

**Proceedings of the Workshop on  
Microcomputers in Transit:  
Issues and Directions**



**FINAL REPORT**

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**URBAN MASS TRANSPORTATION ADMINISTRATION  
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**Proceedings of the Workshop on  
Microcomputers in Transit:  
Issues and Directions**

**Airlie House, Virginia  
November 4-6, 1984**

**Transportation Research Board  
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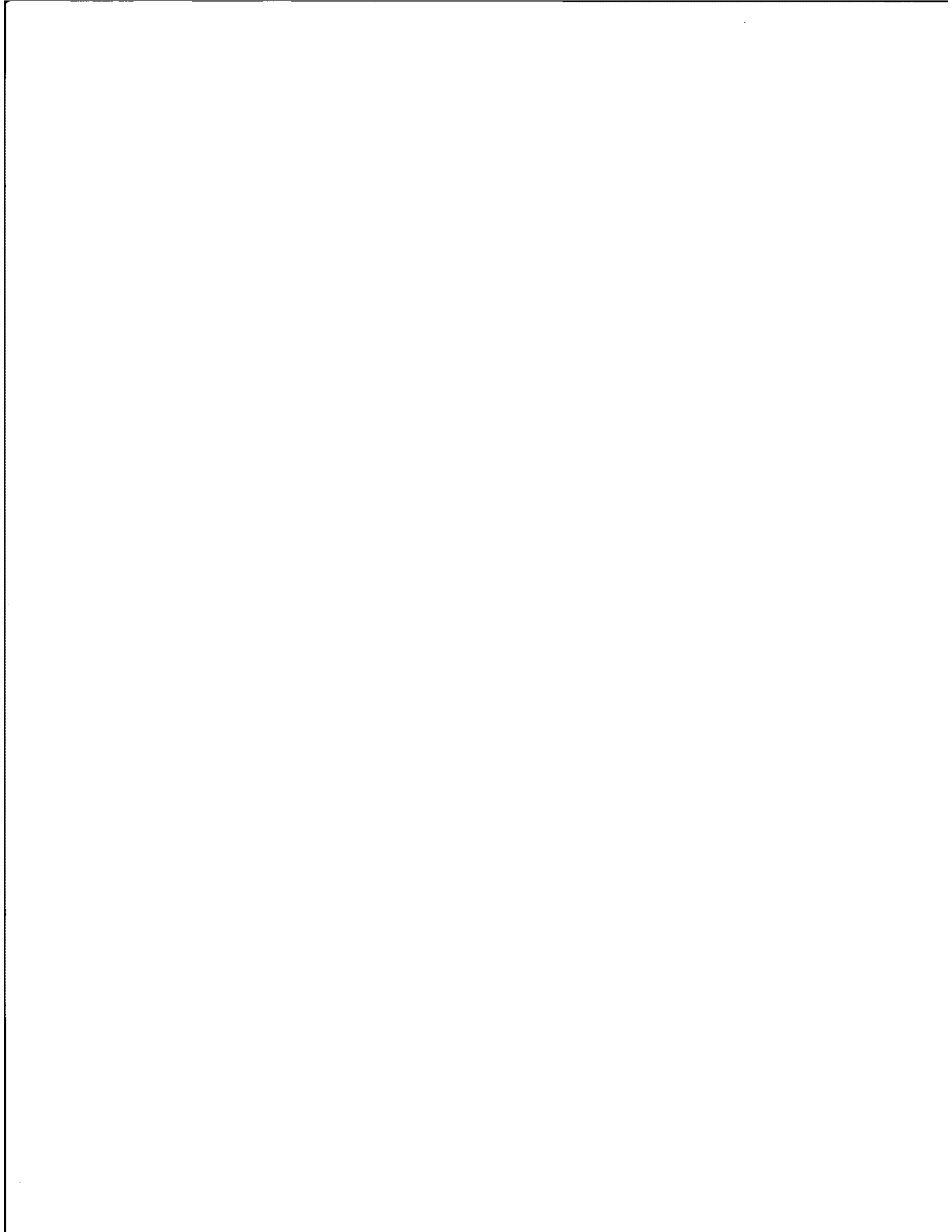
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## Preface

This report contains the proceedings of the Workshop on Microcomputers in Transit: Issues and Directions held November 4-6, 1984, at Airlie House, Virginia. The Transportation Research Board conducted the workshop at the request of the Urban Mass Transportation Administration, U.S. Department of Transportation to determine the role that UMTA should play in this critical area and to provide information to states and local bodies for their programs.

The purpose of the workshop was to serve as a forum in which specialists could freely exchange information on the latest developments, determine good and bad practices, and recommend courses of action for advancing the application of microcomputers in transit-related organizations. In this forum, participants were to define the state of the art, describe how microcomputer technology has been and can be applied, identify institutional problems and solutions, find ways to improve the dissemination of current knowledge, and specify research needs and priorities.

To accomplish this, the workshop focused on answering three general questions:

1. What is the current state of microcomputer development in the transit industry? What have been the problems, and how can they be avoided in the future?
2. Where does transit go from here? What are the solutions to some of the current problems?
3. What organizations and which people in them should take what actions?

Workshop participants were assigned to one of five groups to discuss specific issues in greater detail. The topics discussed were:

1. Support of microcomputers in transit,
2. Software issues,
3. Technology,
4. Benefits and implementation issues in small transit systems, and
5. Benefits and implementation issues in large transit systems.

The 62 invited participants represented the federal government, state departments of transportation, local transit properties, univer-

sities, and private consulting firms. Opening comments were delivered in a plenary session by Granville Paules of UMTA and Janet L. D'Ignazio, chairman of the workshop steering committee and assistant general manager of the Greater Roanoke Transit Company. These comments are included in Part 1. The background papers prepared by the discussion group leaders and summaries of the group discussions are included in Part 2. The division into discrete subjects is neater in theory than in practice and did not hold entirely through the discussions or the recommendations. Many of the problems identified and the suggestions made crossed topic boundaries. The recommendations generated by the discussion groups were presented at a final plenary session and are given in Part 3. These recommendations resulted from the deliberations at the workshop and are based on the opinions of the workshop participants.

To provide workshop participants a slightly different dimension of the impacts of microcomputers on society, Fred D'Ignazio was invited to the opening session of the workshop to discuss the role of the computer in education. Intended to introduce thought provoking ideas to the workshop discussion, this presentation is included in Part 4.

This report is not a documentation of the use of microcomputers per se; rather it is a management overview of a workshop that reflects the collective views of 62 experts in the microcomputer field. Readers of this report should have a minimum knowledge of microcomputer technology because of the highly technical nature of the language.

# Part I Introduction

## Opening Comments

Granville Paules

This workshop offers an opportunity to bring together a brain trust. Everyone here has contributed something to the use of microcomputers in the transit industry, and this conference provides a forum for exchanging information and ideas about a field in which the technology is changing rapidly.

There are three reasons for holding this conference. The first is to let experts get together and trade notes. Each participant should be here to share what he or she is doing and to try to learn from what others in the field are doing. A second reason for being here is to be able to pass on to the transit industry at large the insights that are captured. The final reason is to help UMTA staff decide where to focus the agency's limited resources. Should UMTA concentrate its efforts more on transportation planning or on transit operation? For example, would a support center that offers training in the use of software be appropriate? Although the conference is not entirely dedicated to discussing federal direction, we are interested in hearing any suggestions about what the federal government should be doing with regard to the use of microcomputers in transit.

Participants in each of the five workshops might address some aspect of this issue. In the support session, for example, we at UMTA are interested in hearing about staff training, support fees, and the federal role in general.

There are two aspects of staff training. One is training in the technical use of microcomputers--making them work and getting people to use them to increase productivity. The other aspect is the need to develop functional skills. Sometimes, applications are not used very well because people have not yet learned how to deal with, for example, advanced financial planning or vehicle scheduling using the computer. The transit agency has a procedure that has been used for years and employees now must learn a whole new approach in order to be more productive. So, we at UMTA find that we are involved in both computer training and functional training, and it is difficult sometimes to separate the two.

This administration is asking UMTA to look seriously at charging for technical assistance. In the past most of this assistance has been free. The newsletter has been free, participation in the microcomputer

user groups has been free, training has been free. UMTA now is going to have to charge for those services, and we are interested in knowing what the impact of user fees will be.

In its discussions on the federal support role, the support group could help identify good ideas that are not likely to make it out into the industry without a subsidy or some way to underwrite some of the risks of the development process. Is the leveraging of these new initiatives properly a federal role, or is it a role for the American Public Transit Association (APTA) or some other organization?

Participants in the software group may discuss the desirability of guidelines to be used by the transit industry in developing and selecting software. Transit agencies sometimes go in all directions and buy software packages that do not communicate with one another. An agency may have 10 different word processors that cannot pass text to one another. Perhaps some policy guidelines on standards for buying integrated software are needed.

Single-user systems predominated a year or two ago. Now many transit agencies are buying multi-user systems without giving sufficient thought to the implications. The multi-user systems are on the fringe of technology; they are just beginning to make sense. There is danger in rushing headlong into multi-user systems without some solid thinking beforehand. What is the federal role in that area?

What is the federal role in software development? Should UMTA develop and enhance complex packages or integrated packages, or should it provide catalyst funds for local and private sector development? If UMTA provides catalyst funds, should the focus be on stimulating early adoption of state-of-the-practice software and techniques, or should it be on researching and demonstrating more advanced concepts?

Is UMTA's assumption that local agencies can tailor public domain software to their own situation valid? Can an agency tailor a dBase II accounting package to its own needs without a lot of help? If assistance is needed, who provides it? What is needed to make UMTA's assumption work?

Technology is changing so rapidly that it is impossible to keep up. This expansion offers real opportunities in many areas. The temptation is to apply all this technology to any problem; that is a mistake. Technology should be focused on appropriate problems in functional areas and in internal organizational needs. The UMTA staff would like participants in the technology workshop to identify some of these opportunities in, for example, computer-aided instruction and cellular communications. There are also opportunities in advanced service by management. Many agencies trying to cut back fixed-route operations could benefit from advances in more controlled, low-density service by using the almost-nil-cost communications techniques that are now becoming available.

Another opportunity-filled area is expert systems, sometimes erroneously called artificial intelligence. These systems offer the computer user the benefit of expert guidance through a given process. Expert systems can be used in the transit industry as an aid to market research and service design.

The result is that many of these ideas in the high-tech area are risky and are not likely to be undertaken by individual agencies or the supporting consultant industry. What role should the federal government take in trying to promote or exploit these technologies for the transit industry?

The idea of using microcomputers is new to many small transit systems. Smaller agencies frequently ask UMTA staff: "How do we get started? What is the critical mass of incentives? What does it take to get that first microcomputer into an agency?" The workshop on benefits and implementation in small transit agencies will address these questions.

Is UMTA promoting the right methods and documents to help small agencies get over that first hurdle? Many agencies are buying micros without much planning, even though a lot of good work has been done to guide them through the acquisition process. What else should UMTA do to aid these agencies? The introduction of almost anything to do with computers has a major impact on the organization, breaking down old institutional arrangements and communications media. Perhaps two employees used to talk together and pass a couple of notes around; the introduction of microcomputers and of new ways of organizing data changes the way business is done within the agency. One of the concerns about implementation in both small and large agencies is how to make the transition to microcomputers more positive. As the horror stories current in the industry show, the transition has not always been positive. As Jack Reilly noted in his discussion paper, "Transit agencies are organized to facilitate operations rather than manage technology change." Installing computer systems in almost any organization involves managing technology change.

It is very difficult to successfully introduce microcomputers into small transit systems. Small systems have trouble locating and linking up with consultants, and they find it hard to get through the jargon to get started. It is hard for small systems to take the time to learn. Although small transit agencies are a large market in this country, it is hard for consultants to spend the time to market to them.

What can UMTA or some other institution, such as state departments of transportation, do to help? What documentation could UMTA provide to make the acquisition and implementation of microcomputers easier for small agencies?

UMTA is currently developing software for paratransit planning and operations. Paratransit is a highly individualized market at the local level. Every agency wants to operate in its own way and do things in its own fashion. Often, the problem lies in the way the system is run. Operators would like to make the transition from the way they operate now to a better way. Trying to use computers for scheduling and increasing efficiency sounds like a trivial operations research (OR) problem--and as an OR problem, it is trivial. But as an institutional problem, it is fairly serious. Usually, these paratransit operators are transportation professionals, but they certainly do not have an educational background in any of these technical concepts and they are not accustomed to computers. We would be interested in hearing sugges-

tions from the small systems workshop on how to improve our assistance to small operators.

