Ste Anne de Bellevue, Quebec, Canada, 1982. (TP 3608E)
20. U. Rutenberg and M. Barber. Travellers with Special Needs: Modular Transfer Platform Design Concept. Les Designers Douglas Ball Inc., Ste Anne de Bellevue, Quebec, Canada, 1982. (TP 3796E)
21. VIA Station Standards Specifications for Special Needs. Rail Technology Department, VIA Rail Canada, Montreal, Quebec, Canada, June 1981.
22. J. Nicklin. Protective Container for Wheelchairs: Prototype Build. Davis Engineering Ltd., Ottawa, Ontario, Canada, Jan. 1982. (TP 3491E)
23. W.F. McCaffrey. Air Transport of Wheelchair Batteries. TES Ltd., Ottawa, Ontario, Canada, Sept. 1981. (TP 3210E)
24. VIA Rail's Five-Year Program for Passengers with Special Needs. VIA Rail Canada, Montreal, Quebec, Canada, 1981.
25. U. Rutenberg. Wheelchair Tie-Down/Passenger Seat Prototype Development. Douglas Ball Inc., Ste Anne de Bellevue, Quebec, Canada, Nov. 1978. (TP 1821)
26. T. Van Humbeck and D.K. Woods. Wheelchair Access System for Intercity Buses. TES Ltd., Ottawa, Ontario, Canada, Sept. 1981. (TP 3186E)
27. J. Magee, D.H. Jones, and J.F. Walter. Decision in the Matter of the Inquiry Respecting Intercity Bus Service to the Disabled in Newfoundland. Canadian Transport Commission, Ottawa, Ontario, Canada, Dec. 1981.
28. Hickling-Partners Inc. A Guide to Recognizing, Understanding, and Assisting Travellers with Disabilities. Transport Canada, Ottawa, Ontario, Canada, 1981. (TP 3461)
29. C. Noble. What Year of the Disabled Has Meant to Those Who Would Like to Travel. Toronto Star, Toronto, Ontario, Canada, Jan. 30, 1982.
30. Transportation in Canada: A Guide for Travellers with Special Needs. Transportation Development Centre, Transport Canada, Montreal, Quebec, Canada, 1981. (TP 380)
31. Shared-Ride Taxi Implementation and Evaluation Study. N.D. Lea and Associates Ltd. and Stanley Associates Engineering Ltd., The Battlefords, Saskatchewan, Canada, 1981. (TP 2879)
32. Hickling-Smith Inc. The Mobility-Club Concept in Rural Areas: A Demonstration Project in Huron County. Urban Transportation Branch, Transport Canada, Montreal, Quebec, Canada, Sept. 1980. (TP 2646)
33. Nouvelles coupures possibles à VIA Rail. La Presse, Montreal, Quebec, Canada, Oct. 30, 1981.

Transportation Service for the Physically Handicapped in Toronto—Its Structure and the Integration of Computer Aids

FRANK J. AHLIN, ROBERTO STOPNICKI, AND JAMES H. BOOKBINDER

The structure of Wheel-Trans—the Metropolitan Toronto transportation system for the physically handicapped—and the future operating options under consideration for Toronto are discussed, and the design and implementation process of a computer-aided reservation, scheduling, and dispatching system is reviewed. The growth of the service from 8 vehicles to 53 vans and 21 taxis during the past 7 years has created changes in the current operation to accommodate an increasing demand for service. Examples of these changes are the takeover by the Toronto Transit Commission of the reservation, scheduling, and dispatching functions from a private contractor; the investigation of new procedures such as demand-responsive systems; and the use of smaller vehicles. The increasing demand for service has resulted in a growing number of trip requests that need to be processed and an increased number of opportunities for misplacement of orders and generation of errors. The computer system is being implemented to improve the efficiency of control-office tasks and to provide a high level of service to the users.

In fall 1972 the Council of Metropolitan Toronto adopted a recommendation to establish a Technical Committee on Transportation of the Physically Handicapped to plan and implement a system to provide public transportation for the handicapped, who as a group was estimated at that time to constitute about 7 percent of the municipality's population of more than 2 million people spread over an area of 244 miles^2. About 20 percent of the handicapped were estimated to fulfill the eligibility criteria for the system.

The subsequent implementation of a pilot project was preceded by considerable controversy and debate on the type of public transportation that should be provided to the physically handicapped community of Metropolitan Toronto. Following this debate, the governments of the province of Ontario and Metropolitan Toronto and the Toronto Transit Commission (TTC) decided to support a parallel paratransit system rather than a fully accessible public transit system.

