Peterborough, Ontario. In an area of the city that could not economically be served by a fixed-route bus and where dial-a-bus operation would also have been too costly, a shared-ride taxi providing a many-to-few feeder service was installed for a 9-month trial period in 1974; the deficit is underwritten by the Ontario MTC. The service is provided by a taxi company named Call-a-Cab under contract to the franchise transit operator, Border Transit. The federal government was not involved in organizing this experiment. The experiment has been successful; the service was continued and expanded to cover a service area having 3400 inhabitants and an overall population density of 299 persons/km^2 (778 persons/mile^2). The service is now funded by the city as a regular transit operation.

During the demonstration period the average weekday ridership was 158 and the average number of passengers per taxi trip was 2.13. The present average daily ridership is about 350. The number of vehicles engaged in shared-ride service can be as high as 20. The deficit of the service ($0.90/passenger trip), which ranks in the middle of the scale of dial-a-bus deficits, can be explained by the low population density of the area served [292 persons/km^2 (778 persons/mile^2)] as compared with the population densities of typical dial-a-bus areas [750 to 3000 persons/km^2 (2000 to 8000 persons/mile^2)].

One of the most dramatic effects of the Transcab service is that it has approximately tripled the use of transit by the local population. Annual ridership per capita has increased from approximately 9.3 to 23.0 for one zone, and 77 percent of trips served are for work purposes.

The adult fare for Transcab is a $0.10 premium in addition to the $0.25 regular transit fare. The economic effectiveness of Transcab is shown by a comparison between the deficit per passenger during the demonstration period ($0.60) and that of the previous bus service ($2.34). The deficit has since increased to about $0.90/passenger because of a recent increase in taxi fares unmatched by a similar increase in transit fares, but this situation should be balanced when new fares become effective on the transit services. When not required for Transcab service, the taxis go about their regular business, so that, unlike dial-a-bus operations, cost to the system is incurred only when passengers are carried. This is a very effective way of using the excess capacity of the taxi system and lowering the cost of the transit operation by the principle of marginal cost.

Minibus Service

In Whitehorse, Yukon Territory, a minibus service has been designed, implemented, and run since 1976 by an association of women who contract with the city of Whitehorse. Whitehorse has a population of 14 000 and a population density of only 28 persons/km^2 (74 persons/mile^2). During the 18-month demonstration project, the Whitehorse Minibus Society project received financial and technical help from the local, territorial, and federal governments, and it is now in the process of becoming a continuing transit operation. The service is provided by four minibuses on three fixed routes for a fare of $0.50. The system carried an average of 560 passengers daily and is particularly cost-effective for a city of that size (the deficit is $0.44/passenger trip). This is mostly due to the fact that it is operated with nonunion parttime labor, which eliminates the problem of split-shift salary premiums and is estimated to be about half the cost of conventional transit operation employing union drivers.

Transportation Pooling

Unlike the United States, Canada does not have a significant history of transportation pooling. No particular incentive measures, such as preferential parking or reserved lanes for multioccupancy vehicles, have been widely implemented. Thus far, there are five known examples (Tables 4 and 5).

In Valcartier, Quebec, a bus subscription service has been offered by an employer (Defense Research Establishment Valcartier, a self-governing body associated with the Defense Research Board) to its employees living downtown or in the suburbs of Quebec City. Of the 750 potential users, 60 percent are regular patrons. The overall annual load factor of the 14 buses providing the service is 91 percent, and the average deficit per passenger trip is $1.15 for a 26-km (12-mile) trip.

In Sarnia, Ontario, there is an experiment in car pooling based on a study prepared by the Urban Transportation Research Branch (UTRB), Transport Canada. The experiment began under the aegis of the Office of Energy Conservation, Ministry of Energy, Mines, and Resources, and has thus far produced little information. According to the study, the number of automobiles removed from the road through this program could vary between 366 and 1087, depending on the intensity of the promotional effort. This could result in a potential savings of $43 745 to $129 918 to the community.

In Bathurst, New Brunswick, there is an unstructured (spontaneous) collection of car and van pools with an average of 1500 regular patrons and a vehicle productivity of 2.28 passengers/trip for automobiles and 8.95 passengers/trip for vans. This is organized by private individuals.

In Vancouver, British Columbia, an areawide carpooling demonstration project was initiated in 1976 and funded by the federal government. This project had a two-pronged emphasis:

1. The commuter club promoted a number of measures—such as development of a computerized car-pool matching procedure, reduced parking rates, and preferential parking locations—aimed at encouraging greater use of car pools and
2. The variable-work-hours program aimed at reducing the level of peaking in the rush hours by spreading the demand to other periods of the day, thereby achieving more efficient utilization of the existing transportation system.

However, because of good transit service, reasonably short travel distances, and reasonable satisfaction with current commuting modes, there was little motivation to form additional car pools. Only 86 were formed, and

Table 4. System characteristics of transportation pooling systems.

System					Vehicles		Vehicle Productivity (passengers per trip)
Location	Type of Pool	Start Date	No. of Regular Patrons	Type of Service	Number	Type	
Valcartier	Bus	1952	450	Many to one	14	35-seat buses	32
Vancouver	Car	1976	180	Many to one	86	—	2.2
Bathurst	Car and van	Late 1950s	1500	Many to one	466[a]	—	2.28 for car; 8.95 for van
Ottawa	Car	1977	—	Many to one	—	—	2.85
Sarnia	Van	Early 1960s	700	Many to one	1 or 2/ association (16 associations)	12- and 15-seat vans	12.5

[a] On survey day.

Table 5. Financial characteristics of transportation pooling systems.

System	Fare ($)	Financial Results	Sponsorship	Subsidy	Status
Valcartier	0.70 (round trip)	Deficit of $1.15/passenger trip	Federal Defense Research Board	At first, fully subsidized by federal government; later partially subsidized	Ongoing
Vancouver	—	Revenues cover costs	Federal Ministry of Transport; City of Vancouver	—	Phased out because of lack of response
Bathurst	2.00 (round trip)	Car-pool revenues cover costs; van-pool revenues generate excess	Informal organization	—	Ongoing
Ottawa	—	Revenues cover costs	Office of Energy Conservation; Federal Ministry of Energy, Mines, and Resources	—	Ongoing
Sarnia	2.00 to 5.00/ week	Excess revenues refunded to members	Vehicles purchased and owned by private associations of workers	Financial assistance from employees' credit union; loans repaid in 3 years	Ongoing

the demonstration project was phased out after December 1977.

Transportation for the Handicapped

The transportation needs of the handicapped are becoming an issue in Canada. Thus far, planners have emphasized paratransit as a response, rather than adapting existing public transportation systems to facilitate travel by the handicapped.