The large operators have some real opportunities to use microcomputers, but in some ways introducing micros into large agencies is more difficult than introducing them into small systems. The automated data processing department is more institutionalized, the agencies are more bureaucratic, and there are many more rules to live with.

Many of the big agencies are treading through the same start-up quagmire. There is little information transfer among the large agencies. Perhaps the large-systems workshop can suggest ways UMTA can help break down some of the barriers or get people in contact with one another.

One of the problems in big agencies is that they are not willing to start small, even in micros. How can these agencies be persuaded to begin introducing microcomputers slowly, department by department, without worrying about institutionalizing policies before they begin?

What management concepts, including management systems ideas and office automation, are too risky for any particular agency to undertake? There are some new ideas and many new technologies on the frontier that are worth demonstrating and testing, but they may be too risky for a large property to undertake. Is there anything of that nature to which UMTA ought to devote time and resources to act as a change agent?

If the industry is ready, the opportunities are almost limitless for introducing computer-based operational and management support into transit agencies. The user-friendly concept is very important in easing the transition. It is hoped that this workshop will provide ideas and guidance that will help make the transition exciting and relatively painless.

# Part 2 Background Papers and Discussion Group Reports

## Charge to the Workshop

Janet D'Ignazio

This workshop is different from most workshops in two ways. First, participants are here by invitation only. Second, the purpose of most workshops is to educate those who attend, and certainly, it is hoped that participants will leave this workshop having learned something. But that is not the only goal; one of the primary goals of this workshop is for TRB and UMTA to learn from each and every participant. Each person here has been invited because he or she has made some special contribution to the implementation of microcomputers in the transit industry. Who better to ask what the next step should be than those who have taken the first steps?

We are looking to you to help us find where we should be heading in the future. What are reasonable expectations for the use of computers in the transit industry? Where can they be used productively? What types of problems have been faced, and how can those problems be avoided or overcome in the future? What new technology is on the horizon and how can it be applied in the transit industry? What role should the federal government play, and what should be the role of the state government, the local government, the private sector? All of these questions, along with many, many more, are to be discussed during this workshop.

On the basis of professional background, participants have been divided into five working sessions. Although participants in each of those sessions have been asked to focus on an individual topic, they are free to examine and discuss other problems so that a comprehensive view emerges from the workshop.

The transit industry has only scratched the surface of the use of microcomputers. The industry has a long, long way to go and can find new ways to use them. This group has been at the forefront of experimentation with and implementation of microcomputer systems. It is hoped that the group will let ideas and imagination flow freely and not only direct us into the future but help to shape the future of the industry in its use of these marvelous machines.

# Discussion Group A: Support for Microcomputers in Transit

## Background Paper

Eve M. Wyatt

The transit industry is in the midst of a dynamic change as microcomputers are increasingly adopted by operating agencies. The rate and nature of this process are influenced somewhat by the amount and quality of the support available to the individuals involved in each implementation project. In this brief paper some of the current trends in the use of microcomputers are suggested along with the issues involved in generating more effective support activities.

### STATUS OF MICROCOMPUTERS IN THE TRANSIT INDUSTRY

During the past several years rapid change has occurred in the use of microcomputers in transit operations. Many systems have acquired microcomputers and many more are in the process of applying for grants or are procuring equipment. During this period of change, three patterns for implementing microcomputer technology have emerged:

1. In many situations, the microcomputer is perceived as a versatile tool but is acquired with only a limited idea of the specific benefits it has to offer to the agency. When the equipment is received in-house, applications are identified and implemented in a somewhat ad hoc way, driven by the capabilities of the agency's staff, the particular needs perceived within the agency, and the availability of programs that will perform useful tasks.

2. In some cases, agencies have obtained microcomputers associated with demonstrations of particular applications or turnkey systems. These machines may or may not be used for other applications beyond the demonstration, depending on the abilities and initiative of agency staff and the flexibility and suitability of the machine involved.

3. Finally, in rare cases, microcomputer technology has been implemented as a result of a formal, rational evaluation process, often



at the initiative of state departments of transportation. In these cases, a needs assessment is undertaken to identify the most suitable applications of the microcomputer in the agency. The microcomputer system, complete with software and hardware, is then designed in response to the identified needs.

Transit agencies make use of microcomputers in different ways, depending on their size, staff, and history of computerization. For larger agencies, many of which already have some computer resources, microcomputers fill in niches by performing specific functions that complement a larger computer system. Staff expertise is likely to be available in-house to identify and implement the desired tasks. In smaller operations, microcomputers are often the first computer resource it has been feasible to obtain. The existing staff is likely to have limited experience with computers of any type, and the microcomputer is a resource with potential application in all agency functions. The needs of these two general types of microcomputer users suggest different support requirements.

The vast majority of existing microcomputer applications in transit operations involve the automation in-house of existing procedures that were previously undertaken manually and that can be transferred fairly readily to the microcomputer using generic software (e.g., spreadsheet, file managers.) Many financial applications, such as budgeting and cash management, are in this category.

Second to be tried are applications that address problems in the organization, where better organized and more accessible information is perceived as a solution. These applications may be developed using generic software, purchased as a package, or custom-developed software. Inventory control is a frequent example of this type of application.

Finally, agencies may adopt new techniques that are made feasible by the use of microcomputers. Most of these applications are developed by external agencies, such as UMTA, and are later introduced to operating agencies. Many of the planning models are in this category.

The implementation of any of these applications requires a good understanding by staff of both the management techniques that can be transferred to microcomputers and the use of the technology. Larger agencies are more likely than smaller ones to have professional staff that are familiar with specialized managerial techniques. It is easier for these specialized managers to identify promising applications than for their more generalist counterparts in smaller agencies.

#### SUPPORT FOR MICROCOMPUTERS IN TRANSIT

For purposes of this discussion, the term support refers to the provision of information and expertise to transit operations implementing microcomputer systems. The means of disseminating support include publications, training, telephone communications, and various forms of interpersonal communication. The most immediate reason for support of microcomputers in transit operations is to assist the potential user

in choosing and using a suitable microcomputer system. In order to do this, the supporting agencies must identify and address the needs of microcomputer users in the industry. These needs include primarily the provision of information and technical assistance. Areas of support include:

- Introduction to microcomputer capabilities;
- Technical aspects of hardware;
- Availability, evaluation, and use of software;
- Needs assessment;
- Specification and procurement;
- Implementation; and
- Maintenance and enhancement.

Support mechanisms include:

- Publications and newsletters;
- Training programs;
- Gatherings of microcomputer users, conferences;
- Direct assistance by experts;
- Films; and
- Electronic bulletin boards.

Support may also be used as a means of encouraging coordination between systems using microcomputers. For state government, for example, coordination may be desired to permit uniform reporting by agencies and more systematic oversight of their operations. At the industry-wide level, it is possible that coordination could provide opportunities for software and applications to be transferred more easily between agencies. This objective would suggest emphasis on selecting and promoting standards for microcomputer use within the industry.

State and federal agency policy objectives may also be embodied in the provision of support. Emphasizing particular applications, targeting support to particular groups of users, or promoting particular techniques for planning or selection of microcomputer systems reflects implicit or explicit policies by the supporting institution.

Thus, support may take either a responsive or a proactive form. Responsive support provides resources to address needs identified by the agencies using microcomputers. Proactive support provides resources to promote desired patterns of microcomputer adoption and use. Any support that is not entirely passive or demand responsive implicitly incorporates some action beforehand.

#### ISSUES CONCERNING PROVISION OF SUPPORT

The status of microcomputers within the transit industry, the processes by which they are being incorporated in operations, and the possible roles of support in promoting and shaping microcomputer use

suggest a number of issues related to the development of effective support mechanisms:

1. Market. The use of microcomputers in the transit agency varies according to the specific circumstances of each operating agency. The microcomputer has more or less potential to provide benefits to the agency depending on the availability of alternative computing resources. The agency's ability to use the microcomputer may be limited by the availability of staff expertise and time for development and implementation of applications. What is the market for support for microcomputers in the transit industry? Do smaller agencies have a greater need for support than larger ones? In which areas is the need for information and technical assistance greatest? What mechanisms have been most effective? How do current support programs fit with the existing state of microcomputer use in the industry?

2. Changes. The use of microcomputers in transit is in a dynamic phase. Many agencies are now being exposed to the use of computers for the first time. At the same time, the technology has been changing rapidly. As more agencies and transit professionals are introduced to the use of microcomputers, the needs of the industry for microcomputer support can be expected to change.

In what ways will support needs change as the use of microcomputers in transit matures? How will the use of microcomputers develop? What technological changes may affect the needs for support?

3. Proactive role. Existing federal support mechanisms are often proactive and show certain patterns reflecting implicit policy decisions. The UMTA 2-day microcomputer seminar, for example, is proactive in reaching out to agencies to introduce the uses of microcomputers. The patterns of funding software development also indicate a perception of the role UMTA should play.

Proactive positions that could be taken in the provision of support include:

- Active encouragement of microcomputer adoption in all transit operations meeting certain conditions,
- Support of increasing standardization of microcomputer use, and
- Promotion of a more systematic approach to microcomputer system selection and planning.

Should support play a proactive role in microcomputer implementation? What effects have current support efforts had? If a proactive role is desired, what policy positions would be beneficial and productive? What forms of coordination are worthwhile?

4. Private sector. Consultants provide many forms of support. The directions taken by private sector support are shaped both by market forces and by government funding programs.

In which areas does the market drive the provision of support? How effective have government projects been in directing the orientation of private sector support? To what markets in the transit industry is private sector support most accessible?

5. Users. A large amount of effective application development takes place within the using agencies. These applications are those that are perceived to be immediately beneficial and for which the development resources exist within the operating agencies. Frequently, they would be valuable to other agencies with similar needs, as would the more general experiences of microcomputer users.

In what ways can the experiences of microcomputer users in the industry be shared? How can applications be made available to other agencies? What media (e.g., newsletters, meetings) are most effective for communication? What organizations are best equipped to promote communication?

#### CONCLUDING QUESTIONS

The responses to the general issues presented in the preceding discussion suggest a direction that support of microcomputers in transit should take. The following questions provide additional immediate and specific goals for the development of support.

1. How successful is existing support for each of the following aspects of system development and use:

- Introductory training,
- Needs assessment,
- Selection of software and hardware,
- System procurement,
- Implementation, and
- Maintenance and enhancement.

2. Which of these aspects of system development remain obstacles to the use of microcomputers by transit operators?

3. What form of support can best address each of the deficiencies identified earlier?

4. What, if any, standardization or proactive role should support provide?

5. What documentation (handbooks, users' guides, papers) is needed?

6. What training opportunities (workshops, courses, topics, etc.) are needed?

7. What forms of dissemination (mailings, meetings, on-site visits, telephone contact) are needed?

8. What responsive technical assistance is needed?

9. What support can be provided by industry user groups [American Public Transit Association (APTA), regional, in-house]? How can this be facilitated?

10. What should be the role of independent support organizations (e.g., universities, consultants)? How can their involvement be encouraged?

11. What should be the role of government (UMTA, state departments of transportation, local agencies)?

## Discussion Group Report

Participants in the session on support for microcomputers in transit agreed that the objective of support is to provide a more systematic basis for microcomputer use. The group identified and discussed six major issues:

1. Changing support needs of the transit industry,
2. Special needs of small transit agencies,
3. The role of the state in supporting microcomputer use,
4. Information about and support of proprietary transit application programs,
5. Support for procurement and acquisition, and
6. Implications for support of the close connection between microcomputer applications and methods.

### CHANGING NEEDS

The participants first conducted an inventory of the types of assistance currently available to the transit industry. A summary of this inventory is given in Table 1.

Participants noted that electronic bulletin boards (EBBs) are not included among current resources. The Transit Industry Microcomputer Exchange (TIME) has decided to defer instituting a bulletin board, believing that it would be used chiefly by hackers and that it might discourage less sophisticated users. Other groups are experimenting with electronic bulletin boards, and there is some expectation that the UMTA Source Book will eventually evolve into a bulletin board. Several hundred regular users are needed before an EBB becomes an effective source of support.