The commitment to such a policy was recently reinforced by two major events: (a) the rejection by the TTC of a proposal to provide fully accessible stations in the newest section of Toronto's rapid transit system (an intermediate capacity transit system operating on a 4.4-mile elevated guideway), and (b) the Metropolitan Council's decision to accept the TTC recommendation to take over the reservation, scheduling, and dispatching functions of Wheel-Trans from a private operator to improve the reliability of the service.

SERVICE HISTORY

On February 3, 1975, Wheel-Trans phase 1 was initiated in Metropolitan Toronto; it provided 46 users with a transportation service for work-oriented trips. The 2-year pilot project consisted of eight

vans operating during the morning and afternoon peak hours, Monday through Friday.

The TTC was responsible for the administration of the service, which was operated under contract by a private operator. Financial assistance for the operating deficits of the project were shared on an equal basis by the province of Ontario and Metropolitan Toronto. The success of the pilot project and the enthusiasm with which it was received by the handicapped community led to the decisions to continue the service and that major expansions to the service operation be incorporated.

In February 1977 Wheel-Trans phase 2 was initiated. The service consisted of 12 vehicles operating 12 hr per day, Monday through Friday. In addition to subscription work-oriented trips, service was introduced for nonsubscription trips for shopping, medical, and social purposes. The operating and financial arrangements of phase 1 were continued.

In anticipation of the commencement of phase 2 of the project, an advisory committee was established to assist the TTC with project evaluation and policy decisions. The committee consisted of representatives of the provincial government, various agencies representing the handicapped community, and the TTC. In addition, an eligibility subcommittee was formed, which consisted of representatives from the TTC, the physically handicapped community, and Public Health (who determined the eligibility of applicants for the service). The main criterion governing the decisions of the eligibility subcommittee was, and still is, the inability of the applicant to board regular transit vehicles.

A successful experiment with the use of taxicabs was initiated in August 1978, in which some ambulatory subscription riders were accommodated in taxis under contract to the TCC. The decision to establish the permanent service followed the provincial commitment to share the operating costs on a permanent basis.

EXISTING SERVICE

The permanent Wheel-Trans service commenced operations in November 1979 with an expanded fleet of 27 vehicles operated by a private contractor under a 3-year contract. The basic operating procedures and financial agreements under which the pilot project was administered and operated were maintained, with the exception of the nonsubscription fare, which was reduced to the equivalent of a single regular transit adult fare.

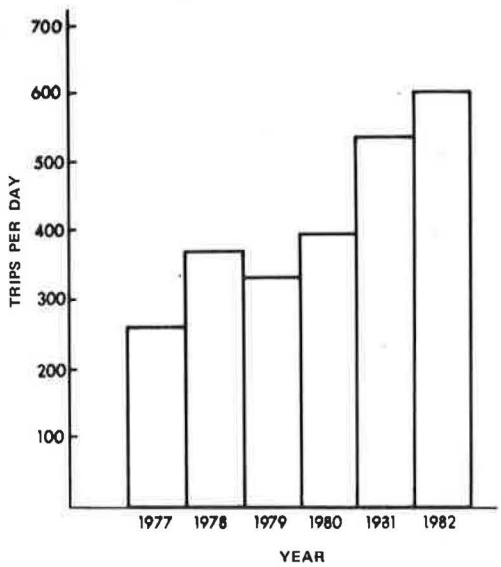
The major change from the pilot project occurred in the Wheel-Trans organization, in which the advisory committee, under its new mandate, took a more direct role in the decision-making process for the operation of the service and in reporting to the transportation committee of the Metropolitan Council. The advisory committee comprises representatives of various metropolitan departments, the TTC, and handicapped representatives from the six municipalities that form the metropolitan area. Three subcommittees were later formed to assist in the activities of the advisory committee: budget subcommittee, long-range planning subcommittee, and community relations subcommittee.

Operating Characteristics

Wheel-Trans offers four types of service.