The provision of transportation services for the handicapped is still occurring in a piecemeal manner, through the active roles of different private associations. Such services, mostly in the form of demand-responsive minibuses, can be found in almost all major cities in Canada (e.g., Calgary; Vancouver; Victoria; Winnipeg; Fredericton, New Brunswick; St. John's, Newfoundland; Halifax, Nova Scotia; Ottawa; Toronto; Charlottetown, Prince Edward Island; Montreal; Quebec; Regina; and Saskatoon, Saskatchewan.

In 1975, the Disabled Adult Transportation Service (DATS) was implemented in Edmonton, Alberta, to offer a special many-to-many service to handicapped persons unable to use the Edmonton Transit System. First developed as a demonstration project supported by the federal, provincial, and city governments, it then became a regular operation. The system uses 16 to 18 minibuses to serve approximately 125 regular patrons at a fare of $0.50/trip. The average number of trips per day is 250—40 percent are for work and 24.3 percent are for medical purposes.

Although it offers a high level of service, this system has a rather low productivity (1.44 passengers/vehicle·h), resulting in relatively high operating costs (a deficit of $8.00/passenger trip). The system is operated by Edmonton Handibuses Association, a private association under contract to the city for the provision of this service.

FUTURE DEVELOPMENTS

The discussion below offers a prognosis of the future of paratransit in Canada, based on emerging trends in service innovation.

Dial-a-Bus

Between 1970 and 1974, 12 or 13 dial-a-bus systems were implemented but, since 1974, no new systems have been introduced. This can be attributed to three problems:

1. The support by senior governments was withdrawn after the concept had passed the demonstration phase, and there were no other sources of funding for mass implementation until the development of the Urban Transit Assistance Program. (This is a $230 million federal program announced in October 1977 to assist the provinces in improving their urban public transportation systems. Each province will share equally in the finding of a formula that allows them $10/person over a 5-year period beginning April 1978.)
2. After the novelty of the concept had worn off, the cities realized that dial-a-bus is not a panacea for solving all public transit problems in low-density areas. It has now been shown that this service concept can be effective within a narrow range of demand and is more effective in serving particular groups (such as the handicapped) than others. Therefore, the cities have now become more cautious about analyzing the alternatives before "jumping onto the bandwagon."
3. Despite its reported social benefits and operationally satisfactory performances, dial-a-bus is hard to sell because of its cost. Increased mobility is rather intangible when compared to the harsh reality of the deficit on a balance sheet. However, the cities must make a decision about how much they are willing to pay for providing added mobility to their residents. This is essentially a political decision in which the public must choose between social objectives and costs.

The recent trend in Canada at both the provincial and municipal levels has been to hold the line on public transit subsidies. This means that expansion of uneconomic fixed routes is unlikely and that less cost-effective modes such as dial-a-bus are also unlikely to gain support.

A strict evaluation of the existing systems will be necessary before further new systems can be justified. Nevertheless, in the short-term future, the following developments and uses of dial-a-bus will probably still be relevant:

1. Door-to-door transportation service for the handicapped, either parallel to or as an integral part of the public transit system, must be provided.
2. Dial-a-bus can be used as a transitional service for new subdivisions or small cities and build up sufficient ridership to lead to a regular transit system.
3. In the larger dial-a-bus systems already operating, the incremental computerization of dispatching functions can be used to test the benefits of automation. At present, the processing of reservations and generation of run sheets in the Calgary DART system is being automated by a program similar to the Ann Arbor, Michigan, one.
4. Door-to-door operations should be rationalized in places where reasonably high demand has been achieved (e.g., in Regina) to cope with the increased peak-period loading. One possible strategy is to organize trips around the subscribers and require casual users to meet the bus on the established route rather than receiving door-to-door service. Another strategy is the use of minifixed routes (i.e., minibuses are used as fixed-route feeders in subdivisions—this makes use of the maneuverability of the smaller vehicles and eliminates the need to provide door-to-door service).
5. Stop-to-stop (divert-a-bus), rather than door-to-door, operations should be tested—i.e., these buses have no scheduled routes but collect and drop off passengers at strategically located shelters or stops. This may be more cost-effective for off-peak, late evening, and weekend services than dial-a-bus.

Of these, items 4 and 5 are moving toward a less demand-responsive and less flexible system, but they improve the economics of dial-a-bus operations.

Privately Operated Systems

Most of the general paratransit systems implemented in Canada are publicly operated, but most of the transportation services for the handicapped are not. Traditionally, private, nonprofit organizations or taxi companies have been active in the provision of social service transportation. Because of the parochial attitudes between the public and the private sectors, only recently have the cities begun to seriously consider the option of using private operators to provide transit services. This has been brought about by

1. The escalating labor costs in the public sector and the corresponding lower labor costs in the private sector,
2. The flexibility of private operators to deliver various forms of paratransit service because of their experience with a multitude of services, and
3. The growing interest of the taxi industry in widening their markets by providing paratransit services.

The role of the private operator in the provision of paratransit service can be expected to increase significantly in the near future, especially in the small cities where there is no other form of public transit.

Recently, the federal UTRB has been encouraging small cities to study the privately operated, shared-ride taxi as a possible transit solution. Thus far, three cities (Bathurst; Battlefords, Saskatchewan; and Charlottetown) have conducted feasibility studies and are considering the implementation of demonstration projects.

Transportation Pooling

In Canada, there has been neither public nor private interest in transportation pooling comparable with that in the United States. In part, this is because Canada was not as severely affected by the energy crisis and in part, it is because public transit did not decline to the same extent as in the United States. However, despite the failure of the Vancouver car-pool demonstration and limited formal ride-sharing activity, there is an awareness at all levels of government that pooling is an important component of any energy conservation program and of any contingency plan for dealing with unreliable energy supplies. In other words, it is recognized that some attention should be given to developing pooling as a standby option should there be a service shortage of gasoline in the future.

It is fair to say that organized car-pool promotion is unlikely to be a central element of Canadian ride-sharing programs. The main thrust in the pooling area will be concentrated on van pooling. The research conducted in the United States, as well as the tentative conclusions derived from the few Canadian experiences, seems to show that the van pool would be the more cost-effective pooling arrangement.

The Federal Ministry of Energy, Mines, and Resources and the Ministry of Transport both feel that van pooling will probably contribute more to energy saving and have wider applicability to isolated industrial complexes located at the periphery of metropolitan areas. These ministries are now contemplating a van-pool demonstration program to be implemented in cooperation with provincial authorities that perhaps would provide data to support a policy of van-pool promotion.

Other Developments

Although it is not a paratransit service, there is one interesting service innovation that is worth mentioning. In Mississauga, Ontario, UTRB has instituted an automated bus passenger information (ABPI) system. Basically, it is a telephone answering service that can inform a potential bus rider about the estimated time of arrival of the next bus at his or her bus stop on request. The system was developed by using manual methods in December 1975 on one bus route. In October 1977, an automated voice response system and a computerized system were introduced. At present, a potential passenger can key in an inquiry by using the telephone dial and obtain an automated voice response as to when the next bus will come. [For example, for bus route 6 and bus stop 35, a passenger can dial 276-0635, where 276 is the prefix to gain access to the computerized ABPI system, 06 stands for bus route 6, and 35 for bus stop 35. The automated voice, named easy rider information computerized assistance (ERICA), then replies, "Easy rider, route 6, stop 35, next bus in X minutes, the following bus in Y minutes."]