Although these support mechanisms are valuable, they do not wholly meet the needs of the transit industry. One reason for this inadequacy is simply that the industry's support needs are evolving over time, as more agencies add microcomputers to their resources and gain some measure of skill in their use. But this development is uneven: approximately 60 percent of TIME members have no microcomputers, and among those who do, the level of computer literacy varies greatly.

Support should be available for transit systems at all levels of expertise. Introductory training programs and materials are needed for those just beginning to teach them the rudiments of microcomputer use and to help them overcome the fear of technology. Transit agencies with some experience tend to reach a plateau and need some stimulus to go farther. More advanced, application-specific support is needed for these systems to train them in useful techniques such as batch files, utilities, macros, and multiple-file data base management.

Participants pointed out that much of the support is provided by local, in-house trainers, who may be staff members officially assigned the training function or who may hold the position informally. There are sometimes organizational conflicts with data processing personnel. In many cases, these staff members work under considerable handicaps;

TABLE 1 Types of Support Currently Available

Publications	Training	Interpersonal Assistance
TIME newsletter	FHWA/UMTA 2-day	TIME telephone referral
UMTA selected readings series	course: includes demonstrations on standard and some industry-specific packages	Public Transportation Network (PTN): on-site assistance, peer oriented
UMTA Software and Source Book		Productivity Program: on site visits, consultant oriented
Other federal documents	4-1/2-day course developed at Rensselaer Polytechnic Institute support center: includes lab and case studies and is offered at several locations	APTA conferences
Hardware and software handbooks		TRB conferences
National commercial periodicals and user guides		Other special conferences
Application-specific professional papers		Peers and consultants
Internal documents available through TIME (e.g., sample RFPs, policy statements, needs assessments)	Wisconsin DOT two 2-day sessions: includes hands-on orientation with general purpose software	Local user groups
TRB compendiums		University transit centers of excellence
Case studies	In-house resources (formal or informal), training materials	Rural Transportation Assistance Program centers
Canadian user group newsletter (CUTA)		Computer dealers
	Generic training resources	State DOTs
	Assistance from software developer	

training is frequently slighted because of the costs involved. Among the suggestions for ways to provide support to these in-house trainers were handbooks providing answers to some basic questions, user groups to share experiences, conferences and courses targeted to in-house trainers, and referral lists of experts who could be called on to answer specific questions.

Transit properties should be encouraged to take training needs into account during the procurement process--properties need guidance in how to go about procurement logically. The choice of software determines (or should determine) both hardware and training needs.

Agencies that have begun implementing microcomputers may be among the most important sources of support for other agencies. Most of the applications in the field are adaptations of general purpose software

like Lotus 1-2-3. If these user-developed applications can be located, documented, and disseminated, other agencies will not have to repeat the development process. Such aids would be particularly helpful to small transit operations.

#### SPECIAL NEEDS OF SMALL AGENCIES

Support needs also vary by agency size. Large agencies generally have more computer expertise (which does not mean that they do not need assistance in establishing microcomputer operations) and greater resources, in terms of staff and money, to draw on. However, the participants identified a need for special attention to the plight of small transit properties.

There are vast numbers of small operations in the 16b2 Section 18 category, particularly in rural areas and smaller communities, that could benefit greatly from microcomputers but have no access to them. These agencies, typically staffed by one or two volunteers, have large amounts of paper work, little time, and few financial resources.

This is a market that has yet to be penetrated, and the logistics of doing so are complicated. Participants did not resolve the issue but did suggest that efforts be made to make maximum use of existing resources, perhaps by using agricultural extension or adult education courses as a source of general training. These general courses could be supplemented by case studies of the specific problems of small agencies and by more specialized small operations training, perhaps coordinated by the TIME Center. This specialized training should be provided in innovative formats because personnel from these properties cannot be expected to attend week-long national or regional courses.

Participants believed that the states should play a particularly important role with regard to small agencies. In many cases, the state departments of transportation are the only ones who know where these agencies are and what their needs may be.

#### STATE ROLE

Because the states have an ongoing relationship with transit properties of all sizes, they are in a position to provide assistance in implementing microcomputers. Among the areas in which state involvement might be suitable are coordination of needs analysis, training, and procurement. Such state participation could lead to some level of standardization making future support easier. Some participants believed that a basic ground rule should be that state and local transit agency hardware be compatible.

Participants also suggested that states might provide a circuit rider to assist in training and to troubleshoot on hardware and software applications. The degree to which states actually participate in these areas varies tremendously. Generally, participants believed that states should become more involved at the operational level, but no formal recommendations were made.

## SUPPORT OF PROPRIETARY TRANSIT APPLICATION PROGRAMS

Agencies that are interested in acquiring a particular kind of application program need help in determining which program is best for them. Participants believed the best mechanism for providing that kind of information at the present time is a peer network. APTA could facilitate the formation of special interest groups among people who are using a particular family of application software (e.g., runcutting and scheduling or maintenance packages). Potential buyers could then consult interest group members before committing themselves to a particular product. Experiences could be shared either through meetings or through telephone conversations.

Application-oriented newsletters are another possible medium for information exchange. Such newsletters would appear periodically, and an entire issue could be devoted to a particular subject, presenting different perspectives on approaches to the same application problem. Participants also noted a need for improved documentation and support for proprietary software.

## SUPPORT FOR PROCUREMENT AND ACQUISITION

Transit agencies need information on how to conduct a needs assessment in a rational, systematic, deliberate fashion. Agencies sometimes approach procurement in a haphazard way, trying out several computer systems before they find one that meets their needs. Other agencies attempt to design the perfect system before buying the first piece of hardware. The best approach is an incremental one in which an agency acquires some basic equipment, becomes familiar with it, and adds further elements according to a logical plan.

Agencies also need help in dealing with contractors and consultants to ensure that they know what to ask for and how to determine if they are getting it. To fill the information void in these areas, participants suggested that UMTA add three volumes to its selected readings series: needs assessment, software contracting, and systems procurement.

Agencies should also be made aware of the true costs of acquiring microcomputers. They often fail to take into account the costs associated with implementation--training, application development, organizing the data to be computerized, staff time spent in gaining proficiency on the new system--and maintenance.

Some managers may overlook the organizational impact of introducing microcomputers. Case studies and implementation handbooks could help them anticipate and overcome these difficulties.

## THE CONNECTION BETWEEN APPLICATIONS AND METHODS

Microcomputers make possible a number of advanced management techniques that are not feasible using manual methods. In using these techniques, the user must know not only how to obtain information from the computer but also how to use the information and what it means. It



is dangerous to employ these techniques blindly, generating performance measures without understanding their meaning or the assumptions inherent in the program.

Applications such as runcutting and scheduling must be used in context. The user must understand the principles and methods involved in order to determine whether the results provided really are what was requested.

Special training and support for users of these advanced techniques are needed. It would be useful to develop case studies to give the reader an idea of how a particular application or technique would fit into the context of his own organization.

## Discussion Group B: Software Issues

### Background Paper

William G. Barker

This is the age of personal computing. The inexpensive microcomputer and its attendant software have created a revolution in the use of computer power in organizations. No longer is the computer used only in the largest of organizations, that is, those that are able to support a data processing staff; computers are now used by individuals in all job categories, regardless of the size of the organizations. Popular computer consultant James Martin has termed these changes the "microcomputer revolt" in corporate America.

The age of personal computing has come about because of the inexpensive microprocessor. It is now possible to buy a computer, although it may be a very limited one, for less than \$100. During the last 15 years, the power of computers has increased by a factor of 10,000 while price per unit has decreased by a factor of 100,000. Figure 1 shows, for example, the drop in computer memory prices.

The first personal computer, the Altair 8800, could be purchased in 1975 in kit form for \$400. Apple, Tandy, Commodore, IBM and others have built and sold hundreds of thousands of microcomputers priced at less than \$10,000 in less than a decade since then. The 1972 Census of Manufacturers counted 518 computer makers. In 1982 the number had tripled to 1,566.

The rapid growth of the microcomputer is not easy on manufacturers, however. In 1978 Tandy's Radio Shack dominated with a 50 percent market share. By 1982 Radio Shack had lost the lead to Apple, who in turn lost it to IBM. What is considered typical or "standard" one year is

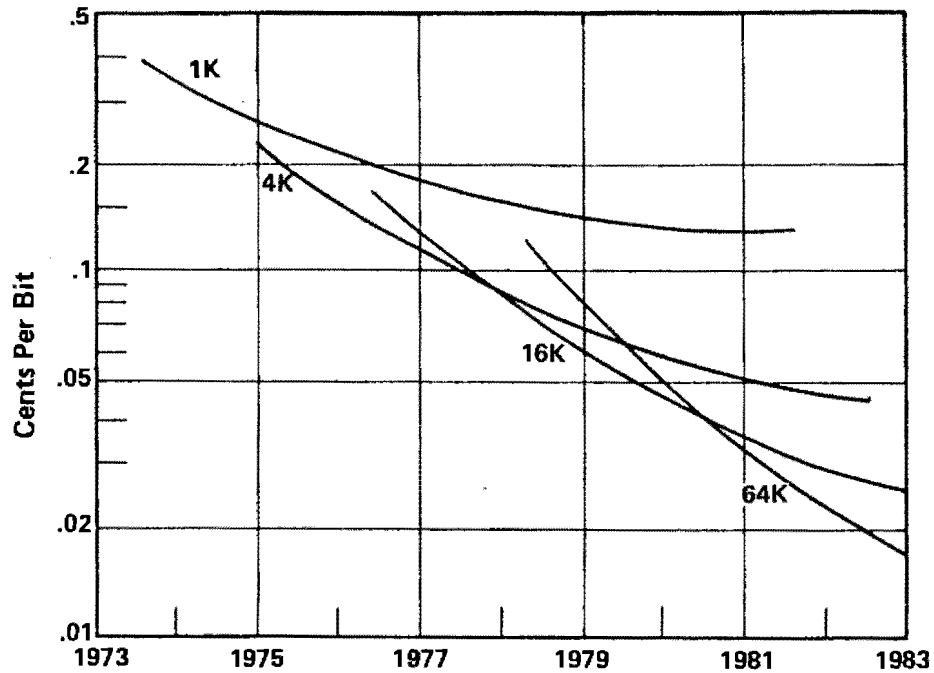


FIGURE 1 Computer memory costs.

obsolete the next. Both hardware and software firms find it difficult to continue to be successful, and shakeouts are continually predicted.

The demand for these products appears to be as volatile as the supply. Although microcomputers were initially purchased by hobbyists, by 1984 the small business and corporate markets grew to 55 percent of the total units sold and 64 percent of the total value. An estimated 92 percent of Fortune 1300 companies currently have an IBM PC installed, up from 77 percent in 1983.

With nearly 2 million computers now installed, the demand for software has been enormous. It is estimated that for every dollar spent on microcomputer hardware each year, another 25 cents is spent on microcomputer software. Hundreds of thousands of copies of programs such as WordStar, VisiCalc, and Lotus 1-2-3 have been sold in an industry that is becoming increasingly similar to the record industry.

Software competition is extremely keen. Major corporations such as CBS, Martin Marietta, and others are entering the microcomputer software market. The number of choices is bewildering to the consumer (there are more than 300 word processing programs for the IBM PC alone). Estimates of the numbers of commercial software packages by system are given in Table 1.