1. Subscription: The subscription service is available for passengers traveling round trip between the same two points at the same time for at least 4 weekdays; typically these are work-oriented trips. The subscription routes are scheduled by the TTC and forwarded to the contractor. These trips are guaranteed, and the passenger does not have to book or confirm the trips on a regular basis. Taxicabs are also used on subscription routes for ambulatory passengers on a separate contract. Subscription riders buy a pass from the TTC equivalent to the number of monthly rides.
2. Prebook: Prebook services are similar to the subscription service for trips undertaken at least once a week. These trips are not guaranteed and are scheduled by the contractor on the basis of space availability.
3. Reservation: Reservation services are nonsubscription trips that can be reserved up to 7 days in advance. The trip reservation and confirmation occurs strictly between the private operator and the passenger.
4. Demand-responsive service: Demand-responsive service, which gives passengers the opportunity of requesting a ride on a short-notice (i.e., same-day) basis, is provided to Wheel-Trans users. However, because of the high demand for the service, the probability of obtaining a demand-responsive ride is low.

Figure 1. Average daily ridership.



On a typical weekday about 40 percent of the rides taken by Wheel-Trans users are subscription related, which requires that more than 50 percent of the mini-bus fleet be used for subscription service during peak hours. In addition, 20 taxicab routes are active for ambulatory subscription riders. The growth of daily average ridership is shown in Figure 1. The service operates on a first-come, first-served basis, and no trip priorities are allowed for reservation or scheduling purposes.

Vehicle Characteristics

The vehicles used in the service are Thomas Might-Mite mini-buses configured to accommodate five wheelchair and five seated positions. In addition to the buses, Wheel-Trans operates two station wagons to transport ambulatory and nonambulatory passengers who can transfer from a wheelchair to the vehicle without difficulty. All vehicles are linked by two-way radio to a central dispatch facility.

Figure 2. Vehicles in service during an average weekday.

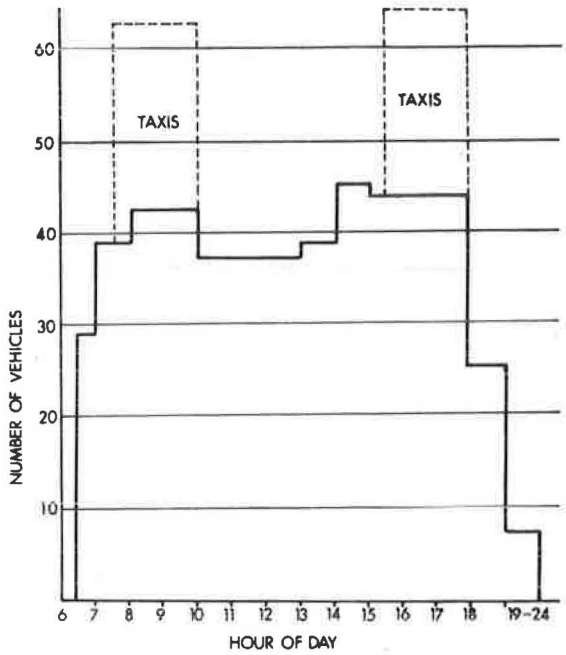


Figure 3. Cost deficit per trip.

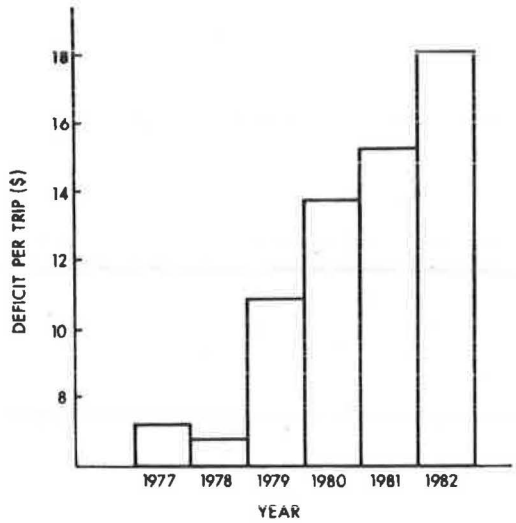
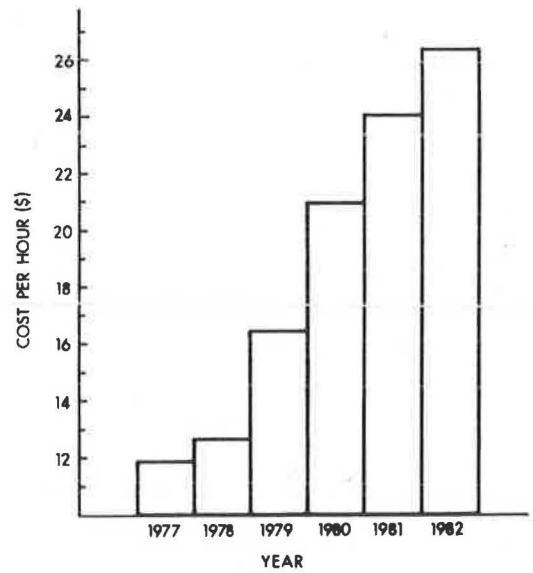


Figure 4. Average costs per vehicle hour.