The harshness of Canadian winters and the excellent telephone coverage accounts for the success of the system. During the manual and the semiautomated phases, the overall ridership on the route being used for the experiment increased by 10 percent. Up to 80 percent of riders are calling during blizzard days. The benefits of the improved service are obvious, and the system is very popular. In addition, the improved flow of real-

time operational information that resulted from the installation of the automated vehicle-monitoring component of the system has already permitted the reduction of total tour time for the experimental route from 120 to 100 min, thus permitting a reduction in the number of buses required to serve the route.

An information and control system of this type is particularly useful for the stop-to-stop type of paratransit service. Because the passengers of a service of this type are picked up at the stops and there is no fixed schedule, the reliability of bus arrival time becomes paramount to the user, as well as to the scheduling and dispatching of buses.

The combination of ABPI and the stop-to-stop concept could prove to be an interesting and cost-effective variation of paratransit services for low-density areas. It is probable that UTRB will test this concept in a demonstration site in the near future.

DISCLAIMER

The views expressed in this paper are ours. They do not necessarily represent the views of the Urban Transportation Research Branch, Canadian Surface Transportation Administration, Transport Canada.

REFERENCE

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Implementation and Preliminary Impacts of Shared-Ride Taxi Service at Boston Logan International Airport

Daniel S. Greenbaum,* Consultant, Boston
Karla H. Karash and John P. Attanucci, Massachusetts Executive Office of Transportation and Construction
Joel V. Bornstein, Massachusetts Port Authority

On April 26, 1977, the Massachusetts Port Authority introduced a pilot shared-ride taxicab dispatching service called share-a-cab from Boston Logan International Airport to 21 cities and suburban towns to the west and northwest of the city of Boston. The service provides for the grouping of up to four passengers in one taxi for a flat fare known in advance to the passenger that is approximately half the average metered fare to the city or town to which he or she is destined. Share-a-cab passengers are grouped from five airport-terminal locations by means of a central assignment and taxi dispatching system that is linked by telecommunications to personnel in the terminals. On July 19, 1977, the service was expanded to 117 additional eastern Massachusetts cities and towns and, on September 19, 1977, service at reduced fares was guaranteed after a maximum 15-min wait even if only one passenger had requested service. Preliminary impacts for the service area of 138 communities indicate that the share-a-cab service has attracted approximately 3 percent of the total daily trips from Logan Airport to these cities and towns. Among the users of share-a-cab trips, approximately 42 percent had shifted from exclusive-ride taxi, 30 percent had shifted from private or rental automobiles, and about 28 percent had shifted from bus, limousine, or rapid transit services. Share-a-cab has significantly increased taxi ridership and revenue. The service was implemented without any major operational problems, although its labor-intensity has resulted in subsidies per passenger that are relatively high. The expected demand levels and diversions from private automobile trips have not yet been reached. The early results have been evaluated to reach conclusions and provide recommendations for improvements to the initial service.

On April 26, 1977, the Massachusetts Port Authority (Massport) introduced a pilot, shared-ride taxicab dispatching service called share-a-cab from Boston Logan International Airport to 21 cities and suburban towns to the west and northwest of the city of Boston. The service was designed to provide convenient, door-to-door taxi service to airport users for approximately half the fare of regular, exclusive-ride taxi service. It was developed in cooperation with state and local government agencies and the local taxi industry and is unique in several ways:

1. Passengers are grouped from five different terminal locations in the airport.
2. Passengers pay a flat fare that is half the regular taxi fare.
3. All passengers are guaranteed service within 15 min even if there are no other passengers to share the ride.
4. Representatives of more than 200 independent taxicab owners and operators participated in the planning and initiation of the service.
5. An aggressive marketing program and extensive signing at the airport accompanied the introduction of the service.

This paper describes the background of the planning, development, and operating characteristics of this new shared-ride taxi service, reviews its goals and objectives, and reports the extent to which they have been met during the first 12 months of operation. Based on this review, preliminary conclusions are reached and recommendations for improvements to the initial service are made.

The data analyzed here were collected from daily operating statistics for the service and three user surveys conducted during the first 12 months of operation. The first survey was conducted at an earlier period when service was being offered to the initial 21 cities and towns and not guaranteed to the passenger (i.e., taxis were dispatched only when groups of two or more passengers had been formed). The follow-up surveys were conducted in December 1977 and January 1978, after the territory had been expanded to include 138 communities in the Boston metropolitan area and guaranteed service had been instituted.

BACKGROUND—GROUND TRANSPORTATION ACCESS TO LOGAN AIRPORT: CURRENT STATUS AND POLICY

In 1977, more than 12 million airplane passengers passed

through Boston Logan International Airport. It is estimated that air travelers going to and from the airport, their friends and families, and the employees who serve them generated more than 35.2 million person trips between the airport and its surrounding communities. Almost all of these passengers traveled by private automobile (80 percent) or taxi (11 percent). The remainder traveled by bus or limousine (3 percent) or by subway (6 percent). In the peak travel month of August, weekday traffic out of Logan exceeded 30 000 vehicles daily; peak volumes were close to 2300 vehicles/h (1, 2).

The location of Logan Airport, 1.6 km (1 mile) across Boston Harbor from Boston proper, means that more than 65 percent of the automobile trips to and from Logan must travel through the Sumner and Callahan tunnels (see Figure 1). The tunnels (two lanes in each direction) operate near capacity during peak travel hours, and through trips on Central Artery in downtown Boston (which connects with the tunnels) cause traffic volumes that exceed capacity and result in stop-and-go conditions during many hours of a typical day. The percentage of tunnel traffic that is airport-related varies from 26 to 56 percent during the course of the day, and airport traffic contributes significantly to tunnel congestion (particularly during the afternoon peak-travel hours).

In addition to causing delays to automobile drivers, this congestion increases levels of air pollution near the tunnels and encourages trucks making deliveries at the airport to divert to streets in East Boston, which increases the noise, congestion, and the possibility of accidents in this community. As the demand for air travel grows in the next several years, the problems associated with ground access to the airport are expected to become worse.

Massport has recognized the problems resulting from the current reliance on the automobile as the primary form of ground transportation to and from the airport and begun to encourage a modal shift away from such automobile use. The airport master plan of April 1976 included a policy declaration to promote vigorously the development of an improved network of alternative surface public transportation services for air passengers traveling to and from the airport. In particular, Massport has sought to divert a significant portion of the existing airport access and egress trips from low-occupancy private automobiles to high-occupancy bus, limousine, and rapid transit services.

