

These Digests are issued in the interest of providing an early awareness of the research results emanating from projects in the NCTRP. By making these results known as they are developed, it is hoped that the potential users of the research findings will be encouraged toward their early implementation in operating practices. Persons wanting to pursue the project subject matter in greater depth may do so through contact with the Cooperative Research Programs Staff, Transportation Research Board, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

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## Modular Approach to On-Board Automatic Data Collection Systems—Seminar

*An NCTRP staff digest of a seminar held to discuss the findings of NCTRP Report 9, "Modular Approach to On-Board Automatic Data Collection Systems." by Lawrence E. Deibel and Barbara Zumwalt. The seminar took place on March 11 and 12, 1986, at the headquarters building of the National Research Council, Washington, D.C., and was organized and conducted by The MITRE Corporation, McLean, VA.*

### THE PROBLEM AND THE SOLUTION TO IT

Current economic conditions coupled with a continuing need to provide operational efficiency require that a transit system improve productivity while making the best use of limited resources. Emphasis on improving route productivity places an increasing importance on good ridership and schedule adherence data so that responsible decisions on routing and scheduling can be made. In addition, because fare-box revenue is important to the stability of transit systems, accurate fare payment information by fare category is needed to calculate the effects of alternative fare adjustment proposals, including an analysis of the equity of fare structures.

Currently the most predominant form of gathering ridership information is collecting data manually. Data gathered in this manner are expensive to collect and process, limited in scope, and usually infrequent. Fare and revenue data are generally available only on a systemwide basis and special efforts that usually rely on driver participation or cumbersome fare-box handling are required to collect route-level, fare-payment information.

In recent years, a few transit systems have turned to automated methods. Although, in general, transit properties that have used these automated

systems have been satisfied, widespread use has not occurred. Some reasons why many transit systems have not implemented automated technology include: (1) a general lack of understanding of the options available in terms of hardware to provide the information; (2) an uncertainty as to how much of what type of hardware and software is needed; (3) the lack of commitment by transit management to implement the technology; (4) the difficulty in quantifying benefits, together with costs, and in determining the net benefits to the transit system; and (5) the lack of standardization of functional requirements of the technologies, which, in turn, dampens the availability of hardware and discourages manufacturer participation.

In December 1984, the Transportation Research Board published The National Cooperative Transit Research & Development Program (NCTRP) Report 9, "Modular Approach to On-Board Automatic Data Collection Systems." Report 9 was the result of research conducted under NCTRP Project 39-1 by The MITRE Corporation, McLean, Virginia.

The MITRE Corporation investigated and developed requirements and implementation guidelines for an automated on-board passenger/fare data collection system using a modular equipment configuration. The guidelines detailed in Report 9 for evaluating the utility of automating a data collection system and for designing and implementing such a system are, however, applicable with or without the modular concept. Recommended performance specifications could also have application regardless of the modular concept. Report 9 was intended to assist transit agencies in the collection of data from either a totally or partially automated system installed on transit buses.

Nevertheless, the modular configuration proposed in Report 9 was an important aspect of the research. The concept was intended to provide flexibility to transit agencies and encourage competition in the marketplace. A truly modular concept permits incremental implementation which may be required by budget constraints or perceived present needs. The concept also allows for unforeseen future data requirements or updates of modules without requiring a redesign and purchase of an entirely new system.

Report 9 recognized that no universal standards applicable to the modular approach existed. Consequently, implementation of the concept would require agreement among at least several transit agencies or manufacturers, or preferably both. A key element in any such agreement would have to be the standardization of the interface between modules to allow the greatest degree of flexibility. Report 9 suggested a computer interfacing configuration to help initiate or, at least, provide a basis for developing a consensus.

Although Project 39-1 could have been considered a successful research project by itself, the NCTRP panel, giving technical oversight to the conduct of the research project, had the forethought to reserve some funding for an

implementation phase. After reviewing several options along with the amount of money available, the NCTRP panel decided the next best step was to provide a forum for the discussion and advancement of the planning techniques and the modular approach. The forum (or seminar) would permit participation by users (representatives from transit agencies) and suppliers and manufacturers. Accordingly, The MITRE Corporation was asked to organize and conduct a seminar for this purpose.

#### FINDINGS

On March 11 and 12, 1986, a seminar was held at the headquarters building of the National Research Council, Washington, D.C. Fifty-three individuals from around the world attended the seminar. Although some transit agencies were represented, most of the attendees were from private consulting firms or were manufacturers and suppliers.

The concept of a modular system as defined by the NCTRP Project 39-1 and the formulation of uniform functional specifications create the need for greater standardization. Consequently, the nature and extent of standardization dominated the discussion at the seminar, particularly because the NCTRP research proposed a particular design approach based on an existing computer interfacing standard known as STD-BUS. The reaction of the seminar participants was generally favorable to some degree of standardization, but not to the extent suggested by the research. While a minority cited the advantages of nonstandardized designs, including reduced competition, security, and brand name recognition, most appeared ready to concede to a standard that pertained to the communication interface between equipment, but allowed manufacturers of individual equipment freedom of design.

A number of the participants, notably manufacturers, expressed the opinion that a communications standard was preferred over a standard computer bus architecture such as STD-BUS. At least to a limited extent, some North American suppliers are now providing systems that consist of multiple modules interconnected by a communications bus, although not necessarily a standardized bus. Whether these advocates of a communications approach over a computer bus approach could accept a standard other than one currently designed into their system is uncertain.