Ridership Characteristics

On an average weekday in 1982 about 800 trips were carried on the bus service from 6:30 a.m. to 12:00 midnight, and about 180 trips were scheduled on the taxi service. On a typical weekend day about 250 users are carried from 9:00 a.m. to 12:00 midnight. Holiday service is also provided from 9:00 a.m. to 12:00 midnight and between 150 and 200 users a day are carried. The number of vehicles in operation during a typical weekday is shown in Figure 2.

A significant problem for the system has been the overall trip-cancellation and no-show rate of about 20 percent per month. This factor introduces an inefficiency in the system that is difficult to overcome because of the lead time required to schedule the daily routes. For example, the service currently rejects an average of 25 daily reservations and 25 daily demand-responsive bookings and, in addition, an average of about 65 people are on the subscription service waiting list. The resulting service productivity translates to an overall ratio of 1.5 riders per van hour and 2.0 riders per taxicab hour.

Funding Arrangements

The Wheel-Trans service is funded jointly by the province of Ontario through the Ministry of Transportation and Communications and by the Municipality of Metropolitan Toronto. The provincial government provides a subsidy equal to 50 percent of the total operating and capital costs, subject to a per capita ceiling based on the metropolitan population. Metropolitan Toronto funds the remaining 50 percent of the costs, less revenue from subscription service. The annual increase in costs per passenger trip and per vehicle hour are shown in Figures 3 and 4, respectively. It should be noted that revenues from nonsubscription users remain with the contractor as an incentive to increase the productivity of this segment of the service.

User Attitudes

Several surveys of Wheel-Trans users have indicated that the general attitude toward most aspects of the service is favorable. Complaints about the service have highlighted the need for improvement in the reservation, scheduling, and dispatching functions, and an increase in the amount of service provided.

PLANNING FOR THE FUTURE

The advisory committee has accepted a recommendation of the budget subcommittee to expand the service in increments to reach a mature state by 1986, according to the schedule given in Table 1, to accommodate the anticipated doubling of trips per week from the current 4,000 to 8,000.

A system evaluation study conducted in 1981 determined that the door-to-door service currently operated for nonambulatory persons is the only real option for that segment of Wheel-Trans users. Sev-

Table 1. Wheel-Trans service growth forecast.

Year	Bus Ridership	No. of Peak-Period Vehicles		Total Budget ($000,000s)
		Buses	Taxis	
1982	250,000	53	21	4.8
1983	300,000	62	24	7.4
1984	350,000	71	28	9.3
1985	390,000	80	32	11.6
1986	430,000	85	34	14.1

eral alternatives were proposed for this service, such as the introduction of smaller vehicles, the operation of the service on a zone system, and the introduction of a reliable demand-responsive system.

The concept of a zone system was discarded because of the difficulty of establishing zone boundaries that would conform to the thinly dispersed pattern, in terms of geography and time, of trip origins and destinations.

The study recommended that the long-term goal toward which the service for nonambulatory persons should be directed would consist of a door-to-door demand-responsive service that operated predominantly smaller vehicles that had a capacity of four to five wheelchairs.

Various service options were considered for ambulatory users, such as a single-ride taxi, a shared-ride taxi serving only Wheel-Trans ambulatory passengers or sharing with the public at large, the inclusion of ambulatory users in areawide carpool and vanpool programs, and the establishment of policies that would encourage self-drive vehicles. Some of these options would require some form of legislative changes to either the licensing laws or the subsidy agreements under which the taxi industry or Wheel-Trans operate.

Further, in anticipation of the expiration of the existing Wheel-Trans contract in October 1983, the TTC reviewed the future operating alternatives of Wheel-Trans, which included full integration with the TTC, partial integration with the TTC, or continuation of a private-sector operation.