Because of the numbers of software products entering the market, a demand for high-priced "Madison Avenue" advertising is being created. Microsoft, a major microcomputer software publisher, is currently

TABLE 1 Microcomputer Commercial Software, 1984

System	Number of Products
Apple	6,428
TRS-80	5,047
PC-DOS	4,111
CP/M (excl. 86)	3,382
Commodore	2,136
CP/M-86	1,314
CP/M-86	852

spending approximately \$250,000 per month in magazine and newspaper advertising. Predictably, software prices are decreasing as the competition continues to increase (see Figure 2). And software is improv-

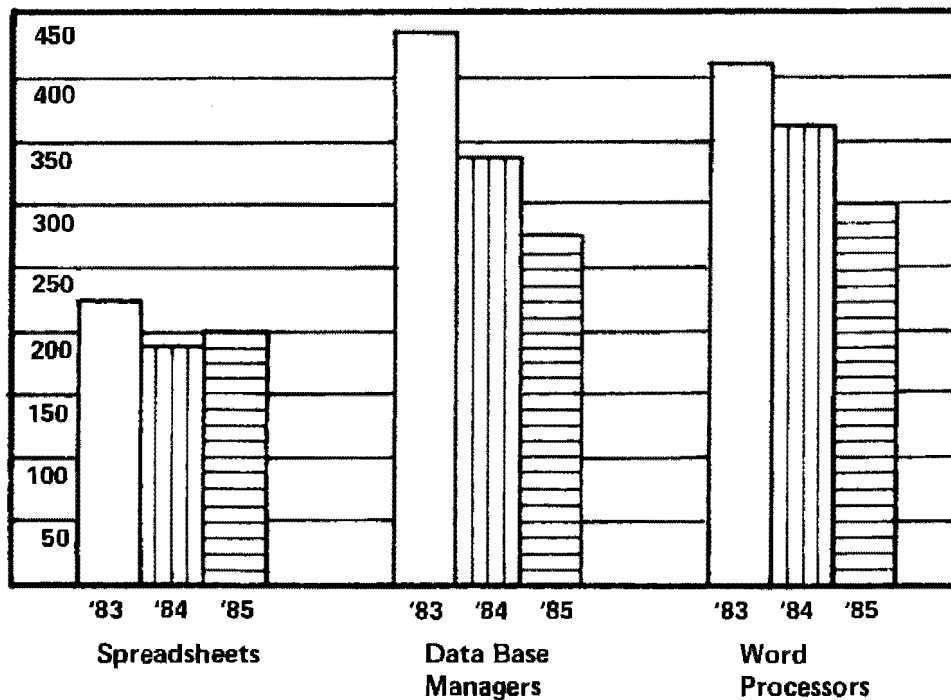


FIGURE 2 Software price trends.

ing. The enormous profits possible from a best-selling microcomputer program justify a substantial market research, testing, documentation, and coding effort. The lay user of this software (as opposed to the

data processing professional) requires user friendliness in the software. Integration is packing more and more capability into individual programs.

#### MICROS IN THE TRANSIT INDUSTRY

The transit industry uses microcomputers in much the same way as other industries. The primary uses are for word processing, general book-keeping, inventory control, payroll, and so forth. Transit operations also have some special uses for microcomputers, however, including fuel monitoring and runcutting and scheduling.

UMTA and the Federal Highway Administration (FHWA) sponsor a Software and Source Book that includes software developed by or available to transit operators. In several instances this software is in the form of templates for popular spreadsheet programs. The categories of software listed in the 1983 edition of this document are listed, along with the number of entries for each category, as follows:

- Ridership and revenue estimation (5),
- Route performance (6),
- Cost estimation (5),
- Scheduling and runcutting (5),
- Maintenance (7), and Payroll (1).

A 1983 survey of 31 properties in the southwestern United States revealed that 81 percent of the transit systems did not have a microcomputer. Transit managers without microcomputers perceived them as being most useful for:

- Inventory control (48 percent),
- Word processing (41 percent),
- Accounting, including Section 15 (33 percent),
- Runcutting and scheduling (19 percent),
- Preventive maintenance (17 percent),
- Fare change analysis (15 percent),
- Accident analysis and safety (13 percent),
- Forecasting (11 percent), and
- Personnel records (6 percent).

In general, however, the transit industry is behind in the installation and use of microcomputers. Whereas a recent survey revealed that 80 percent of businesses in the \$5 to \$10 million range now use microcomputers, apparently only about 20 percent of fixed-route transit systems now use them.

There are several hypotheses to account for the disparity. One is that transit managers are much more likely to adopt changes to increase the productivity of the transportation operation rather than changes to improve the management function. Another hypothesis is that the use of grants to procure such equipment delays purchases. Heavy investment in mainframe and minicomputers and the attendant reluctance

to decentralize the operation are other possible reasons for the disparity.

In the past, the transit industry was supplied with software from several sources, including:

- Direct UMTA software development and distribution;
- Consultants who modified software developed by the federal government;
- Software development, indirectly supported by UMTA, at local and state agencies;
- University research projects; and
- Consultants who developed programs for competitive purposes.

Microcomputer software is apparently coming from the same sources, but in different proportions. Thus far, universities and individual transit properties appear to be more active in developing software, at least for smaller applications, and UMTA has not sponsored many large projects. A few private firms have developed and marketed microcomputer software for transit agencies, often through translating mainframe or minicomputer transit software to the microcomputer.

It appears that there is a general lack of appreciation in the transit industry of two general aspects of microcomputing: (a) the personal, interactive nature of microcomputing, and (b) the cost of customized microcomputer software.

Most transit managers view the microcomputer as simply a small computer. Most believe that, because they already have a "big" computer, there is little need for a micro. They generally do not appreciate the use of the microcomputer as a personal productivity tool. Further, it is difficult for the average transit manager to envision interacting with a computer: these managers have been brought up with the static, periodic computer printout.

With regard to costs, most transit managers believe that transit software for a micro should cost proportionately less than software for a mainframe. Actually, a line of microcomputer code costs just as much to write, test, and document as a line of mainframe code, even though the cost of the computers may differ by two orders of magnitude. This places a burden on the microcomputer software vendor. If the vendor charges \$2,000 for a software package, he cannot make money because the agency wants him to travel across the country and give a demonstration before it purchases the software package. If the vendor charges \$20,000 for the same package, it is quickly pointed out that "the whole computer didn't cost that much!"

The problem, therefore, is marketing. If the transit operator expects on-site marketing characteristic of mainframe packages, it is unlikely that much software will be available. Some alternative marketing schemes can be used, such as:

- Distribution of demonstration disks that show the power of the software but have some limitation, such as an inability to save files;
- Distribution of video tapes demonstrating the software;

- Leasing or renting of the software (copy protected, of course) for a trial period; or
- Provision of thorough user documentation.

The success of these schemes depends on the acceptance by the transit operator of this type of marketing and on the ability of private enterprise to develop software that can be widely sold to transit, given the size of the transit market.

What is the size of the transit market? There are approximately 1,000 fixed-route transit systems in the United States (only about 300 of them submit Section 15 data). There may be as many as 10,000 para-transit operations. In comparison, more than 600,000 copies of VisiCalc have been sold to the general microcomputer market.

Although at first glance the paratransit operations appear to be a sizable market for microcomputer software, the continual shortage of funds that plagues most of these operations makes them a poor market. Further, commercial data base and other programs will likely fill many needs of this market and reduce the possibility of vertical (i.e., industry-specific) applications.

The fixed-route systems are more likely to be the purchasers of custom microcomputer software, but the cost of such software and the proliferation of machine types will likely make this a difficult undertaking from a marketing standpoint. There is probably only enough business for a few firms with strong transit-marketing capabilities already in place. The firms that now sell to the transit industry, whether or not they currently sell software, are in the best position to sell to microcomputer software transit in the future.

It is unlikely that much choice in transit-specific software will be offered by private enterprise because of

- The limited size of the transit market,
- Competition from inexpensive commercial software,
- Rapid obsolescence of specific microcomputer technologies,
- The possibility of government sponsorship of similar software,
- The ease of duplication of microcomputer software, and
- The low cost of the hardware.

#### THE UMTA ROLE

UMTA has been involved with microcomputers almost since the inception of the Apple. This could be expected because UMTA has been involved with computer-based transit planning since it was an element of the U.S. Department of Housing and Urban Development.

Microcomputer activities undertaken by UMTA include

- Sponsorship of limited microcomputer software development,
- Production and distribution of overview documents,
- Establishment of transportation user groups,
- Provision of lecture and hands-on courses, and
- Encouragement of local microcomputer projects.

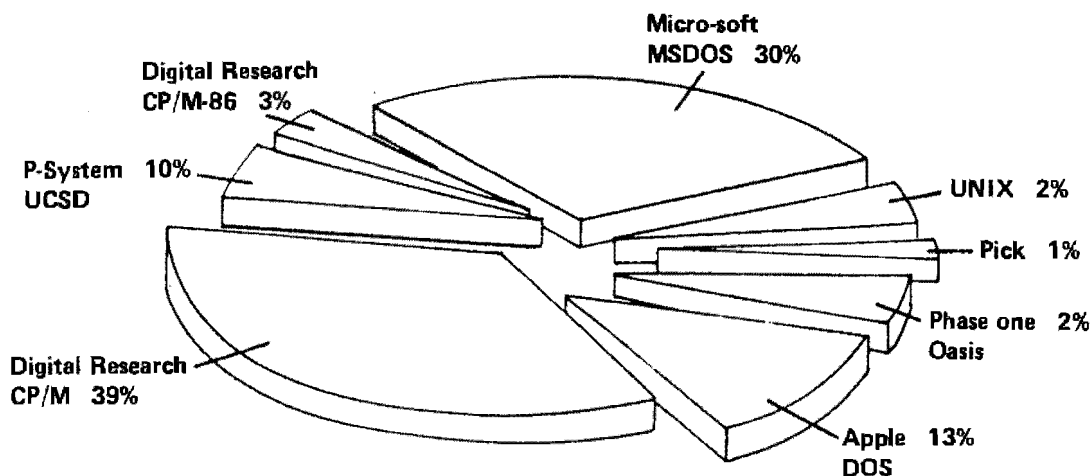


FIGURE 3 Operating systems market, 1983.

In the past, the incompatibility of mainframe computers forced FHWA and UMTA to select a single manufacturer (IBM) for software development. However, the proliferation of microcomputer types has resulted in an operating system that can be quickly and easily transported from one machine type to another. The p-system is just such an operating system, and its use by UMTA for software development is only one approach to avoiding dependence on a single computer manufacturer.

Although it is widely available, the p-system is a relatively unpopular operating system used by only about 10 percent of all microcomputer users (see Figure 3). UMTA's use of the p-system creates problems because almost all of the popular microcomputer application software is written for other operating systems, and the transfer of files from transit-specific software to general spreadsheet, word processing, and other programs is extremely difficult. Products have been announced to allow the transfer of p-system files to MS-DOS formats and even the operation of the p-system applications under DOS. However, the extra steps involved in these translations will no doubt be a deterrent to their general use.

What operating system or systems should be used for the development of transit software? How important is it for specialized transit software to be compatible with popular commercial packages? Are there certain templates, procedure files, or data bases that could be developed for the commercial packages that would be particularly useful?

Perhaps the path to take toward widespread software compatibility in the microcomputer arena is the ability to import and export data in a number of formats, such as DIF, DBF, and so forth. In this way, data can continue to be used even as the application software advances. Such files can be translated to other operating systems via a modem or sometimes by translation programs.

How important is it to try to utilize standard file formats in transit applications? Are there unnecessary limitations imposed by this practice? Will private software developers support or sabotage such efforts?

Operators' needs vary from location to location. Software needs depend greatly on the size of the operation. Each transit manager is entitled to his or her own management style in using information systems.

What type of microcomputer software should be developed for public transit under UMTA sponsorship? Should UMTA limit itself to highly specialized software or choose more generally usable programs? Should it try to provide software that can be used by all properties, just the small properties, or the largest ones? Is it possible to provide software with general applicability that really satisfies the needs of a specific transit operator?

UMTA software development projects tend to require a considerable amount of time. The pressures to reduce the size of government require that most programming be done under contract rather than by staff programmers. By the time all of the steps in a competitive procurement process have been completed, the need for the product may have been met in some other way.

Although there appears to be a need for specialized transit software, who should provide it? Should UMTA try to foster a small transit software industry to be available to work on transit problems? Can such an industry exist without direct UMTA assistance? Would this raise the quality of transit software or cause stagnation? Can government-sponsored software development ever be as responsive as that provided by the private sector?

#### FUTURE DIRECTIONS

Microcomputers will enable a different form of transit management to take place. Because of the low cost of the microcomputer, information will be available in ways never before possible: new, timely, accessible, graphic. Transit systems will be run better as a result, saving money for governments at all levels. It makes sense, therefore, for UMTA to encourage microcomputer use.

It also makes sense for UMTA to prepare transit system managers to operate their systems in a data-rich environment. This will be a new experience for them. It is a new management environment for corporate America as well.

This will become increasingly obvious as data communications networks are put into place. Within transit properties, multi-user and local area network systems will quickly emerge, making every aspect of the system's operation available for incorporation into a highly responsive decision-making process. Transit properties will eventually link with one another and with UMTA through data communications. At the same time, the magic of personal computing will continue to stimulate the creativity and accomplishment of the individual.



