RESEARCH AND DEVELOPMENT IN DEMAND-RESPONSIVE TRANSPORTATION

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The concept of using electronic data processing (EDP) equipment as a tool in the dispatching of demand-responsive transportation (DRT) vehicles is not new. Numerous studies and simulations have been carried out on the use of EDP equipment in dispatching demand-responsive service, some of which incorporated algorithmic formulas relative to trip length, vehicle availability fare structures, and other factors. EDP equipment has been used in the operations of certain publicly funded demand-responsive systems and of a few taxicab operations. The results have varied.

In 1971, the Los Angeles Yellow Cab Company started using an NCR 100 disk-oriented unit with 32K capacity memory; the program was written in NEAT III language. This system allowed input from as many as 12 and dispatching from as many as 3 CRT positions. Simple orders only, i.e., no advance orders, emergency orders, or call-backs (repeats of previous orders that had not been serviced) could be processed through the system. Other orders continued to be handwritten on an order blank and physically processed to the dispatcher—called an order-sender in this instance.

The result was that the EDP equipment handled approximately 75 percent of the incoming orders. Those orders handled by the EDP equipment are received, processed, and displayed in a matter of seconds. The system validates the received order, assigns it to an area within the service area, assigns it a "stand" or physical cab dispatch location, and routes it to the appropriate order sender position. The system eliminates to a large degree the attitude of proprietorship of certain individuals, who, because of their knowledge of the large service area involved (some 425 miles^2 or 1105 km), quite literally held the dispatch organization between their ears and who, when they did not desire to operate efficiently or failed to show for work, caused a distinct deterioration in the quality of service rendered.

Faced with declining orders, a situation not unique to this operation but experienced nationwide in the taxicab industry, and the limitations imposed by equipment and software, we made a review in 1973 of available equipment and software that would improve response time, eliminate paper work in handling orders, and still maintain the economic advantages that had resulted from eliminating some personnel and not having to rely on a select few. These improvements more than balanced the cost of the EDP equipment.

As a result of this review, we installed equipment that receives and validates all types of incoming orders: simple orders, advance calls, call-backs, cancellations, and emergencies. Orders are automatically routed to the appropriate order sender, and the first, second, and third alternate stand calls are displayed along with the address. The system automatically displays advance calls before the required service time. In the case of call-backs or repeat calls, the system checks the status of the original call and gives the order sender the option of calling the original cab sent or, if the call has not been sent, flagging the call as a repeat call. Cancellations are

automatically eliminated from the active order file or displayed with the appropriate vehicle number if a unit has already been sent. Other special and emergency calls are given order file priority. Also, as an option to the order sender, the system processes and displays cab status, which is manually input by the order sender. Vehicle status retains an automatic drop time and also is removed automatically from status screens when the vehicle number is used on an order. All disk access times have been accelerated with advance programming technology to ensure that operators are not "waiting" for the system to respond to a command.

Several business-oriented reports monitor the total communications operation and the individual performance of the operators. The computer hardware consists of 2 Data General Nova series minicomputers of 32K each, 2 dual disk driver units, 1 line printer, 1 teletype, 14 Hazeltime CRTs, and appropriate switching gear to enable the system to be fully backed up in case of computer hardware failure.

Some conclusions may be drawn from this operation:

1. The use of EDP equipment in dispatching demand-responsive vehicles is technically feasible;
2. It is economically feasible for an operation in which a minimum of 2,700 orders per day are handled;
3. It gives management greater flexibility in the utilization of personnel;
4. It improves service to the public; and
5. When the day of economically feasible AVM arrives, the circle of control of the historically independent taxicab driver will be more nearly complete.

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From 1967 to 1971, much research at M.I.T. and elsewhere was devoted to the potential use of computers in the control of demand-responsive transportation systems. Two of the most tangible outputs of these efforts were

1. A computer simulation model to test alternative computer control algorithms and to predict system performance; and
2. A recommended set of computer control procedures in which (a) the immediate assignment of each request was made to the current "tour" of the best vehicle, (b) the assignment was based on feasibility conditions, under which each user receives service within specified bounds, and (c) the determination of the best assignment was based on the minimization of total service times for current and future passengers.

These control procedures were tested by a simulation model and were found to perform well on intuitive grounds (i.e., an examination of individual assignments and their comparison with judgment) and relative to other proposed algorithms. However, since no optimal-solution algorithm has been developed, absolute statements about their performance were impossible.

One result of this research program was the decision to mount a demonstration project of the concept in Haddonfield, New Jersey, to obtain a market test of the service concept and to obtain data on the potential of computer dispatching. The system (which has been extensively described elsewhere) has just terminated; its demonstration project phase provided valuable data in both of these areas. In particular the computer control system used in the latter stages of Haddonfield was developed by the Mitre Corporation using the control algorithms previously developed at M.I.T.

M.I.T. is now the recipient of a university research and training grant from the Urban Mass Transportation Administration to develop advanced DRT control procedures based on the experience gained in Haddonfield and to look explicitly at the problem of controlling integrated DRT and fixed-route transit services. This presents a