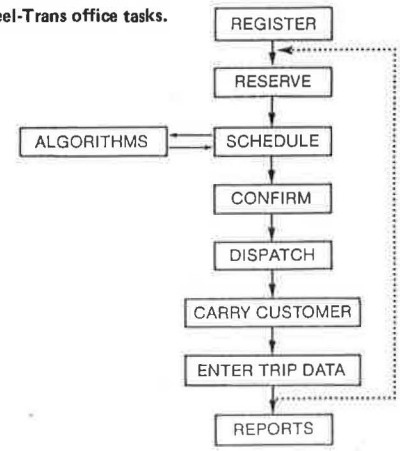
The partial integration of the service with the TTC was recommended and later approved by the Metropolitan Council. Under this alternative the TTC will take over the reservation, scheduling, and dispatching functions of the service. A more structured organization such as the TTC would provide better control of the areas that generate the most complaints, although the drivers and vehicles would still be operated by a private contractor.

INTEGRATION OF COMPUTER AIDS

There has been a constant increase in demand for Wheel-Trans service and in the size of the vehicle fleet. It is envisioned that during the next 4 years the demand will double, with a corresponding requirement for the doubling of the vehicle fleet. Accommodation of the extra order processing and an increase in the information flow will require additional office staff. Retention of the existing manual office procedures during this period of growth would be labor intensive and would also result in more staff errors because of the increased work load. It is expected that the implementation of the computer-aided system will provide a higher quality of service to the user through the reduction of errors and a more rapid processing of requests (1,2).

The system will accomplish these improvements by assisting the staff in performing various Wheel-Trans administrative functions, such as order taking, cancellation processing, handling of inquiries, production of schedule and driver run sheets, and recordkeeping.

Figure 5. Wheel-Trans office tasks.



Currently, the majority of the control-office staff work in the bus contractor's office. This staff is responsible for the processing of the prebook, reservation, and demand-responsive trips and the day-to-day operation of the mini-bus fleet. As an indication of the work load involved, there are 13 telephone operators, 6 schedulers, and 2 dispatchers on duty at the contractor's office during peak periods. The TTC employs two clerks and two schedulers to process the subscription trips. In addition, the taxi contractor handles the day-to-day operation of the peak-hour taxi service through his regular dispatcher. A simplified view of the sequential tasks carried out by the Wheel-Trans control office is shown in Figure 5.

Computer System Design Issues

The use of the computer is envisioned to be implemented in two phases (3). The first phase is to duplicate the current information flow and office tasks, but replace the current paper transfer and storage with the computer as the flow manager and storage medium. The computer has the advantage of quicker transfer of information, quicker retrieval of stored information, the ability to obtain information under a variety of keys, standardization of office procedures, elimination of transcription of written data, a decrease in the loss of orders, and a reduction in errors. There would be no attempt in the first phase to use the computer to accomplish any decision-making tasks; it would be used only for straightforward data processing tasks.

The second phase of the computerized information system, if implemented, would involve the expansion of the software to include automating some of the scheduling and decision-making tasks. Two tasks that are being considered are (a) determining the optimum number of vehicles and the hours of the vehicle runs to satisfy fluctuations in anticipated demand, and (b) scheduling requested trips onto the appropriate vehicles in the most effective manner.

The latter task is one that has been discussed and worked on by various researchers; one program--the Massachusetts Institute of Technology (MIT)/UMTA dial-a-ride package (4)--has been written and operationally tested. Nevertheless, this package has some deficiencies, and further work is required before it could be implemented for Wheel-Trans operations. There are currently also several research

efforts occurring to develop advanced-reservation scheduling algorithms (5-8), but further operational testing is required.

The first phase of the computer system, which in its design will incorporate expansion interfaces for the second phase, is described in this paper.

To give a brief perspective into the future environment that the Wheel-Trans computer system will be expected to operate, following are some of the issues that the computer system is being designed to accommodate:

1. Rider issues--(a) expansion to increase system capacity (proposal to double the current size of the vehicle fleet by 1986), and (b) reduction of time between request for service and actual delivery of service; and
2. Provider issues--(a) reduction in the cancellation rate, (b) improved productivity (passengers per hour), (c) possible increased use of shared-ride taxis to reduce costs and provide more flexible service, (d) possible operation of the mini-bus service by the TTC, (e) provision of control-office functions at efficient staffing levels, (f) minimization of misplaced orders and errors, and (g) good human factors interface.