New forms of software, such as artificial intelligence, will emerge because of the microcomputer revolution. Will the transit industry benefit from this progress in management through software? Or better yet, can the transit industry be insightful enough to set the example for other industries?

## Discussion Group Report

Four main topics were the focus of the discussion in the session on microcomputer software issues in the transit industry:

1. Industry software needs;
2. Federal, state, local, and private sector roles;
3. Standards and formats; and
4. The user environment.

### INDUSTRY SOFTWARE NEEDS

After reviewing transit operations, vehicle maintenance, and general and administrative functions, the group found that existing general purpose or transit-specific software available in the public domain, from commercial sources or from private sector consultants, shows the potential to meet most needs, at least to some degree. The data in Table 1 indicate these categories of software. The particular software chosen is a function of the size of the transit property or agency.

TABLE 1 Software Categories

Category	General Purpose	Transit-Specific
Public Domain	For example, PC-file	For example, Chapel Hill scheduler
Private/Commerical	For example, Lotus 1-2-3	For example, Mini-scheduler

In general, personal computing needs are being met better than microcomputer business system needs. Microcomputer software has been developed primarily for personal computing. Using personal computers

for business applications usually entails higher software costs, more support, and probably software customization.

Application of general purpose commercial software can greatly reduce software costs and should be encouraged. However, agencies should recognize at the outset that these packages are not panaceas and will not meet all needs. In many cases, some customized application programming will be needed.

Although participants recognized that not all existing software is fully developed, they believed that progress is being made in most areas. Two areas that appear to need specific development are (a) maintenance management information systems and (b) paratransit scheduling and routing algorithms for large systems (those with more than 25 vehicles).

#### UMTA, STATE, LOCAL, AND PRIVATE SECTOR ROLES

The participants perceived a limited need for UMTA to engage in micro-computer software development. They believed that UMTA should provide seed money to develop software packages in the two areas mentioned earlier, but under an arrangement different from the one usually used. Generally, UMTA provides 100 percent of the funding, and the product passes into the public domain. In high-risk areas, the group suggested that the consultant, to be selected through a competitive process, share development costs and receive in return the exclusive right to license the software at an agreed-upon fee. Such an arrangement might offer incentives for consultants to develop appropriate transit-specific software and market it effectively.

UMTA should continue to provide training and other support for local agencies venturing into microcomputer use. These agencies often need assistance in selecting the software that best meets their needs. It would be helpful to include in UMTA's Software and Source Book matrix summaries indicating program capabilities.

Because commercial software is so much less expensive than custom-developed software, UMTA should encourage its use wherever it is prudent. In many instances, local agencies have adapted commercial products to their own needs. UMTA should promote this practice and should also distribute user-developed templates and associated procedure files and other documentation, so that agencies do not have to struggle to arrive independently at the same point.

The participants noted a declining interest in basic computer literacy courses and suggested that UMTA might restructure its training to focus more on functional areas, such as financial planning, than on specific computer topics. An effort should also be made to educate agencies about the "real" or life-cycle cost of software and to assist them in the procurement process.

The transit industry in general harbors an unrealistic expectation that transit-specific microcomputer software should be as inexpensive as general purpose commercial packages. This is simply not the case--the development costs are high and the market is small--but participants suggested that transit software producers try to develop less expensive, more generally applicable software packages.

If costs for these transit-specific products are to be reduced, their producers must find new ways of marketing them, and agencies must be willing to pay an additional charge for training. It simply is not feasible to provide in-person demonstration and training courses for a \$300 package, for example.

At the state level, participants believed that governments could do a great deal for transit through the coordination of transit needs and the procurement of microcomputer hardware and services. State involvement in these activities will, of course, vary from state to state.

#### STANDARDS AND FORMATS

Although transit systems can clearly benefit from using compatible microcomputers, operating systems, and data base managers, advances in these fields make it impractical and counterproductive to recommend a standard for the industry. Today's standard may well be obsolete within 6 months or a year. Instead, participants suggested that UMTA distribute public domain software on the two or three microcomputers and operating systems most commonly used at any given time.

In the absence of a mandated standard, local agencies would do well to determine what hardware and software others in the industry are using before they make purchases. Compatibility among different agencies will make it easier to share data and applications.

Within a transit system, integration of software packages can be increased by selecting programs that can utilize common file formats such as ASCII and DIF. Because templates can be converted relatively easily from one format to another, making interagency sharing possible, no standard need be set.

Developers of transit-specific software should use the machines and operating systems that best suit the development process. Additional target markets for the resulting products can be different machines and operating systems because in many cases, software that is distributed for microcomputers was developed on mainframes or minicomputers.

#### USER ENVIRONMENT

The transit industry has lagged behind other industries in adopting microcomputers. Among the reasons participants suggested for this slowness were:

- Lack of productivity incentives in the industry;
- Fears for job security, especially among data system managers in large properties or clerical personnel in small agencies;
- Perception by management that the amount of additional information made available by the microcomputer would simply raise additional questions;
- Caution in procuring technology; and
- Relatively high total costs, particularly for small operations.

Transit system managers in many cases are unfamiliar with microcomputer capabilities and the associated benefits for their organizations. The participants identified a need for a briefing for managers and for a book or document, to be prepared by UMTA, that would list the benefits of microcomputers from a manager's perspective and show how they could help meet management objectives.

Probably the best way to introduce microcomputers into an agency is to bring them in as personal computers rather than as office computers. Transit-specific applications could be introduced through simple, easy-to-use, inexpensive programs (to be developed by UMTA) in areas such as Section 15 reporting and parts inventory management.

The barriers to microcomputer use will continue to fall as more and more transit agencies acquire microcomputer systems. There is a move toward standardization within the industry, making software exchange among properties easier.

Looking to the future, the participants believed that increased budget pressures in the transit industry are likely to increase the popularity of productivity-enhancing software. Data collection will become more automated, and there will be more intelligent vehicles with microprocessors on board. Future systems will be easier to access and will include more video and graphics capabilities.

Communications software will assume more importance. Transit properties will move beyond automated record keeping toward true decision-support systems that permit ad hoc queries, exception reporting, and the like. If these decision-support systems are to become reality, however, more dialogue between transit management and transit software developers will be needed to keep developers apprised of the industry's needs.

## Discussion Group C: Technology

### Background Paper

Thomas M. Cypher

The evolution of small, powerful microprocessors has combined with technological advances in communications to create expectations of sophisticated, yet simple-to-use, computer systems that will revolutionize transit operations. Progress in development of networks, through which hundreds or thousands of microprocessors can communicate, has led to anticipation of easy and rapid automation of almost every aspect of a transit agency.

## NOT-TOO-NEAR-FUTURE TECHNOLOGY

Some high-tech enthusiasts envision the day when a handful of policy makers and a staff of systems personnel will be sufficient to run even the largest transit operation. Their discussions focus on:

- Buses and trains operated exclusively by robots;
- Vehicle locator systems controlled by artificial intelligence and capable of receiving passengers' inquiries, via voice recognition, and responding, through voice synthesis, with up-to-the-minute status on any aspect of the system;
- Sophisticated on-board sensors continually feeding ridership data to the scheduling processor which, in turn, makes necessary route and schedule modifications and disseminates that information;
- Robotic maintenance crews capable of not only making precision repairs and performing preventive maintenance, but instantaneously relaying parts usage information to maintenance history and inventory files, as well as feeding continually updated reliability and maintainability data bases;
- Self-monitoring vehicles that identify potential problems before they occur and simultaneously schedule needed maintenance;
- Intelligent fareboxes that accept transit credit cards and immediately bill the card company;
- Material-management systems that issue parts and monitor inventory files, establish historically determined reorder points and stock-storage locations, supply vendors with purchase orders, receive shipments, and concurrently update the inventory files;
- A national transit data base providing agencies across the country with current operational and management information; and

High-tech enthusiasts point to the increasingly complex roles microcomputers are playing in transit in several other countries as indicators of the future direction of the American transit industry. They declare that the days of the large, mainframe-oriented data centers are numbered. In their opinion, the rapidly advancing technology will provide individual transit microcomputer users with mind-boggling, number-crunching capabilities in a truly distributed processing environment.

On the other hand, a number of industry professionals believe that such futuristic claims are the dreams of science fiction buffs. These realists point to the inability of hardware manufacturers and software developers to establish and abide by standards that are necessary to develop such sophisticated systems. A look at the extent of the transit industry's current use of microcomputers (about 25 percent of that of other comparable industries), they contend, is the best indicator of transit's future direction. The relatively recent implementation of mainframe and minicomputer systems within transit leaves agencies and funding sources unwilling or unable to turn around and begin introducing micros. Many perceive the industry's present reluctance to commit dollars to microcomputer projects as having a long-range dampening

effect on the development of the needed transit-specific microcomputer technology. Hardware and software developers will invest their research and development funds in vertical markets with greater potential for return.

#### CURRENT AND NEAR-FUTURE TECHNOLOGY

Microcomputer technology is being introduced into transit agencies around the country. A limited number of agencies are using single-user, stand-alone micros to run transit-specific applications that have been developed in-house or by one of the few transit-software vendors. Most of these micros, however, are single-user, stand-alone units running general purpose word processing, spreadsheet, and data base management software such as WordStar, Lotus 1-2-3, and dBase III. There is little evidence of a widespread adoption in transit of multi-tasking, multi-user micros running transit-specific software.

Users having a need for multi-tasking, multi-user machines are frequently choosing more expensive minicomputers. Many cite the transit microcomputer software industry's inability to match the developmental pace of the microcomputer hardware industry as a key factor in their decision. Though the cost is higher, many agencies believe the minicomputer or mainframe route is the only safe one open to them. Others acknowledge the promise of the new "supermicro" technology but believe that its practical use at this time is premature. There are a number of management as well as technological issues, they maintain, that have to be resolved before these machines can be introduced as viable solutions to some of the information-handling problems in transit. For example, for micros to begin to realize their potential, reliable networks must be available. These networks must not only pass data but must allow utilization from one machine of transit-specific applications to another machine of general purpose applications. Networking applications must satisfactorily address intricate data base management questions.

In existing mainframe-oriented transit data centers, the introduction of microcomputer technology is raising serious problems of data security and integrity. The micro/host relationship becomes a complex issue. Users want and expect the freedom and flexibility of a personal desktop unit but require data from the central system. The ability of users to enter, manipulate, and store data independently of the central machine poses real "data currency" difficulties. Such situations force management information system (MIS) managers to reevaluate system management techniques and controls. The introduction of microcomputer technology and its accompanying decentralization of information handling necessitates rethinking the concept of a transit management information system.

Computers are often viewed as a threat to jobs, and transit is a labor-intensive industry. Unions may fear that the microcomputer can do their work better and faster and that union members will be dis-

placed or their skills made obsolete. At the same time, management may believe that a micro cannot really do the work and that people's jobs will only be made more difficult and productivity will suffer. Individuals at any organizational level may harbor the belief that using a computer is difficult and that it requires detailed knowledge that they do not have and cannot attain. Some observers indicate that such attitudes by top management and labor personnel have signaled vendors to avoid spending time and money developing transit-specific microcomputer technology.

That the introduction of powerful and inexpensive microcomputer technology into transit is progressing so slowly is attributed by some to a lack of emphasis by government funding sources. This, they claim, serves as a warning to vendors not to invest heavily in transit-specific microcomputer technology. Vendors believe that a push is required by the government if this technology is to be widely accepted and used. They argue that the potential for sophisticated passenger-counting systems, bus-diagnostics systems, and fare-collection and data-analysis systems will not be realized without government commitment.

At the same time, much of the microprocessor hardware and software technology that is, or soon will be, available to transit is not transit specific. Technology such as voice recognition and synthesis, bar coding, video input/output, electronic mail, office automation, optical character recognition, electronic bulletin boards, agency-external networks, national data bases, and so forth, can have an enormous impact on the way transit agencies do business. The difficulty is in determining which technology will have a positive and enriching influence and which will negatively affect transit's efforts to provide improved service for less cost.

#### ISSUES FOR DISCUSSION

In order to focus the discussion of these and other issues, members of the Technology session will use the following list of questions as a point of departure.

