GENERAL PURPOSE COMPUTER DISPATCHING SYSTEM

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Is a computer necessary and desirable for a dial-a-bus operation? We would like to submit that, in certain instances, it is. It can certainly provide more effective routing in 2 respects. First, higher vehicle productivity can be achieved through computer decision-making than through manual decision-making. Hence, higher dispatching cost or higher control center costs can be justified on the basis of a reduced overall transportation cost because of the very high percentage cost that is reflected in the driver and vehicle components of the system (about 70 percent of total costs). Second, the computer provides a very consistent, effective dispatching service, the quality of which does not correspond to the good days and bad days a dispatcher may have, as Cherry observed. Gustafson pointed out the importance to patrons of on-time arrival at their destination and the variability of waiting time before obtaining service. With a computer system, one can maintain much more effective controls over these very sensitive service quality parameters.

Computers can possibly reduce the overall cost of the control function because personnel costs will be reduced. This can be effected in 2 ways: The first is by introducing digital communication and thus reducing the need for dispatchers, and the second is by allowing people to bypass the telephone operator and actually input their request for service. Costs can ultimately be reduced.

Underlying all of this is the fact that computer systems have higher capacities than manual systems. When systems grow to 30 vehicles or more, manual decisions will become increasingly difficult.

There are other features that can be implemented through computer dispatching. These include automatic billing so that people do not have to pay when they get on the vehicle; use of standard trips so that personnel costs are reduced; and more than 1 quality of service so that people can choose according to the price they are willing to pay.

The first and foremost computer requirement is reliability. This can be achieved in a number of ways. In initial systems, reliability is ensured through some sort of manual backup mode. Looking farther ahead, we can expect duplication of certain elements in the computer system and perhaps completely duplexed systems to provide the level of reliability required. This, of course, has implications for the economics of the dispatching system.

Other requirements for computer-based systems include address-to-coordinate translation so that one can type in street addresses but have the algorithm operate on coordinates or perhaps zones and coordinates; error-handling capability because initially operators and dispatchers interfacing with the computer will create errors, and typing errors will always be made; capability to handle unusual events because people will want to cancel their trips, vehicles will break down, and people will not show up after they have requested service; graphic-display capability to enable a supervisor to maintain control of the system and influence the quality of transportation service being provided; and capability to receive standing requests, i. e., requests for service at the same time every day from the same origin to the same destination, and advance requests, i.e., requests for service several hours after the call is made. Less necessary but nonetheless desirable features are automatic billing, standard trips, and digital communications.

When implementation options are considered, it is useful to define systems in terms of machine size. Selection of a particular machine is largely dependent on

time and development costs, which will vary with computer type. For example, the decision may be between using an existing operating system or developing from scratch a real-time operating system. This is a very significant decision and one that will affect the amount of time needed to get a completely operational system that provides transportation service. Another important decision is that of the programming language to be used. Will the software be written in a high-level language, such as FORTRAN or PL1, or will machine language be used? The machine language will provide a much more effective and efficient computer system but when implemented will be harder to modify (and consequently less adaptable to a third party not familiar with that machine) and will probably take more time to develop.

Operating costs are clearly a very important point in deciding what computer system should be implemented.

Adaptability is one of the most important considerations in computer system choice and design. It is desirable to have a computer system that can adapt to handling an increasing number of vehicles as the demand increases within the service area or as the service area is expanded. Limited core storage and computing time are significant restraints. If it should happen in the future that dial-a-ride requires a certain computer or software feature, then adaptability of this kind is also required.

An important step in the phasing of dial-a-ride experiments is operating with a manual system. This phase provides a significant market test for the dial-a-ride concept and can be important in decisions on the role the federal government should play.

In the next phase, the dispatching system would be operated by a medium-sized computer programmed in a high-level language such as FORTRAN or PLI. The reason for using a high-level language is that it can be easily developed. Ability to build a computerized dial-a-ride system quickly is important. Flexibility is also important. Ability to expand and to modify is necessary so that errors in the initial system design can be corrected. The medium-sized computer is governed primarily by the requirement of the high-level language, which tends to presuppose such a computer. That such computers are easily available is also an important consideration.

In terms of the information to be gathered at this stage, one should first determine the feasibility of computer dispatching. Until recently, there has been significant doubt in the minds of many people that computer dispatching can really work. Beyond this, field testing of assignment algorithms must be performed. Are proposed decisions rules effective in an operational environment? A third area of information is the utility and the necessity of features included in the dial-a-ride system.

Computer dispatching with a minicomputer system would have the feature of low capital and operating costs and thus be more economical. Because its development is based on experience gained in testing of the medium-sized, high-level language system described above, it could be quickly installed and operated without the operator knowing much the machine language in which it was programmed.

A further stage in the development of computer dispatching systems is the provision of more powerful systems with features such as standard trips and digital communication interfaces to reduce personnel costs and the overall dispatching costs.

The system developed at M.I.T. is

programmed in a high-level language and fits in the medium-scale computer category. It evolved from the research into assignment algorithms and the simulation model constructed to test various dispatching policies and economic feasibility. This formed the basis for a very simple unsophisticated, real-time dispatching system that was itself the basis for the final medium-scale FORTRAN product. The programs can operate on any IBM 360 or 370 computer with more than 220K bytes. It is programmed in FORTRAN, operates under the disk operating system; can be operated either in dedicated or in multiprogrammed mode (e.g., dedicated on a 360/30 or partitioned on a 360/50); and has provisions for teletypes, 1050's, 2741's, and an advanced remote display station for graphical input and output. We feel that this system can handle 20 to 30 vehicles. To use this system, one must first code the street network so that the address-to-coordinate translation scheme can work effectively. The travel-time prediction formula used by the algorithm must be calibrated, and the algorithm must be tested and modified as a function of the characteristics of the particular area being served.

The key questions for the future are, How much will a computer improve service provided by a transportation system? and How much will it increase productivity? These questions are now largely unanswered. Looking at the overall costs of dial-a-ride, we see that perhaps 70 percent of the costs relate to the drivers and vehicles and that the remaining 30 percent relate to control and dispatching. If productivity of the transportation service can be increased by, say, 25 percent as a result of using computer dispatching, then it would be reasonable to increase control costs by as much as 55 percent because of the greater weight vehicle costs play in the total cost of the system. So, it is conceivable that a 7-person manual-dispatching system could be converted to a computer system with no personnel reduction if productivity could be increased by 25 percent or more. This is the big unknown: Can we achieve increases of 25 percent?

There are 2 ways to find the answer to this question. The first is through studies of systems such as that of Royal Cab in Davenport, Iowa. The indications given in Davidson's paper are encouraging in this respect. However, those increases were achieved under dynamic management when the company was growing rapidly, and it is difficult to isolate the part played by the computer. Nonetheless, it provides an important data point. The second way is through the Haddonfield Project. When computerized dispatching is under way in that project, we will have a basis for comparing manual and computer dispatching.