Because the introduction of the management information system will have its most noticeable impact in the control office in which it is used, the system is being designed with the needs of the office staff in the forefront. The benefits that are derived by this group of personnel by having quicker access and more accurate and timely information will be extremely helpful in providing a higher level of service to customers. For the schedulers and dispatchers, the display of information in other formats and the provision of automatic sorting features should reduce the amount of information they have to consider. This would allow for a quicker production of schedules or the provision of additional time to optimize a schedule. In addition, the reports generated by the information system will prove valuable to managers and administrators who must make service-level and operational decisions.

A typical weekday distribution of trips delivered (by service category) is 47 percent subscription, 14 percent prebook, 37 percent reservation, and 2 percent demand-responsive service. Note that a major characteristic of the current Wheel-Trans system is that 98 percent of the delivered trips are scheduled by, at the latest, the day before the trip is required.

These figures provide an insight toward the impacts of implementing a possible policy of increased demand-responsive trips if the scheduling task can be reduced in time and staffing. Nevertheless, implementing a policy of demand-responsive scheduling also requires that additional vehicle resources be available to satisfy all trip requests, because clients would not have sufficient time to arrange for alternate transportation if they cannot be accommodated. The computer system is being designed from the outset to accommodate such a policy change.

Tasks

There are several types of tasks performed in the control office of the Wheel-Trans transportation system for the disabled. These tasks are performed by clerks, telephone operators, schedulers, dispatchers, and supervisors. These tasks or portions of the tasks are also currently split between three agencies: the TTC, the bus contractor, and the taxi contractor. This leads to a slightly more complex communications and coordinating structure than would otherwise be entailed if all functions were under the control of one organization.

The reservation, scheduling, confirmation, and to some extent the dispatching functions can be further broken down by the four trip-type categories: subscription, prebook, reservation, and demand-responsive service. The various trip categories allow a layered scheduling process to occur. In the case of a subscription or a prebook trip, there is a greater guarantee of service to the customer.

A number of common tasks exist in the dispatching environment of any shared-ride paratransit system. Several other items peculiar to transportation systems for the disabled, such as registration requirements and the wide range of handicaps, add an extra element of complexity to operating a door-to-door transportation system. Generally, though, the set of tasks that exist in the operation of transportation systems for disabled persons is common to all shared-ride paratransit systems.

These tasks are generally all processed in a sequential order. What does vary among the transportation systems for handicapped persons in various cities is the type and number of personnel who perform the various tasks and the time frame in which the various tasks are performed. The computer system is being designed to provide this flexibility.

Because the current control-office operation can be separated among the TTC, the bus operation, and the taxi operation, there exists a need for timely and accurate transfer of information between the various locations. The computer system is considered an ideal medium for coordinating the actions taken by staff at these locations.

Although the majority of the information-processing tasks are fairly straightforward information retrieval and storage tasks, two of the tasks--scheduling and dispatching--are crucial to the operation of any paratransit transportation system. The personnel involved in these two tasks have the difficult jobs of either efficiently allocating a large number of trips or of monitoring the real-time delivery of passengers by the vehicles and drivers. The adequacy with which the system is designed around these two tasks determines the successful implementation of the computer system.

The key to achieving high productivity in the Wheel-Trans shared-ride service is the ability to shift clients' desired pickup and delivery times within an allowable 1.5-hr time window to allow grouping with other fares. Scheduling is currently based on a combination of efficiency (i.e., accommodating the maximum number of riders within a fixed system capacity) and also first scheduling those who called earliest.

An example of another type of operation that the computer system is being designed to accommodate is a demand-responsive format with a strict first-come, first-served priority. Only a certain number of trips are accepted by the reservationist for each vehicle hour of service. Once this limit is reached, the trips are scheduled and new trips are rejected, or the client must choose an alternate time. Because there is no preselection of trips, demand-responsive systems have lower levels of productivity and must generally have adequate resources to service all the trips because people do not have time to arrange for alternative means of transportation.

Examples of two basic methodologies to display scheduling information in a paratransit operation are described in the following sections. Which system is used usually depends on the complexity of the scheduling task.

Scheduling Board

The scheduling board is one of the most common methods used to display information in shared-ride systems with advanced reservations. The board can be a physical board with slots to insert cards that contain information on trip origins and destinations, or it can be (as it is in the Wheel-Trans control office) a large sheet of paper in which information is transcribed from the call slips onto the large scheduling sheets.

In the Wheel-Trans office a 3 x 4-ft schedule will contain 144 rows, with each row representing 5-min intervals and 16 columns representing the vehicle runs. Thus four of these sheets are currently required to display all the vehicle runs during the peak periods. The scheduling process is initially one of standing back and assigning grouped rides to the free spaces on the scheduling board. The scheduler can determine the location of a vehicle by moving in closer to the board and subsequently reading the addresses or the geographic coordinates.