#### Status of Microcomputer Technology

1. How is microcomputer technology used in transit, in both operations and management?
2. What aspects of microprocessor technology are most commonly in use within the transit industry? Transit-specific: scheduling and run-cutting, ridership and revenue estimation, route performance, maintenance, paratransit planning, other? General purpose: spreadsheet, word processing, data base management, bar coding, electronic mail, other?
3. What factors have been key in determining how transit currently uses microcomputer technology? Technological, sociopolitical, cost, other?

4. What roles have the federal government, state and local governments, industry organizations, and others played in encouraging or discouraging microcomputer use?

5. What has most encouraged the use of microcomputer technology in transit? Governments, industry organizations, public opinion, other?

6. What has most discouraged the use of microcomputer technology in transit? Governments, industry organizations, public opinion, other?

7. How has microcomputer technology affected vehicle technology? Passenger-counting systems, bus diagnostics, fare collection, communications, other?

8. How has utilization of microcomputer technology affected the concept of transit management information systems?

#### Future Direction of Microcomputer Technology

1. What microcomputer developments in hardware and software are most likely to affect transit management and operations?

2. What data communications developments are most likely to affect transit management and operations?

3. What general purpose microcomputer technology should transit embrace? Electronic mail, word processing, spreadsheet, graphics, computer-aided design, electronic bulletin boards, voice recognition, voice synthesis, bar coding, data base management, other?

4. What factors will be key in determining how transit uses microcomputer technology in the future? Technological, sociopolitical, cost, other?

5. What roles should the following play in encouraging the use of microcomputer technology in transit? Federal government, state and local governments, industry organizations, other?

6. How can microcomputer technology be expected to affect vehicle technology? Passenger-counting systems, bus diagnostics, fare collection, communications, other?

7. How can utilization of microcomputer technology be expected to affect the concept of transit management information systems?

8. What should be the relationships between microcomputer and host computers?

9. How can transit management and unions be expected to deal with

- Rapidly changing job content due to automation;
- Reduction in clerical tasks resulting in a generally higher skill level being required of employees;
- Obsolescence of traditional transit skills like runcutting, extraboard assigning, and so forth;
- The use of computers in labor negotiations; and
- Information management policies required by decentralized computing?

10. How will the development of specialized software be affected by inexpensive, general purpose software that is increasingly powerful and flexible?



## Discussion Group Report

During the discussion, the participants examined two facets of microprocessor technology: (a) microprocessors embedded in special-purpose devices (black boxes) and (b) general purpose software-driven devices that allow the user somewhat more flexibility. At some points in the consideration of the latter, it becomes difficult to separate hardware and software. Much of the discussion was in terms of software applications, which are made possible by the hardware (microprocessors).

Participants also examined the current state of the art and discussed barriers to transit industry implementation of available technologies and constraints on future development.

### CURRENT STATE OF MICROCOMPUTER TECHNOLOGY

Participants reviewed the current state of microcomputer technology, both general purpose and transit specific, rating it according to its usefulness to the transit industry and its stage of development--prototype, infancy, or adolescence (no technology was considered to have reached maturity) as follows:

1. At the prototype stage, a working version exists; the opportunity is there for use of the technology, but the benefits are undefined.
2. In its infancy, a technology has moved beyond research and development and is used in a few places but has not achieved widespread use. The opportunity for further enhancement exists.
3. In adolescence, a technology is widely used and generally accepted, but there are still opportunities for improvement.

The results of the review are given in Table 1.

In the course of the assessment, a number of needs were identified. The fulfillment of some of the needs is dependent on the computer industry at large, and the transit industry has little or no influence on meeting them. Among these needs are:

- Standardization,
- More graphics and graphics integration,
- Local area network integration,
- Video disk technology,
- Better training,
- Touch screens,
- Integrated software (separate packages with data interface),
- Automated data collection,
- A humanized electronic environment, and
- Improved documentation standards.

TABLE 1 Current Technology

Technology	Stage of Development <sup>a</sup>	Benefit/Payoff <sup>b</sup>
Operations (special purpose):		
Farebox data recorders	3	B
Vehicle locators	3	A
Passenger counting	3	B
Teleride (marketing)	1-2	A
Scheduling and runcutting	2	A
Ridership data collected	2	A
Radio (standard)	3	A
Paratransit dispatch	2	
Fare payment and operator timekeeping system	3	A
Maintenance (special purpose):		
Fluid and consumables recording and control	2	A
Vehicle diagnostics (on-board, oil analysis)	1	A
Parts inventories (bar coding)	2	A
Work order data entry	2	A
Vehicle history	2	A
Management (general purpose):		
Spreadsheet	2	A
Word processing	2	A
Electronic mail	1	B
Site-to-site transmission	2	A
Graphics	2	A
Integrated software (closed system)	1	A

<sup>a</sup>1 = prototype; 2 = infancy; 3 = adolescence.

<sup>b</sup>A = high payoff; B = questionable payoff.

Participants also cited a need for firmware. Firmware is the bridge between general purpose desktop computers and special-purpose devices with embedded microprocessors. It enables the user to reprogram microprocessors inside special-purpose devices, which, in the transit industry, would include fare monitors, passenger counters, bus-diagnostic devices, bar code readers, electric eyes and other sensors, and robotic devices used in bus cleaning and maintenance.

Another category of needs is more closely tied to the transit industry, and here the industry may be able to take some initiative in developing the products and services. This category includes:

- Establishment of a mechanism for management of technical change within the transit industry;
- Computer-aided training for transit-specific applications;
- Bar code standards among vehicle manufacturers;
- Automated data capture;
- On-board micros for paratransit;
- Computerized maintenance manuals;
- Voice recognition;
- Electronic bulletin boards for problem fixes;
- Computerized troubleshooting guides (expert systems);
- Alternative data entry procedures (e.g., pictures, list options);
- Cellular radio technology applied to transit (a possible replacement for vehicle locators);
- Robotics; and
- Home videotext query of schedules.

Passenger counters and vehicle locators should be further developed and tied into integrated managerial control systems for schedule adherence, load factors, and performance measures.

#### BARRIERS TO IMPLEMENTATION

The consensus was that widespread implementation of microprocessor technology in the transit industry offers opportunities for substantial increases in efficiency and productivity and may provide operating cost savings, especially through

- Better tailoring of capacity to demand;
- Better utilization of vehicles as a result of improved maintenance and consumables management;
- Increased revenues through better off-peak utilization as a result of consumer information systems;
- Better cash-handling methods;
- Better utilization of operating personnel through better management tools;
- Better utilization of management and clerical personnel through productivity-enhancing tools; and
- Increased productivity through improvements in the quality of working conditions as a result of productivity tools.

If all of these benefits enure to transit agencies that install microcomputers, why are so few agencies taking advantage of the new technology? Several factors have slowed interest in doing so.

One is unfamiliarity with, and therefore a certain fear of, computers in general and microcomputers in particular. This fear can be

overcome by a combination of formal education and training and the general cultural change now taking place. Computers are becoming increasingly a part of everyday life, at least for young people. Some participants predicted a period of some conflict during the next several years as younger employees urge the introduction of microcomputers while some older managers resist.

For those agencies that do begin to take advantage of the new technology, a number of possible evolutionary paths to optimum utilization were suggested. Noninteractive black boxes could be introduced first (usually in the maintenance area), and more sophisticated, interactive devices could be installed later (e.g., equipment that would allow mechanics to query a data base of vehicle history). An enthusiastic employee could be enlisted to function as a catalyst to show others some of the possibilities presented by microcomputers.

In addition to these academic and psychological barriers, organizational obstacles sometimes stand in the way. In large systems, for example, there may be well-established data processing departments that view microcomputers as threats either to their own positions or to the security and integrity of data.

Other agencies may face political problems with their boards, and still others may be swayed by initial bad experiences, whether in their own systems or elsewhere, like those encountered with electronic farebox data collection.

Lack of standardization is a major barrier to full utilization of available technologies. The multiplicity of hardware and software in the market can make it difficult to put together a fully integrated, compatible system within a single agency; the difficulties of achieving compatibility among a number of agencies are greater still. The lack of standardization impedes the flow of information, slows the implementation of software, and prevents properties from taking advantage of economies of scale.

General computer industry trends have brought about some degree of standardization, but there has been little progress toward developing transit-specific standards. Participants generally agreed that top-down imposition of standards would meet resistance. What is needed is a degree of standardization sufficient to promote technological development and effective interchange among functional areas while still allowing properties to tailor the applications to meet their own particular needs. To this end, an industry consortium, working with UMTA, should establish standard data formats and transfer protocols in maintenance and inventory, route performance, operations control, and finance and administration.

#### CONSTRAINTS ON TECHNOLOGICAL DEVELOPMENT

The chief constraint on development of transit-specific technology is market size. Related to this is UMTA policy regarding the ownership of rights to products developed with federal funds. Lack of standardization is also a factor that discourages technological development in such a small market.

The transit market has two disadvantages: it is small and it is fragmented. If every transit agency in the country bought a given transit-specific product, only about 11,000 would be sold. The likelihood of one product being used by all agencies is extremely small because transit properties vary tremendously in size and in degree of computerization. The lack of standardization of computer equipment even among agencies similar in other respects further shrinks the market.

Clearly, such a market is too small to attract sufficient development capital. Progress to date (in implementation as well as in development) is largely a result of UMTA funding. The risks are too high for the private sector or a local or state transit agency to bear alone.

But products developed with UMTA seed money pass into the public domain, reducing incentives to expend the effort to develop, package, and market them effectively. If present policy were changed to permit ownership and licensing rights to pass to the developer in return for sharing development costs, the profit potential would fuel better marketing efforts and, quite likely, better documentation.

The transit industry should focus on transit-specific hardware and software and on effective strategies for implementing microcomputer applications, leaving more general purpose concerns to the computer industry at large. UMTA should encourage further advances, including adaptations of general purpose technologies, by supporting the formation of self-sustaining consortiums of local and state agencies, private firms, universities, and others to develop prototypes and market products.

Ways of expanding the market for microcomputer products developed by and for the transit industry were examined. Two possible avenues are the international export of products and services and cross-industry migration of transit microcomputer technology. Participants suggested that UMTA examine the possibility of sponsoring a trade show for promoting such technology, as well as encourage its inclusion in related industry trade shows.

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## Discussion Group D: Small Transit Systems: Benefits and Implementation of Microcomputers

### Background Papers

#### MICROCOMPUTERS IN SMALL TRANSIT SYSTEMS: BENEFITS AND IMPLEMENTATION ISSUES

James Beckwith

In September 1982 the Conference on Future Directions of Urban Public Transportation was held at the National Academy of Sciences Conference Center in Woods Hole, Massachusetts. This conference, like the Workshop on Microcomputers in Transit, was conducted by the Transportation Research Board and sponsored by the Urban Mass Transportation Administration. Its purpose was to reassess the direction of strategic planning for the nation's transit systems: "How should the transit industry position itself for the future?"

Before attempting to identify future directions, the conference participants reviewed the causes of their current problems. Although the list was fairly long, these problems were cataloged under three broad headings:

1. Societal conditions and trends that are largely beyond the control of the transit industry or transportation policy makers,
2. Federal policy that contributes to transit problems, and
3. Management problems in the transit industry.

The conference participants worked toward a consensus position statement on future directions for public transportation. Although it is not necessary to relate all their statements on how transit can position itself for the future, it is important to point out that several of the research and development issues identified as being critical in positioning transit for the future dealt with computerized systems for handling various transit functions. The conference participants noted the need to further the applications of microcomputers for inventory control, maintenance record keeping and analysis, per-

formance monitoring, route and schedule planning, and other operations planning functions. Their message was clear: The proper application of automated systems can contribute to the solution of some of the management problems that face the transit industry.

But what is the proper application of automated systems? Is it different between large, medium, and small systems? Can there truly be benefits to the small transit properties with less than 100 buses? Less than 40?

Certainly, the need for reliable, timely information is just as important to the successful operation of a small transit operation as it is for a larger system. Most small transit properties today collect data on virtually all aspects of their operation. Unfortunately, the high cost, time, and effort associated with manually processing these data often preclude their preparation in a format best suited for those who need the information. Consequently, those benefits that could result from having the appropriate information cannot be realized to the fullest extent.