However, the proposal to expand the use of these services met with strong protest from Boston taxi operators, who provide the primary taxi services at the airport. Airport trips constitute a significant portion of taxi industry revenues, and the operators viewed the promotion of other services as an unfair threat to their competitive position. Because Boston taxis were prohibited by regulation from offering multiple-ride services, the operators felt that they were not being given an opportunity to compete fairly with bus and limousine services. These taxi-industry concerns resulted in a week-long airport taxi strike (which later spread citywide) and in requests for the right to provide multiple-ride services at the airport.

Because of the pressure generated by the taxi industry and in recognition of the potential transportation benefits to be derived from a sophisticated multiple or shared-ride taxi service, Massport, together with the Massachusetts Executive Office of Transportation and Construction, the city of Boston, and representatives of the taxi industry, developed the share-a-cab service. This service is consistent with federal and state policies to encourage the taxi industry to play a greater role in providing public transportation and, if all goes well, will become an important link in the development of a network of airport ground transportation services.

OBJECTIVES

The development of the share-a-cab service was guided by the objectives of Massport and the taxi industry. Although these groups had distinct sets of objectives, these objectives were generally complementary, a factor that was essential to the coordination and cooperation needed for the development and implementation of the service.

The objectives of Massport in establishing the share-a-cab service were

1. To provide an innovative, high-quality group-ride taxi service to air passengers that would offer personalized door-to-door service at substantially reduced rates per person;
2. To divert airport ground access and egress trips from low-occupancy private automobiles to more efficient, high-occupancy shared-ride taxi service;
3. To reduce the traffic congestion and vehicle travel, air pollution, and energy consumption that are associated with airport ground access and egress; and
4. To ensure the continued economic viability and availability of demand-responsive transportation services at the airport.

The objectives of the private taxi industry in establishing the share-a-cab service were

1. To increase the total number of air passengers using taxi services for their airport ground access and egress trips and
2. To increase the average revenue received per vehicle kilometer for taxi trips to and from the airport.

DESCRIPTION OF SHARE-A-CAB SERVICE

Characteristics of Service

Massport, the city of Boston, and the executive office of transportation and construction spent several months developing and analyzing potential share-a-cab services. The characteristics of the service desired were then reviewed with the taxi industry, and a final set of service characteristics was agreed on. In the course of the discussions with the taxi industry, three important aspects of the service were modified in deference to their concerns.

First, Massport had proposed that the service be developed on a trial basis for 12 communities to the north and west of Boston, but the taxi industry felt that it should be developed for the entire metropolitan area (excluding the city of Boston) as soon as possible. The compromise reached was to initially develop the service for the 21 communities to the north and west of Boston that represent the focal point of travel outside Boston and account for approximately 25 percent of all air passengers. Then, 3 months later, the service was expanded to the remaining 117 communities in the greater Boston metropolitan area (these account for an additional 28 percent of all air passengers). The service was not developed initially for the city of Boston because the taxi industry feared that it might detract from their existing markets without attracting substantial numbers of new passengers. Figure 2 illustrates the locations of the initial and final share-a-cab service areas.

Second, as originally proposed, share-a-cab service at reduced rates was to have been guaranteed to all passengers within 15 min regardless of whether other passengers were available to be matched. This was in-

tended to increase the reliability of the service and its attractiveness to the traveler. The taxi industry, however, was concerned that during the initial months, when demand was only developing, there would be a large number of single-passenger trips at reduced fares, resulting in financial losses for the industry. In deference to this strongly expressed concern, it was agreed that guaranteed service would not be initiated until 2 months after service had been introduced to all of the 138 communities in the Boston metropolitan area.

Finally, it had originally been hoped that two-way service could be developed. However, because of the difficult task of organizing diverse suburban taxi companies for the inbound trips and the pressure from the Boston taxi industry to implement the outbound service as soon as possible, the initial service was limited to trips outbound from the airport.

For the service finally implemented, the following service characteristics were established:

1. Share-a-cab service is available at the airport between 7:30 a.m. and 11:30 p.m., 7 d/week.
2. Each passenger matched in a group receives door-to-door service from the airport to his or her particular destination in any of the communities served.
3. The share-a-cab fares are flat rates established for trips to each of the communities per person and independent of the number of passengers grouped in the vehicle. The rates are set at approximately one-half the average metered rate to each community and include all tolls and other applicable fees. The fare per person is known by the passenger in advance and does not vary with traffic conditions or routes.
4. Share-a-cab service within 15 min is guaranteed to any passenger requesting it. (Before September 19, 1977, service was guaranteed only if two or more passengers could be matched to form a group; if a group could not be formed, the waiting passenger was so informed and given the options of waiting longer or taking an alternative service.)
5. The size of the group is limited to a maximum of 4 passengers/vehicle (in accordance with Boston taxi regulations), and each passenger is limited to two pieces of luggage unless the size of the group or the storage capacity of the vehicle permits more.
6. Once a passenger is assigned a share-a-cab group, he or she is guaranteed service at share-a-cab rates, regardless of whether the other passengers scheduled to ride in the taxi actually join the group.

Figure 1. Logan International Airport and downtown Boston.

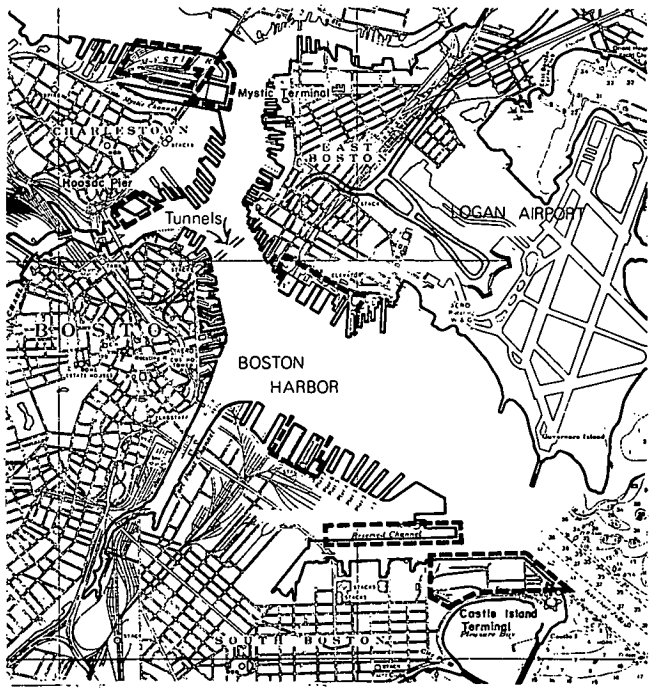
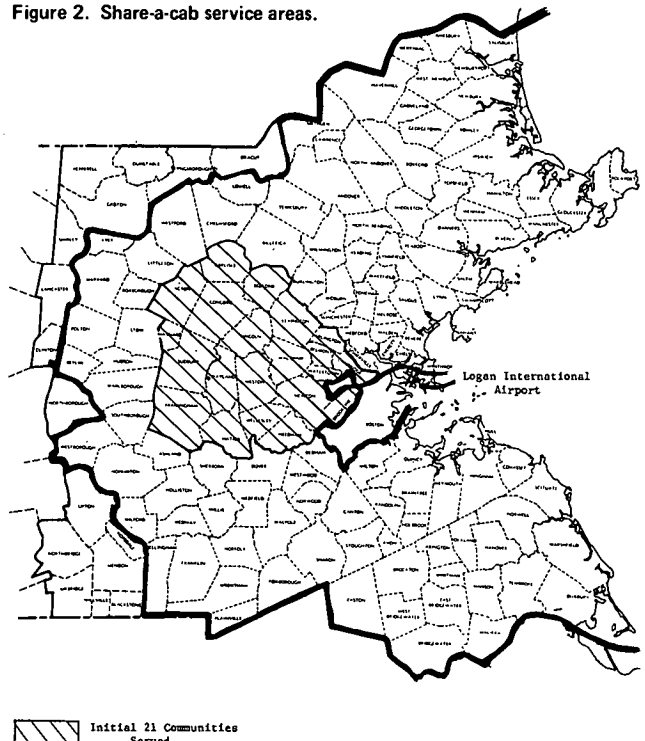