It is difficult to display on a computer terminal the large amount of information that is currently displayed on the paper schedules. Thus various methods of displaying these data by computer will be tested. Some procedures to display information would include the use of several terminals, the use of sorting procedures to allow the scheduler to quickly window-in on a particular schedule, or the continuation of the use of paper schedules and the generation of gummed labels for manual insertion onto paper schedules.

Map Display

The second major method of displaying information is by a map of the service area. Such a method is generally used in exclusive-ride demand-responsive systems.

Although such a display is excellent in determining spatial patterns, it is generally deficient in that it cannot display the time element that the scheduling board contains. For this reason, the use of such a display has generally been relegated to demand-responsive taxi and courier systems where pickup and delivery times are not generally of primary consideration. Nevertheless, such a display is beneficial to the dispatcher in determining the location of vehicles in real time.

Such a display also has potential for displaying the desire lines of trips. In the same way that a scheduler currently presorts trip requests by time, a mapping feature could be used to sort the trips by spatial distribution to indicate how the requested pickup times might be adjusted. The mapping display would use the coordinate information obtained from street address files to display desired trips to the scheduler.

Note that the phase 1 scheduling aids previously described do not involve any decision-making processes by the computer, but consist of displaying preorganized information to the scheduling staff. The development of sophisticated displays of information to the schedulers in this first phase is an important prerequisite to the second phase. This will avoid a common complaint of the previous work on automated scheduling that the algorithms appeared to be black-boxes from which it was difficult to determine their intermediate processes, sensitivity, and final results.

Expansion

Although not part of the first phase of this project, several options have been proposed as part of a possible phase 2 expansion program. These expansions can be categorized as two basic types: software and hardware expansions. The software expansions would be accommodated in the hardware acquired in phase 1. On the other hand, the hardware options involve additional specialized hardware devices that interface with devices outside the control office and generally have a high cost element associated with them.

The current software options consist of improving the precision of the location coordinate file and implementing both advanced-reservation and demand-responsive-type scheduling algorithms. This would allow the scheduler to predefine service standards and determine the most efficient number of vehicles required or to predefine the number of vehicles and hours of service and determine the most efficient service standards obtained.

The current hardware options consist of telephone dialing aids, voice synthesized or stored-message confirmations, and digital communications to the vehicles.

CONCLUSIONS

In 1983 the TTC initiated the detailed design and installation of the computer-aided system to serve the Toronto area. Such a system was designed from the outset to be adaptable to other smaller transit properties in Ontario.

The implementation time frame of this project will see this computer system introduced in a parallel mode with the current manual operations in early 1984. This will provide for an operational debugging period of several months before the final transfer of all paper files, records, and communications to the computer system occurs in mid-1984. During this time, evaluations will be initiated into the ongoing research on advanced-reservation and demand-responsive scheduling algorithms. A testing program of the various concepts and approaches will be developed to determine the most acceptable aids to the decision-intensive scheduling problem.

Such computer-aided systems are not justified for all installations because of their high initial costs and ongoing operating costs. Nevertheless, they are suitable for larger properties where savings in the administrative overheads or improvements in productivity will equal or exceed the implementation costs.

Although firmly established as a permanent public transportation service for the physically handicapped in Metropolitan Toronto, Wheel-Trans can still be considered a development project. It is hoped that the introduction of the computer management information system and the transfer of the reservation, scheduling, and dispatching functions to the TTC will provide an improvement in the areas that currently cause the largest number of complaints.

The anticipated doubling in growth during the next 4 years will continue to see major changes take place in the operation and structure of the Wheel-Trans service and an improvement in availability and the quality of service. Subject to funding constraints, it is expected that the future Wheel-Trans system will have increased system capacity and a reduction in the time between the request for and the delivery of service. This will be accompanied by higher user expectations and an increasing demand for service from a generally aging community.