The NCTRP research effort reviewed several of the then-emerging communications standards for possible recommendation in its modular design concept. At that time, none had been adopted as standards. Consequently, many were still not yet fully defined or documented and many that were documented were not yet supported by multiple suppliers or available in production quantities. Several have now advanced to the point that they represent viable alternatives and should be considered as possible bases for a modular data collection system. Perhaps, the most notable development in

this area is the Integrated On-Board Information System (IBIS) specified by the German Association of Public Transit Operators. This system provides a uniform (standard) method for data communication between on-board units and is being considered as a possible basis for a yet-to-be-announced implementation in Canada.

Many of the issues associated with the implementation of on-board automatic data collection systems were also addressed in the seminar. For the most part, the opinions expressed by the participants were consistent with the findings and conclusions contained in NCTRP Report 9. The three areas that received the greatest emphasis and generated the most discussion were system sizing, registering farebox integration, and system software.

The premise that 10 percent of the fleet must be equipped with on-board modules to obtain adequate data continues to be widely supported. The 10 percent figure would ensure that about 5 percent of all trips would be sampled and, thus, would establish a statistically valid database.

The majority of the seminar participants held the opinion that addition of electronic fareboxes is not a cost-effective approach for collecting fare and revenue data because of the high cost of new fare collection systems. Since a new farebox approximates the unit cost of all other automated data collection system equipment located on-board the vehicle and practicality dictates the need to retrofit the entire fleet, the cost implications are not inconsequential. Other reasons -- revenue security, bill handling, fare evasion control -- must provide the basis for justifying electronic fareboxes.

The feasibility and utility of linking revenue data to automated passenger counter (APC) systems at transit agencies that already have electronic registering fareboxes have not yet been fully explored. Demonstration projects at the Metropolitan Atlanta Rapid Transit Authority (MARTA) and Kalamazoo Metro Transit, which are aimed at achieving farebox/APC integration, have had slow starts due to a variety of funding and institutional problems. However, the potential for success has been shown by recent efforts in Baltimore in which registering fareboxes and magnetic ticket-validators from different manufacturers were integrated into a single data collection system. It appears that a considerable effort remains before APC systems routinely interface with registering fareboxes and data collection systems to provide integrated passenger and revenue data.

A minority view -- that registering fareboxes can serve as the focus of a transit agency's data collection effort -- was the subject of considerable discussion. The premise of this concept is that the relationship between ridership and revenue is relatively stable and therefore data from electronic fareboxes coupled with manual checks and perhaps a small APC fleet is the most economical approach. Many of the participants, however, expressed concern with this approach and cited several potential problems to a

farebox-based data collection system, including: (1) the cost implications of equipping an entire fleet with fareboxes, (2) the practical considerations and data accuracy implications of requiring data entry by vehicle operators, and (3) the inability to forecast ridership where there are a large number of noncash passengers (i.e., transfers or passes).

APC software was a major topic throughout the seminar. Issues addressed included the importance of flexible APC software, the requirements for data processing and external files, the high cost of software development, and the alternative approaches to software development. The emphasis on software issues represents a significant change from the late 1970's when hardware considerations were dominant and provided further evidence of the maturation of APC technology. Despite the high visibility of APC software, there was no agreement on the need for standardized software. The perception remains that each transit agency requires customized software. For the near future, off-the-shelf software is not likely to be available.

#### APPLICATIONS

The seminar generated a considerable amount of debate not only with respect to the standardization of the hardware but also regarding the relative merits of such automated systems in transit operations. It was recognized at the start of the NCTRP Project that no single system configuration would likely be satisfactory because of differing management priorities and information needs. Consequently, one of the objectives of the project was the development of a set of procedures to follow during the planning and implementation of such systems. The guidelines contained in NCTRP Report 9 are expected to be useful to any transit manager faced with making decisions concerning automated data collection systems, regardless of the prospective application or specific agency characteristics. In addition, NCTRP Report 9 provides an update of the advances made in the area of automated data collection and contains significant reference material designed to highlight the trade-offs and key decisions associated with such systems.

Although the research project proposed the STD-BUS as the basis for a standardized system, complete standardization of the hardware was not expected as a result of the research. The specifications that were developed as part of the effort are presented in the report in terms of functional modules and, as such, are usable and readily adapted to other hardware approaches, including those based on communications standards. The specifications represent guidelines for future procurements and their use would foster increased modularity and ultimately lead to greater standardization. As was evident in the seminar, a number of system suppliers are already beginning to bring more and more modularity into their designs.

The results of NCTRP Project 39-1 are viewed as providing a foundation for subsequent implementations of automated data collection systems. Its guidelines and specifications are intended to reduce the duplication of effort experienced in past implementations. This seminar represented the beginning of an industry dialogue that would further facilitate the development and use of such systems. For now, at least, it appears that any advances towards increased modularity will be the result of a continuation of this dialogue informally between the principal suppliers and major prospective users. The most immediate need at present is for greater information dissemination by those that have had experience with automated data collection systems so that prospective users can benefit from this experience.

Copies of NCTRP Report 9 and an agency report documenting the seminar are available from the Publications Office, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C., 20418 as follows:

- NCTRP Report 9, "Modular Approach to On-Board Automatic Data Collection Systems," is available for purchase at \$10.40 per copy.
- Agency report, "A Modular Approach to On-Board Automatic Data Collection Systems -- Seminar, August 1986" (Project 39-1) is available for loan or purchase of microfiche (\$5.95 per copy). A limited number of xeroxed copies are available for \$5.00 each.

A check or money order, payable to Transportation Research Board, must accompany orders totalling \$20.00 or less.