Managers recognizing this problem and turning to the microcomputer as a potential solution often have encountered resistance at the local level. For many, their involvement with computer processing has been limited to selected financial applications usually controlled by another city department. Thus, these managers have found themselves unprepared to address specific questions concerning benefits, costs, and implementation issues: What specific benefits will be realized? How can the benefits be measured? What price will be paid for these benefits? What problems are likely to arise during implementation? Can the city's mainframe computer be used instead? Without adequate information concerning the use of microcomputers by small transit properties, these managers will not be able to answer these questions and in the end may lose out altogether.

There are, of course, a few small transit property managers who for one reason or another have been successful at implementing a microcomputer-based data management system. These managers have found several major applications that are providing valuable support to their daily operation. Some of these include budget development and monitoring, vehicle-history record keeping, financial accounting and payroll, parts inventory management, revenue and ridership accounting, vehicle servicing, vehicle maintenance management, and word processing. These applications usually utilize existing data base management systems and electronic spreadsheets. Many of the applications are menu driven, data are often input on easy-to-use computer screens, and there are numerous operational and management reports available from each of these applications.

In addition to the preceding popular applications, transit personnel are discovering many smaller manual tasks that can easily be converted to a microcomputer system. Included in this list are elderly/handicapped and school pass recording/accounting, accident data recording and analysis, personnel data records, time-off accounting, uniform-allowance control, training records, cash flow management, street hazards inventory, token/pass sales outlet accounting, disadvantaged business enterprise (DBE) accounting/reporting, boarding-and-

alighting survey processing, and fare structure analysis, to name a few.

Although the benefits accruing to the transit property with a microcomputer have not been very well documented, managers appear to believe that the availability of additional data and the related analysis, combined with the reduction in manual record keeping and manual data analysis activities, together more than offset the cost of implementation and maintenance of the system. If this is the case--and most people appear to agree that it is--then transit managers need to be provided the necessary documentation to help them make a successful transition to microcomputers.

#### QUESTIONS FOR DISCUSSION

Some of the questions and issues associated with identifying the benefits and implementation concerns of a microcomputer-based data management system are identified in the next section.

#### Benefit-Related Issues

1. What types of benefits can be attained through the implementation of microcomputer applications?
2. Can the benefits of using microcomputers be quantified? If so, how?
3. In what areas (which applications) can small transit properties benefit most from microcomputers? What functions specifically are most effective when automated? Will this vary from property to property? What property indices might be used in this analysis?
4. Is there a minimum system size where benefits do not exceed the costs? Must benefits exceed costs?
5. Can cost/benefit relationships be established? Should net benefits be identified, and can they be identified?
6. Are benefits of a direct or indirect nature? How might these be addressed?

#### Implementation-Related Issues

1. How does a transit manager become knowledgeable enough about microcomputers to be able to sell the concept to his city or board? What support is available to him?
2. What are the people problems and opportunities presented by the introduction of a microcomputer?
3. How does the introduction of the computer affect management structure and organization, and how do changing job functions impinge on union agreements? How might the role of the transit manager of the small property change?
4. What are other personnel issues, such as motivation, matching people with tasks, staff development, turnover, hiring and training?



5. What are the issues related to buying packaged hardware and software as compared to in-house development?
6. What costs can be identified with implementing a microcomputer system?
7. Who can a manager turn to for help or for continuing support?
8. When does buying a minicomputer or a mainframe computer make more sense than buying a microcomputer? Should an interface to a central computer be considered?

## IMPLEMENTATION ISSUES

Jack M. Reilly

Despite the fact that by now a large number of transit agencies have installed some computer equipment, anecdotal evidence suggests that nearly all have some difficulty in making a transition from traditional manual systems of information processing to a computerized information system. Perhaps this is part of the cost of doing business. On the other hand, the experiences of those who have installed such systems should be shared with those who will in the future convert to computerization of information management. This is critical because the reduction of the real cost of information processing has enabled smaller agencies to enjoy the benefits of data processing. These smaller agencies with smaller and less technically specialized staffs are probably even more vulnerable to the implementation difficulties of their larger counterparts.

The reasons that agencies do encounter difficulties in computer installation are as diverse as the agencies themselves. A primary reason is that transit agencies are organized to facilitate operations rather than to manage technological change. Transit systems, particularly those in small to medium urbanized areas, have small staffs with few persons with management systems background or experience. This is compounded by a management focus on day-to-day operations rather than on the more strategic activities.

The experience base of agencies that have made the transition to automated information systems is immensely valuable to agencies planning to undertake such a project. For the most part, preparing management for what to expect during both the transition period between manual and automated systems and the time after full installation would be most useful.

There are four areas where the assistance of those with some experience could yield large payoffs:

1. Better matching of expectations of automated systems with their actual performance,
2. Improvements in planning for system installation,
3. Reducing the trauma in the installation of systems, and
4. Improvements in project management and control.

#### PERFORMANCE VERSUS EXPECTATIONS

A major reason for difficulty in installing systems is the mismatch between system performance and preconceived expectations. Some of these expectations include staff reduction and instantaneous access to management data. A particularly vexing problem is that the report-generator software included in most management information systems is not intended for the casual user. Thus, although it is technologically possible for an end-user to obtain complex reports that cut across several files, some knowledge of file structure and query-language commands is essential.

The solution to this problem may not be to dampen expectations or to improve the capability of systems. Rather, it is important to communicate to end-users that the transition is a continuous rather than a discrete process and that although in the short run there are certain to be some disappointments, most user expectations can probably be met over a longer period of time.

Further, particularly in customized applications, such as runcutting and dispatching, extensive software testing is required. Because this task is best performed by end-users, considerable staff time is consumed in the meticulous and ungratifying task of testing. Again, this occurs at a time when users' expectations are rising.

#### SYSTEM PLANNING

Hindsight in computer installation is nearly perfect. At least some individuals who have worked on computer installations would have performed certain tasks in a different manner. Unfortunately, several planning tasks such as assessing data-capture practices, file relationships, and report formats are not undertaken until decisions about them lie on the critical path of system installation. This can cause such decisions to be made blind of their implications for long-term consequences. Further, problems do arise when internal working procedures, which are well steeped in organization tradition, must be altered to meet the requirements of the system.

A common difficulty, not restricted to transit operations, is trying to computerize poorly documented, loosely controlled manual systems. Interestingly enough, a management-improvement study, independent of any computerization study, would probably be a good first step in advance of computer installation. Careful attention to data capture and transcription, paper flows, and the summarizing and distribution of data are essential components of such a study.

## TRANSITION TRAUMA

A common lament among end-users of data base management systems is that results useful in making strategic management decisions require the accumulation of a series of data records. For example, data-driven management actions to reduce vehicle accidents do not manifest themselves until data are recorded for at least a full year. Ironically, this transition time during which little benefit accrues occurs when there is considerable effort in establishing the new computerized system. These tasks include creating master files and code books, debugging software, and operating parallel systems. Given this, it is easy to see why implementation is difficult and end-users are easily discouraged. Although early awareness of the potential difficulties may reduce the transition problem, other strategies such as batch entry of historical records may more clearly illustrate the benefit of a computerized information system.

## PROJECT MANAGEMENT AND CONTROL

The installation of automated management information systems is a complex undertaking that cuts across several units within an organization. Frequently, such installations require the intervention of outside contractors and suppliers. This is compounded by the fact that even within transit agencies there may be considerable diversity in the quality and style of management, existing information-assessment practices, and the receptivity of management and staff to technological change. Other complex undertakings, such as garage construction, lend themselves to classical project management techniques such as PERT and CPM.

Unfortunately, considerable uncertainty exists about the time needed to complete certain tasks. Therefore, the use of such techniques should allow for significant slack time, perhaps derived from experience elsewhere, in the performance of certain tasks. The benefit of such management techniques may be more in early identification of the critical tasks upon which the completion of other tasks depends in the implementation process. For example, a file of existing inventory stock numbers and levels must be available before the installation of an integrated maintenance work order and inventory system.

## PROPOSED QUESTIONS FOR DISCUSSION

A few critical areas that warrant further discussion have been highlighted in this paper. The following questions are proposed for discussion in the implementation workshop.

### 1. Performance versus Expectations

- How should the concept of computerization be introduced to an

agency? What is the role of site visits to other agencies? Who should attend?

- How can the experience of those who have computerized this operation be made available to others?

## 2. System Planning

- How should a management study or needs assessment be conducted? What is the role of internal staff and consultants? What is the expected product of such a study?

- Can a standard procedure or "cookbook" be used in such a study?

- How can line managers be persuaded to organize and specify their real management information needs?

- How should an agency be organized or reorganized for information automation? Someone must be responsible for system administration; who should this be?

- What activities should be accomplished before system implementation (create code books, etc.)?

## 3. Transition Issues

- What can be done to reduce problems of transition to automated systems?

- Should basic data-file building (e.g., parts master file) be done by contractors or by in-house staff? How and when should training be done? How can the quality of training be assessed?

## 4. Project Management and Control

- What is the responsibility of the project manager? How should disputes between project manager and end-users be resolved?

- What is the best sequence of implementation? Should a few procedures in each department be implemented (parallel) or should automation be completed in each department before advancing to the next?

- What are the appropriate methods for accepting software?

- What are elements of a good contract between a software/hardware vendor and an operating agency?

- What are appropriate project management techniques for such a project?

## Discussion Group Report

The discussion group found the federal definition of a small transit system as one with fewer than 100 vehicles unhelpful in dealing with microcomputer topics. Participants instead divided the transit uni-

verse into properties that do not have professional management information staff and those that do, then focused on those that do not. In these agencies, it is up to the general manager, the operations manager, and the maintenance foreman to determine whether and how microcomputers will benefit the organization and to oversee their implementation and daily use.

#### BENEFITS TO THE SMALL PROPERTY

The group's premise was that microcomputers are beneficial to small properties because they allow easy access to data, giving management the information necessary to improve operating efficiency and service effectiveness, perhaps at reduced cost. The degree to which benefits accrue to a particular agency is dependent on (a) the level of microcomputer utilization and (b) the applications used.

The group identified three levels of utilization:

1. At the lowest level the microcomputer is used off-line in a support function in areas such as budgeting and route planning. Its use is not necessary to the ongoing, day-to-day operation of the system.
2. At the second level the microcomputer is used on-line; many activities--maintenance, inventory, ridership and revenue analysis--flow through it.
3. At the highest level the microcomputer is used to perform real-time, on-line applications. The manager makes hourly and daily decisions on the basis of microcomputer-generated information. Probably no agency has yet attained this level. Small transit properties will only be concerned with the first two levels.

The applications appropriate for specific property use are determined in large measure by its size. A sophisticated parts inventory program, for example, is of less benefit to an agency with 15 vehicles than to one with 50. Additionally, fixed-route systems and paratransit-responsive systems have different needs and may derive different benefits from the introduction of microcomputers.

Participants listed almost 75 perceived benefits that small systems might derive from about 50 applications in equipment and materials management, maintenance, financial analysis, operations, communications, administration, and service planning. These benefits are given in Tables 1 through 7. Benefits at this point are classified as "perceived" because there is little or no quantified data to prove that the expected benefits are in fact realized. It is not possible today to advise a general manager investigating the advantages of microcomputers that the highest payoff will come in parts inventory management or financial management or maintenance. If benefits could be quantified in dollars and cents, managers would have less difficulty persuading city management or transit boards to fund microcomputers.

Some benefits, although real, may not be fully reducible to monetary terms. Among the ones in this category are the impacts of microcomputers in

- Making additional data available,
- Freeing staff time for other jobs,
- Raising the level of decision making,
- Raising the quality of performance,
- Increasing job satisfaction,
- Increasing accuracy,
- Allowing quicker response time, and
- Reducing rework.

TABLE 1 Equipment and Materials Management Applications and Benefits

Specific Application	Potential Benefit
Inventory control	No stock out/reduce vehicle downtime
Parts tracking (use)	Reduced inventory/stock, resulting in reduced inventory cost
Parts reordering	Supports purchasing/manpower savings
Parts costing	May reduce theft
Parts locations identification	Optimizes purchasing (economic order quantities)
	Supports annual physical inventory
	Supports budgeting functions
	Reduces time required for physical inventory

Participants suggested that further study be devoted to determining which benefits are quantifiable and which are not. Two types of aids are needed:

- Case studies of the results achieved by agencies that have installed microcomputers, showing the actual benefits (in dollar terms where possible) derived from the use of the new technology; and
- Tools, methodologies, and procedures to assist managers in determining where the greatest potential benefits for their own agencies lie.