Figure 2. Share-a-cab service areas.



Mechanics of Share-a-Cab Service

Massport is responsible for the share-a-cab dispatching system at the airport. Only city of Boston licensed taxis can participate in the service. (According to state statute, only city of Boston taxis can pick up fares at Logan Airport unless a prior arrangement has been made with an out-of-town taxi.)

The service is designed to fit smoothly into the passenger's normal routine for leaving the airport. After claiming his or her baggage, the passenger approaches one of the share-a-cab booths located in the baggage claim areas of the terminals. At the booth, a trained attendant and informative signing provide information about the service and aid the passenger in making a service request. The attendant and the passenger use an easy-to-read service-area map to locate the passenger's destination zone, and the attendant then relays this information to a central control office.

At the central control office, a call taker records the request, marks a dispatch constraint time 15-min hence, and relays the information to the dispatcher. By using a large-scale area map and personal knowledge of the service area, the dispatcher forms the groups from among the passengers waiting at all the terminals. To aid in this process, a series of matching guidelines that minimize wait and travel times have been established. After a group has been formed or when 15 min have passed, the dispatcher calls the next taxi in the taxi queue and gives the driver a dispatch form that identifies how many passengers are waiting at each terminal. The dispatcher

then notifies the attendants in the terminals that a taxi is on the way. The passenger is informed of the number of the dispatched taxi by the attendant and then waits at the curb to be picked up. Because the fares do not vary with time or incremental distance, the driver has an incentive to find the shortest and quickest route for delivering the passengers.

Taxi operators can choose to provide either share-a-cab or regular (exclusive-ride) service by entering the separate queues for each. In the share-a-cab queue, the driver may be assigned between one and four passengers. A driver who picks up only one passenger receives a rain check that allows preferential placement when he or she returns to the queue.

Costs of Share-a-Cab Service

Capital Costs

Fixed one-time costs for the Logan Airport share-a-cab system included a number of low-cost improvements to the terminal and taxi-pool holding areas. These costs included the design and construction of a special share-a-cab-pool holding area; the purchase and furnishing of the central dispatching and matching center in the taxi-pool area; the construction of share-a-cab information booths in each of the five terminal areas; and the design and purchase of dispatching equipment (such as maps, time clocks, and telecommunication and paging systems). These costs totaled approximately $130 000. In addition, there was a one-time initiation marketing cost of approximately $60 000 to introduce the service to the public and develop a permanent share-a-cab signing program for the airport.

Operating Costs

Annual operating costs for the share-a-cab program include personnel salaries and benefits, expenditures such as utilities and maintenance, and a continuing marketing expenditure. These costs totaled $293 000 for the first year, of which approximately 67 percent are attributable to personnel costs. The system as currently designed is labor-intensive because of the need to match passengers at a number of terminals at the same time.

Revenues and Deficit

A $0.50 fee is charged to each taxi entering the share-a-cab taxi-pool area. For the first full year of service, it is expected that an average of 100 taxis/d will be dispatched, which will result in an annual revenue of $18 250 and an operating deficit of $275 750.

This deficit is being partially offset by an increase in revenue from the regular taxi pool. Before the initiation of share-a-cab service, only the regular taxi pool existed, and taxis paid a $0.10 entrance fee to help pay for the regular dispatching personnel (who are located at curbside in each terminal area). The revenue from this charge was very small compared with the labor costs of maintaining the regular dispatchers at each terminal and in the central area; the annual deficit was $286 250. At the initiation of the share-a-cab service, the fee for entering either pool (regular or share-a-cab) was set at $0.50 and, because of the high continued use of regular taxis, this has resulted in a reduction of the regular service deficit to $11 400. Therefore, the total annual deficit from taxi operations after the introduction of share-a-cab service was $287 150, which is only a slight increase.

PROJECTED EFFECTS

In the course of developing the share-a-cab service, a demand prediction methodology was developed to compare alternative corridors, fare structures, and dispatching techniques. By using this methodology, predictions of shared-ride taxi trips, exclusive-ride taxi trips, revenue per taxi, and taxi industry revenue could be made. The methodology allowed the planners to explore the effects of the shared-ride strategy with respect to the objectives set for the service. A summary of the expected results was produced for the initial 21 communities served by assuming a flat half fare, the availability of share-a-cab service for trips to as well as from the airport, and guaranteed rides for single passengers. Demand was estimated based on the size of the potential market among automobile users and on the potential for diversion of existing regular taxi users. Given the anticipated demand, estimates of one-, two-, three-, and four-passenger share-a-cab groups were made by assuming a Poisson arrival rate over 15-min periods.

Three of the projected effects—level of projected ridership, impact on vehicle travel, and impact on taxi industry revenues—are worth reviewing here.

The expected increase in taxi ridership was 149 passengers/d in the western corridor and 217 passengers/d in the northwestern area. The percentage increases in the taxi market ranged from 20 in Cambridge (where taxis already carried 41 percent of the trips) to 165 in Framingham (where taxis carried only 7 percent of the trips). The demand estimates were based primarily on diversion from regular taxi and the automobile, although it was assumed that a certain amount of the total demand would probably come from other modes.

One of the important potential benefits of share-a-cab service is a reduction in vehicle travel (VT) for airport trips. Although a detailed analysis was not performed before implementation, the following example illustrates the projected benefits. The average round-trip VT for share-a-cab trips to the western corridor was estimated by (a) computing the probability (based on the relative number of trips to each town) that the last destination for a certain size group is in each town and (b) adding a penalty of 3.2 km/round trip (2 miles/round trip) for each additional passenger. This technique gives an average share-a-cab round-trip VT to the western corridor, assuming four passengers per taxi, of approximately 56 km (35 miles). Average two-way VT to the western corridor by exclusive-ride taxi is approximately 42 km (26 miles) and by automobile is 46 km (29 miles). For those who would have taken an automobile parked at the airport or have rented an automobile, the average one-way VT is 23 km (14.5 miles). Thus, a four-passenger share-a-cab group would have a 24 percent saving in VT over a parked or rented automobile, a 62 percent saving over an automobile pick-up trip, and a 58 percent saving over exclusive-ride taxi. At the average projected occupancy for share-a-cab service of 3.9 persons/taxi, there would be considerable VT saving. Of course, this saving would be partially offset by increases in VT for passengers formerly using transit or buses, but the expected diversions were not large enough to completely offset the potential benefits of share-a-cab service.