REFERENCES

1. C.T. Hendrickson. Evaluation of Automated Dis-

patching for Flexibly Routed Paratransit Services. In Paratransit: 1979, TRB, Special Rept. 186, 1979, pp. 56-62.
2. J. Collura and D.F. Cope. Assessing User Needs in Design of a Management Information System for Rural Public Transportation Services. TRB, Transportation Research Record 854, 1982, pp. 67-70.
3. E.J. Miller, F.J. Ahlin, P.D. Bunt, J.H. Bookbinder, and R.N. Wolff. Wheel-Trans: Feasibility of Computer-Aided Reservations, Scheduling, and Dispatching. Univ. of Toronto-York Univ. Joint Program in Transportation, Toronto, Ontario, Canada, Res. Rept. 73, Nov. 1980.
4. N.H.M. Wilson and E.J. Miller. Advanced Dial-a-Ride Algorithms Research Project--Phase II: Interim Report. Center for Transportation Studies, Massachusetts Institute of Technology, Cambridge, Rept. R77-31, July 1977.
5. T.R. Sexton and L.D. Bodin. The Single Vehicle Many-to-Many Routing and Scheduling Problem with Desired Delivery Times. State Univ. of New York, Stony Brook, 1979.
6. L. Bodin, B. Golden, A. Assad, and M. Ball. The State of the Art in the Routing and Scheduling of Vehicles and Crews. Presented at the Operations Research Society of America and The Institute of Management Science Conference, May 1981.
7. L. Chapleau, J.A. Ferland, and J.M. Rousseau. Clustering for Routing in Dense Area. Centre for Research in Transportation, Univ. of Montreal, Montreal, Quebec, Canada, April 1981.
8. H.N. Psaraftis. Two Heuristic Algorithms for the Single Vehicle Many-to-Many Dial-a-Ride Problem. Massachusetts Institute of Technology, Cambridge, Jan. 1981.

Long-Range Transportation Planning for the Elderly in Ontario

ROBERT A. WOLFE AND ERIC J. MILLER

In Canada few long-range planning studies have addressed the transportation needs of the rapidly growing proportion of elderly people in the general population. In this paper the characteristics of the elderly population are identified, and forecasts about this population to the year 2021 are discussed. Given these data, the elderly population is segmented into seven life-style groups, such that the group definitions are invariant through time, but the number of people in each group is allowed to change. Next technological, organizational, and service-related innovations that may be applied to five modes of transportation are enumerated. These innovations are briefly discussed, and how they might affect the seven life-style market segments is outlined. Finally, three scenarios for the future are developed to indicate which innovations are most likely to affect large groups of the elderly. Findings indicate that innovation in small-scale, locally oriented types of special transit appears to be able to increase the mobility of the largest number of elderly persons.

In Canada few long-range planning studies address the issues of transportation for elderly persons; it has been only recently that Canadian governments realized that the elderly will comprise a rapidly growing proportion of society. Various government ministries in Ontario have begun to address seriously the long-term issues of future housing, health care, and social requirements of the elderly population into the 21st century. The analysis reported in this paper was commissioned by the Ontario Ministry of Municipal Affairs and Housing because it was interested in how transportation plans could be blended with its own long-term housing plans.

The procedure adopted in this study was totally conceptual, and not statistical. Instead transportation demand was treated in terms of the needs and requirements of tomorrow's elderly population. The supply system was discussed in terms of innovations and changes to current supply that could affect future needs and requirements. Finally, a rough attempt was made at scenario development, so that supply changes could be somewhat related to the future quantity of demand.

The study was conducted in the absence of any reliable or thorough data; only the most simple demographic tabulations were available. Consequently, the results of the analysis, and certainly the methodology, could be applied to areas other than Ontario.

Given this context for the study, the population groups being discussed are first identified and then their needs and behavior are outlined as briefly as possible. Supply innovations are then discussed as they affect the needs of the elderly. Finally, the scenario results are briefly reported in a policy-making context.

THE ELDERLY IN ONTARIO

In this section the characteristics of the elderly are described only to the extent required to establish their travel behavior and needs. More complete treatments of the socioeconomic dimensions of the elderly population of Ontario may be found elsewhere (1,2).

The term elderly has a varied meaning but is generally taken to mean those people aged 65 years or older, although United Nations documents include people aged between 55 and 64 in this definition. Clearly, such a definition is problematic because many people aged 65 or older act much younger, and many younger people have patterns of behavior similar to much older people. Although this important point is recognized, in order to coincide with the census definition in Canada, as well as typical retirement ages, the elderly are defined in this paper as those people aged 65 and older.

Data based on the 1976 Canadian Census place 865.3 thousand people in this group in Ontario in 1981. A breakdown of the elderly population by age and sex, and a comparison of this breakdown to the population in Ontario as a whole, is given in Table 1 (1). The data in this table indicate that the elderly account for approximately 10 percent of