Total taxi industry revenues were projected to increase by 41 percent with the introduction of share-a-cab service because of the high number of new riders that would be attracted. Given that average occupancy was also expected to increase, taxi VT was projected to increase more slowly than revenue, which would result in a projected 14 percent increase in revenue per vehicle kilometer.

Thus, the projected effects were highly beneficial to

both the transportation system and the taxi industry. However, as indicated above, at meetings between Massport, the city of Boston, the executive office of transportation and construction, and the taxi industry before implementation of the service, several important changes in the specifications were made. Two of these changes—the delay of provision of guaranteed service and delay of provision of two-way service—strongly affected the attractiveness and marketability of the service. As a result, the initial demand levels for the service were well below those originally projected.

RESULTS

During the first 12 months of operation of share-a-cab service, two forms of data were collected about passenger levels and user characteristics. Weekly statistical reports were compiled directly from the operation (these included numbers of service requests, passengers served, and taxis dispatched; taxi occupancy; and frequency of destinations served). In addition, a user survey that consisted of nine short questions was conducted on three week-long occasions by share-a-cab personnel. The survey requested information about user modal choice in the absence of share-a-cab service, frequency of airport use, method by which the user first learned of share-a-cab service, and other items. The first survey was conducted during the week of July 12-18, 1977 (when nonguaranteed service was being provided to only the initial 21 communities). The second and third surveys were conducted during the weeks of December 16-22, 1977, and January 10-17, 1978 (when guaranteed service was being provided to 138 communities).

Service Use Before Guaranteed Service

The initial service patronage was lower than projected. A total of 10 600 passengers (174 passengers/d) used the service during May and June. Daily average patronage increased during May and June from an initial 148 passengers/d to a peak of 196/d. The number of taxis dispatched averaged 60/d during May and June, which resulted in an average occupancy of 2.9 passengers/taxi. This occupancy was below that expected and was caused by a lower level of demand than that expected.

On July 19, 1977, the share-a-cab service was expanded to 117 additional communities, but still excluded the city of Boston. Despite the higher potential demand of the expanded service area, total share-a-cab patronage remained about the same as in May and June and there was an actual decrease in patronage in the initial 21 communities. In early September, average share-a-cab patronage was 189 passengers/d (of which 151 were from the initial 21 communities) or 2.1 percent of total travel to the 138 communities (and 3.5 percent of total travel to the 21 communities).

Demand by the additional 117 communities was much below that expected from the overall travel demand in these communities. This was due in part to the introduction of service to these communities during the summer and in part to the high number of potential users to those communities who were not matched because of the dispersed nature of the demand. The number of potential users not matched increased from 1.4 percent (with 21 communities served) to 10 percent (with 138 communities served). At the same time, the average taxi occupancy decreased from 2.9 to 2.7 passengers/taxi. In addition, the unreliability of the nonguaranteed service apparently hindered the normal growth one would expect after the introduction of a new service (although it is difficult to estimate the normal growth curve of an airport service that serves infrequently made trips).

Among the significant findings of the first user survey (July 1977) was that 52 percent of users were going to a residence and 25 percent were going to a hotel. The majority of users were relatively infrequent airport travelers; 15 percent had never traveled through Logan Airport before. If share-a-cab service had not been available, about 60 percent of the respondents would have used a regular taxi, 20 percent a private or a rental automobile, and 19 percent bus, limousine, or transit service. However, for trips to the airport, modal use shifts significantly; 36 percent would have used private or rental automobiles, 36 percent would have used regular taxis, and 12 percent would have used bus, limousine, or transit services. Seventeen percent of the users (1 in 6) had used share-a-cab service before. In terms of learning about the service, the extensive airport signing was clearly the most effective marketing mechanism, and newspapers and friends and relatives were next most effective.

Effects of Guaranteed Service

The introduction of guaranteed service on September 19, 1977, had significant effects on share-a-cab patronage and taxi occupancy. Patronage increased from 189 passengers/d in early September to 245 passengers/d in October and November (or 2.7 percent of all travelers to the communities served) to an average of 291 passengers/d in the January to March period (or 3.2 percent of all travelers). Single-person trips ranged between 10 and 15 percent of all trips and, as a result, average share-a-cab taxi occupancy decreased to 2.2 passengers/taxi during the fall (although by March 1978 it had increased to about 2.4). Trips to the 117 additional communities increased from 16 percent of all share-a-cab trips to more than 30 percent as previously nonmatched passengers were provided guaranteed service.

The findings of the second and third user surveys (December 1977 and January 1978) include important changes in service use. The combined results are summarized in Figure 3. Had share-a-cab service not been available, approximately 42 percent of users would have used regular taxi, 30 percent would have used automobiles (including rental ones), and 28 percent would have used limousines, buses, or rapid transit. This is a substantial change in previously used modes (compared with the first user survey); many more respondents to these surveys had shifted from automobile and transit to share-a-cab service. This shift occurred throughout the 138 communities served, but was most evident in the 117 new communities where less than one-third of the users would previously have used taxis.

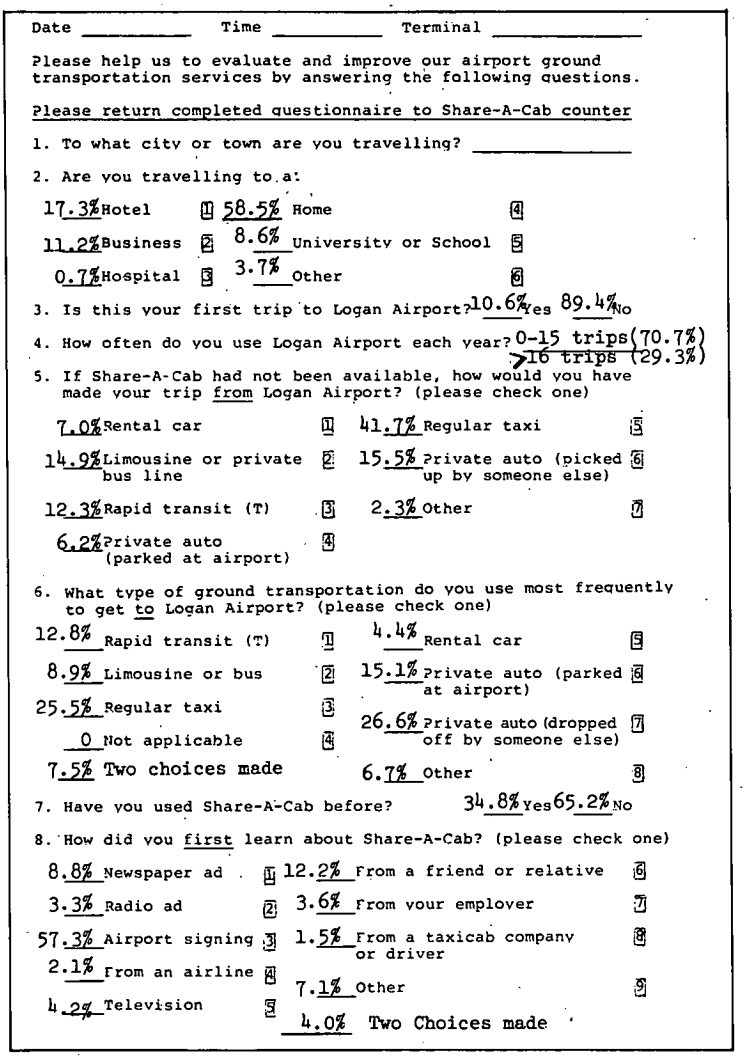
In addition to these changes in previously used modes, these surveys indicated that the percentage of users who had previously used the service had more than doubled (from 17 percent in the first survey to 35 percent).

Service Objectives

The data now available (Table 1) allow a preliminary evaluation of the ability of share-a-cab service to meet the objectives set forth.

1. To provide high quality service: Service implementation went smoothly; the telecommunications and logistics worked well. At first, when service was not guaranteed, the percentage of potential users who were not matched into groups was higher than expected, but monitoring the dispatching techniques and guidelines reduced the percentage of nonmatches to 1.4 percent (with 21 communities served). Group formation and dispatching also generally went well, although there was an early

Figure 3. Share-a-cab questionnaire.



Date _____ Time _____ Terminal _____

Please help us to evaluate and improve our airport ground transportation services by answering the following questions.

Please return completed questionnaire to Share-A-Cab counter

1. To what city or town are you travelling? _____

2. Are you travelling to a:

17.3% Hotel	1	58.5% Home	4
11.2% Business	2	8.6% University or School	5
0.7% Hospital	3	3.7% Other	6

3. Is this your first trip to Logan Airport? 10.6% Yes 89.4% No

4. How often do you use Logan Airport each year? 0-15 trips (70.7%) >16 trips (29.3%)

5. If Share-A-Cab had not been available, how would you have made your trip from Logan Airport? (please check one)

7.0% Rental car	1	41.7% Regular taxi	5
14.9% Limousine or private bus line	2	15.5% Private auto (picked up by someone else)	6
12.3% Rapid transit (T)	3	2.3% Other	7
6.2% Private auto (parked at airport)	4		

6. What type of ground transportation do you use most frequently to get to Logan Airport? (please check one)

12.8% Rapid transit (T)	1	4.4% Rental car	5
8.9% Limousine or bus	2	15.1% Private auto (parked at airport)	6
25.5% Regular taxi	3	26.6% Private auto (dropped off by someone else)	7
0 Not applicable	4		
7.5% Two choices made		6.7% Other	8

7. Have you used Share-A-Cab before? 34.8% Yes 65.2% No

8. How did you first learn about Share-A-Cab? (please check one)

8.8% Newspaper ad	1	12.2% From a friend or relative	6
3.3% Radio ad	2	3.6% From your employer	7
57.3% Airport signing	3	1.5% From a taxicab company or driver	8
2.1% From an airline	4	7.1% Other	9
4.2% Television	5	4.0% Two Choices made	

Table 1. Service data.

Item	Before Share-a-Cab Service	After Implementation of Guaranteed Service to 138 Communities	
		All Taxi Service	Share-a-Cab Service Only
Total no. of daily passengers	1196	1366	291
Change, %	—	+14.2	—
Total no. of daily taxis	747	749	123
Change, %	—	+0.3	—
Avg no. of passengers/taxi	1.6	1.82	2.4
Change, %	—	+13.8	—
Total daily revenue, $	8420	8948	1892
Change, %	—	+6.3	—
Avg revenue/taxi trip, $	11.27	11.95	15.38
Change, %	—	+6.0	—
Total daily taxi travel, km	31 314	33 464	4514
Change, %	—	+6.9	—
Revenue/vehicle-km, $	0.27	0.27	0.42
Change, %	—	0	—

Note: 1 km = 0.6 mile.

tendency of the dispatchers to wait too long for an additional rider. Correcting this resulted in a slight decrease in average occupancy but also in reductions in cancelled requests for service and average wait times.

Overall, the service worked very well. The lower than expected demand levels resulted in some complaints of less than optimal matches, but passenger and media response has generally been enthusiastic. By July 1977, 17 percent of the users were repeat users and, by January 1978, there were 35 percent repeat users. When cross tabulated with frequency of travel through the airport, more than 50 percent of users who were frequent airport travelers had used the service before.

Taxi industry response has been similarly enthusiastic; the major concern has been that waits in the taxi pool have been too long. The industry was extremely interested in the July 1977 expansion of share-a-cab service to additional communities so as to increase overall use and awareness of the service. The industry did have some concern that initiation of guaranteed service was premature, but this proved unfounded and there have been no driver complaints since September 1977.

2. To divert trips from automobiles: The results of the December and January user surveys indicated that a significant part (41.7 percent) of share-a-cab users would previously have used regular taxis. Nonetheless, 15.5 percent would have been picked up in automobiles, 6.2 percent would have parked automobiles at the airport, and 7.0 percent would have used rental automobiles. Table 2 summarizes these data and shows that a total of 1.3 percent of automobile users changed to share-a-cab service. This modal-split shift varied significantly among the towns served; in the farther-out towns as

Table 2. Estimated modal shifts.

Item	Percentage of Total Share-a-Cab Passengers	Percentage of Total Airport Trips Using Share-a-Cab	Previous Modal Split (%)	Estimated New Modal Split (%)	Shift (%)
Previous mode for trips shifting to taxi service					
Bus, limousine, or transit	27.2	0.9	9.7	8.8	-9.3
Automobile (including rental)	28.8	0.9	66.8	65.9	-1.3
Other	2.3	0.1	0.9	0.8	-11.1
Total shifting to taxi service	58.3	1.9	77.4	75.5	-2.5
Trips shifting from regular taxi	41.7	1.3	22.6	21.3	-5.8
Total share-a-cab trips	100.0	3.2	—	3.2	—

Table 3. Effect on daily vehicle travel.

Mode	Daily Passengers From Mode	Previous VT (km)	Share-a-Cab VT	
			Value	Change (%)
Rental automobile	20.8	484	510	+5
Bus or limousine	44.3	—	1082	
Transit	36.5	—	894	
Automobile (park and fly)	18.4	428	450	+5
Automobile (pick up)	46.3	2149	1133	-47
Taxi	124.7	5187	3051	-41
Total	291	8248	7220	-14

Note: 1 km = 0.6 mile.

many as 40 percent of share-a-cab users would have previously used automobiles. Had share-a-cab service not been available, 27.2 percent of users would have chosen rapid transit, bus, or limousine service. This represents a shift of 9.3 percent of the previous users of these modes to share-a-cab service.

3. To reduce vehicle travel, traffic congestion, and air pollution: Share-a-cab service has had both positive and negative effects on vehicle activity, but overall has resulted in a significant reduction in VT. As indicated in Table 3, VT by share-a-cab users to the 138 communities served has been reduced by 1100 vehicle·km/d (700 vehicle miles/d) or 14 percent. The most significant reductions have been from previous automobile users and regular taxi users who have shifted to share-a-cab service. Despite the relatively low patronage in the period before service was guaranteed, overall taxi occupancy increased from 1.6 to 1.82 passengers/taxi (which was instrumental in the significant reduction in VT). Bus, limousine, and transit users changing to share-a-cab service caused a gain in VT, but this was more than offset by the reductions.

4. To increase taxi market share: One of the prime objectives of the taxi industry was to increase the share of the airport travel market being served by taxis. Based on the December and January surveys, 58 percent of the users of share-a-cab service (approximately 170 persons/d) would not have used taxi services before the initiation of share-a-cab; this is a shift of 1.9 percent of total airport travelers to the share-a-cab service area. Taxis previously served approximately 1196 daily trips to the service area; thus, even the low level of current patronage has resulted in over a 14 percent increase in total taxi passengers.

5. To increase taxi revenue per vehicle kilometer: As shown in Table 1, the overall taxi-industry revenue to the service area has increased by about $500/d or 6 percent. Since the total number of taxi trips to the service area has remained almost constant, the overall average revenue per taxi trip has also increased by about 6 percent. But the higher average round-trip travel of share-a-cab trips [58.8 km (36.7 miles) as compared with 42.0 km (26.2 miles) for regular taxi] has resulted in a growth in daily taxi VT of about 7 percent. Therefore, the industry revenue per vehicle kilometer has remained about the same because the increase in taxi VT has offset the increase in revenue. However, as passenger volume and taxi occupancy grow, the revenues per vehicle kilometer should increase.

CONCLUSIONS AND FUTURE DIRECTIONS

The few-to-many share-a-cab service at Logan Airport is a precedent-setting service in many ways. The fare structure and the dispatching system, which guarantee service at a reduced fare, are unlike those of any other airport taxi service. Implementation of the service required the cooperation of diverse public agencies and many independent taxi operators. And, despite the short time since implementation, the service works well and is being enthusiastically received by the traveling public.

In its first 12 months of service, share-a-cab service has accomplished several important objectives. It is providing door-to-door service to almost 300 airport users daily at half the regular taxi fare. It has attracted a large number of new riders to taxi service, which has resulted in substantial increases in taxi markets and revenues. Because the total number of taxi trips has remained about the same, the new fares have significantly increased industry revenue per trip in the share-a-cab service area. It has also reduced total VT from Logan by a slight but significant amount.

Several of the objectives of share-a-cab service, however, have not yet been fully obtained. Demand for the service has been lower than expected and, as a result, occupancy of share-a-cab service is only 2.4 passengers/taxi. Taxi vehicle kilometers have increased along with taxi revenues and, thus, revenue per kilometer has not changed. Therefore, although share-a-cab service has improved average taxi occupancy at Logan, it has not, as yet, increased taxi industry profitability.

Although 30 percent of the users of share-a-cab service have been diverted from the automobile, 28 percent have been diverted from bus, transit, and limousine services. Reductions in VT by former automobile users are thus partially offset by increases in VT by former public transportation users. The net effect, however, is a reduction in VT and this can be expected to increase as ridership and occupancy increase.

Share-a-cab service had relatively high operating costs during its first 12 months. At the current level of ridership, the subsidy for the dispatching costs incurred by Massport is approximately $2.50/passenger.

Share-a-cab service will be able to attain all of its objectives in the future if its ridership grows. Increased passenger levels will increase taxi occupancy and profitability while reducing VT and the subsidy per passenger. The steady growth observed since the introduction of guaranteed service is expected to continue as the service becomes more reliable.

In addition to the expected natural growth in service

use, several planned or proposed improvements could greatly improve the ability of share-a-cab service to meet its objectives. First, share-a-cab service to the city of Boston is proposed to begin sometime in 1978. Boston was not served initially because of taxi industry concerns that the service would damage their existing strong market. With the general success of the service, however, it is expected that industry support for the Boston service will be forthcoming. Initiation of share-a-cab service to Boston will greatly increase demand and enable dispatchers to make more and better matches. Although service to downtown Boston will probably attract a high number of users from existing taxi service, these diversions should be more than offset by diversions from automobiles and other modes in other sections of the city, which will result in increases for the taxi industry and reductions in VT.

Second, Massport is currently investigating potential ways to reduce the operating cost of the service without sacrificing its quality. Automation of portions of the dispatching system may increase its cost-effectiveness while also aiding dispatchers to minimize air-traveler wait times and travel times. Also, less costly dispatching systems are being reviewed for possible use in off-peak hours (e.g., direct passenger telephone communications from less busy terminals to eliminate the staffing of share-a-cab desks during morning hours).

Finally, continuing efforts will be directed toward developing inbound share-a-cab service. Before implementation of the service, Massport contacted all the taxi companies in the initial 21 communities and sought their interest in providing inbound service but, although a small number expressed interest at that time, it was determined that the small number of towns those companies served would not provide the level of demand required for efficient grouping of passengers. The lack of a uniform suburban taxi industry and the fractured nature of the service areas hinder development of inbound service. Nonetheless, provision of two-way service could substantially increase the attractiveness of share-a-cab service to current automobile users, and efforts at developing a central inbound dispatching system will continue.

ACKNOWLEDGMENTS

Many persons played important roles in the planning and implementation of the share-a-cab service at Logan Airport. Only a few will be mentioned here. Frederick Salvucci first promoted the concept, and he, Emily Lloyd, and Dave Davis provided policy guidance as planning went forward. Daniel Brand, Howie Morris, and Ned Dodds assisted us in the planning analysis for the service. Many representatives of the Boston taxi industry worked with the planners and policy makers in determining the specifications of the final system. In particular, Leslie Barenholtz, Ted Kline, Donald Mullen, Jim Speros, and Felix Testa spent many hours reviewing the implementation of the service. Multisystems, Incorporated, was largely responsible for the successful implementation of service in a short time.

This paper was partly funded by a technical studies grant from the Urban Mass Transportation Administration, U.S. Department of Transportation. However, the views expressed here are ours and not necessarily those of Urban Mass Transportation Administration.

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Mr. Greenbaum was with the Massachusetts Port Authority when this research was performed.