Transit properties should not, however, wait until these studies and tools are available to begin acquiring microcomputers. If a perceived net benefit from a given application exists, the agency should move ahead. The greatest perceived benefit may not be the one that saves the most money but the one that helps the manager solve his most persistent information management problem.

TABLE 2 Maintenance Applications and Benefits

Specific Application	Potential Benefit
Preventive-maintenance scheduling	<p>Reduces downtime with better utilization of vehicles</p> <p>Promotes better use of maintenance resources</p> <p>Defines appropriate inspection levels</p> <p>Provides better interface with parts inventory</p> <p>Supports risk-management practices</p>
Vehicle history	<p>Supports decision making on vehicle replacement and refurbishing/continued maintenance, reduces overall costs</p> <p>Helps reduce repetitive repair work through analysis of maintenance history, thus reducing overall costs</p> <p>Assists in quality control, both parts and labor</p> <p>Supports equipment scheduling decisions</p> <p>Assists in tracking warranty work</p> <p>Supports parts management</p> <p>Supports decision making on spare ratios</p> <p>Supports equipment-specifications decisions</p> <p>Tracks vehicle and component maintenance activities (defect analysis)</p>
Daily servicing	<p>Flags immediate problems with fluid use</p> <p>Tracks mileage, triggering preventive-maintenance scheduling</p> <p>Tracks consumables</p> <p>Triggers tire rotation and replacement</p> <p>Supports reconciliation of fuel purchased and fuel consumed</p> <p>Provides farebox control</p> <p>Aids in better purchasing</p>

TABLE 3 Financial Analysis Applications and Benefits

Specific Application	Potential Benefit
General ledger asset control	Provides timely management control
Accounts payable	Allows single entry versus multiple data entry
Accounts receivable	Promotes better cash management
Payroll	Generates scenarios in contract negotiations
Budget	Supports grants control
Revenues/expenses	Improves internal and external reporting
Cost allocation	Supports audit function

TABLE 4 Operations Applications and Benefits

Specific Application	Potential Benefit
Daily operations assignment	Improves timeliness and accuracy of information
Scheduling	Reduces missed assignments
Runcutting	Aids in personnel planning
Driver record keeping	Optimizes extraboard
Dispatch	Reduces accidents
Route selection and driver bids	Improves performance
Incident and accident reports	Provides ability to respond quickly to operational change
Daily ridership and revenue recording	Provides interface with service planning
	Reduces need for training and experience

#### IMPLEMENTATION

After a property has decided to introduce microcomputers, the transition from a manual to an automated system begins. There are four parts to this transition: (a) planning, (b) procurement, (c) design, and (d) installation.



TABLE 5 Communications Applications and Benefits

Specific Application	Potential Benefit
Telephone information	Increases ridership and revenue
Teleride	Improves quality of service
Customer inquiries	Improves customer communications
Schedule information	Improves awareness of customers' desires
Trip planning	Improves accuracy of information
Data transfer	Supports service planning
Transfer of financial activities	Improves paratransit system productivity
Electronic mail	Improves wayside information
Electronic bulletin board	Provides access to historical data bases
Call management	Supports marketing activities
Mailing list	

TABLE 6 Administration Applications and Benefits

Specific Application	Potential Benefit
Time records/reporting	Facilitates access to benefits information
Fringe-benefit administration	Helps assess personnel performance
Word processing	Can result in reduced risk-coverage costs based on experience rating
Personnel management	Improves clerical productivity
Special-projects management	Supports collective-bargaining process
Grants management	Supports accounting and budgeting
Risk management	
Ticket and pass record keeping	
Ticket sales accounting	

TABLE 7 Service Planning Applications and Benefits

Specific Application	Potential Benefit
Ride check	Facilitates alternatives analysis
Forecast	Reduces unproductive services
Service	Improves service effectiveness
Ridership	Improves operating efficiencies
Revenue	Provides support for operations
Cost	Provides support for alternative service modes
Market research	Allows efficient evaluation of numerous system operations
Performance measures	Increases ridership and decreases deficit
Socioeconomic data	Supports budgeting process
Pricing policy	Facilitates ridership analysis
Alternatives analysis	
Ridership survey analysis	

The conversion does not always go smoothly, and general managers should be given a realistic picture of what is likely to happen. The participants believed that the benefits (at least in terms of immediate payoff) have perhaps been oversold and the costs and difficulties of implementation understated. A 1-day course as part of a regional or national general managers' meeting could help to provide a better correspondence between expectations and realities.

Good planning is extremely important and should not be rushed. The temptation to borrow another transit agency's request for proposals (RFP) and recycle it should be resisted. Each agency should conduct its own needs assessment, identifying both current needs and projecting future needs; and its own internal management study, examining paper flows and defining current information voids. This process should involve key personnel at an early stage, and site visits to and from similar transit properties that have already begun using micro-computers may also be helpful.

The decision to buy software off the shelf, have it custom designed, or employ some combination of the two should be made as early as possible. Care should be taken to create a system that is flexible enough to allow for expansion. Here, again, one property can profit from the experience of others, which may be able to help determine whether what is desired is available at the right price. Such as-

sistance could be made available through the Public Transportation Network.

Some external guidelines in the procurement process would be helpful to transit agencies insofar as computer hardware and software procurement contracts are unusual items for such agencies to purchase. It was recommended in one discussion that, in several functional areas (e.g., maintenance and human resource management), generic functional specifications be developed for use by transit agencies. Such specifications would include, for example, the required number of digits for bus part numbers for buses used in the United States. This would obviate the need for each individual agency to determine such specifications.

Contracts should provide for adequate training. The software developer may not be the best person to provide training, but he or she could perhaps train staff at the agency to provide support after installation.

For most transit managers, working with software developers is a new experience, much different from buying new buses. The project manager should expect to devote a good deal of time to working with the contractor and documenting the project. Single-vendor contracts covering hardware, software, training, and support are recommended. Agencies should consider getting some outside technical assistance, not necessarily from within the transit industry, to help ensure that specifications are being met and that work is progressing satisfactorily.

Some participants suggested that state departments of transportation should take the lead in project management if small systems are to implement management information systems successfully. If the state worked with several small properties simultaneously, they could take advantage of economies of scale in software production.

To reduce installation trauma among employees, managers should explain to employees at the outset how the microcomputers will (or will not) affect their jobs. Good training is a key to reducing computer anxiety and lessening resistance to using the applications once they are in place. Many participants believed that it is important that the initial experiences with computers be positive, to provide a basis for further learning. Menu-driven programs and those with good documentation are best.

In spite of careful planning and introduction, demoralizing glitches of some kind are almost certain to occur. Managers and staff should be prepared for them and should realize that some payoffs will not be immediately obvious but will become evident as time passes.

# Discussion Group E: Large Transit Systems: Benefits and Implementation of Microcomputers

## Background Paper

Marisa Altschul

In any large corporation, a large amount of data are collected by various groups, usually in different formats. Large transit properties generally have already installed mainframe computer systems, and many of their procedures have been computerized by data processing department analysts working in conjunction with each user group. As a result, there is likely to be some duplication of effort in both the software development and in data collection.

The random introduction of microcomputers into a large transit property tends to increase this scattering of energy. The larger the property, the worse are the consequences of nonstandardized, helter-skelter mushrooming of microcomputers and their software. The introduction of microcomputers as stand-alone systems, even without trying to coordinate them with mainframes, requires extensive and continuing end-user training and support, which in itself puts more pressure on the data processing department.

The dividing line between mainframe and microcomputer application is getting thinner as the microcomputers get bigger and faster, which brings up the issue of data security. In any corporation, the need to access common data is always present. In large systems, this need is often ignored outside the mainframe environment, because of data security.

### QUESTIONS FOR DISCUSSION

With this background setting, a number of questions arise. The questions listed in the following paragraphs appear to have the most impact in large transit properties. They are divided into those related to potential benefits and those related to implementation problems.

#### Benefit-Related Issues

1. How can the benefits of installing microcomputers be quantified per se?
2. Are there benefits to using microcomputers for data processing that was previously done by mainframes?
3. Are there some areas of transit that will clearly benefit from the introduction of micros, others that clearly will not?
4. Can microcomputers give more timely responses than mainframes to some immediate problems? Are such responses less costly?

### Implementation-Related Issues

1. Will the introduction of microcomputers into a large transit property require the restructuring of job descriptions?
2. Is there a need to set standards for hardware and software for microcomputers?
3. At what level of management should purchases be authorized and justified? Where should the focal point for purchasing be in data processing?
4. Is there a need to make microcomputer hardware and software compatible with existing mainframe hardware and software; if so, should long-term plans address this issue?
5. Should local area networks be encouraged, or should the networking be done through the mainframes, in order to maintain better control over security and backups?
6. Should data security for micros be a part of general security? Should a special person be assigned to perform the duties of microcomputer security analyst?
7. In the issue of custom versus third-party software for microcomputers, how closely should general data processing and microcomputer data processing analysts work?
8. Are there any advantages to implementing microcomputer uses in a given sequence (e.g., first scheduling applications then payroll, and so forth)?
9. Is upper-level management willing to plan and budget for comprehensive, integrated implementation (hardware, software, but especially support staff and equipment maintenance)?

### Discussion Group Report

As the starting point for its discussion, the group focused on the questions included in the background paper.

In large transit agencies, microcomputers can be used in two general ways: (a) to enhance personal productivity and (b) to automate functional areas, whether as a mainframe replacement, a mainframe supplement, or a service bureau to manipulate data from the mainframe.

Although it may be difficult to justify the cost of installing microcomputers as personal-productivity enhancers, the equipment itself is not really expensive and the potential for increased office productivity is substantial, especially when the units are put into a system.

The assignment of benefits (e.g., reduced manpower costs, shorter turnaround time, increased availability of information) makes it easier to justify the cost of automation of functional areas. This use of microcomputers is more expensive, however, because it requires the purchase or development of dedicated software for each functional area.

Some transit agencies face particular difficulty in their quest to install microcomputers. Some communities have one central data processing system run by the county or the city, and individual agencies may not be allowed to go outside it. In many cases, the central computer is so heavily used that it is difficult to get access. Participants suggested that transit agencies in such situations should document their problems with memoranda and should perhaps demonstrate that many transit-specific applications will not run on the mainframe.

Most transit agencies introduce microcomputers into one area at a time. No one sequence can be recommended for all agencies. The best place to begin is where personnel appear most receptive--that is where the greatest chance for success lies. A successful initial experience makes expansion into other areas easier.

Using microcomputers in functional areas has a considerable impact on organizational structure and may, at least initially, create jurisdictional conflicts between microcomputer users and the central data processing department. Some restructuring of job descriptions will be necessary, and the sooner this can be accomplished, the better.

Data processing department personnel often express a concern that microcomputers are a threat to security. When multiple microcomputer users can tap into data stored in the mainframe, how are data security and integrity to be maintained?

Although various safeguards (e.g., passwords) can be instituted, a dedicated hacker can almost always break through, and many agencies simply find elaborate security measures too cumbersome. In any event, a certain element of trust is necessary--with the mainframe as much as with microcomputers. The issues with all types of computers are much the same, and the same general security measures should apply to all.

The group set the following order of priorities for computer security:

1. Security of ongoing operations (e.g., payroll),
2. Data security,
3. Documentation of ongoing operations, so that one staff member can assume work when another is away, and
4. Hardware security.

Participants believed that, insofar as possible, it is better to have policy and security issues formalized before the first microcomputer is introduced into the agency.

There is a tendency in large agencies with well-established mainframe operations to consider microcomputers merely a sideline. This attitude should be discouraged and upper-level managers should be educated to think of microcomputers as a legitimate part of a general set of information resources or management tools. Likewise, microcomputer projects deserve the same attention as mainframe projects, and the same general management practices with regard to planning, implementation, evaluation, and redirection should apply to both.

The group suggested that a committee of managers, technicians, and user peers set some minimum guidelines for hardware and software. This committee would also approve purchases. To create a coordinated computer resource system, microcomputer and mainframe analysts should work together closely. This coordination does not necessarily mean that all mainframe and microcomputer hardware must be compatible. Hardware, participants noted, is considered replaceable after about 6 months--an entire generation in microcomputer technology. Software compatibility is much more important because software should remain in use a long time--especially if microcomputer planning is treated as part of general information-system planning.

Requests to purchase new microcomputer applications should include training and ongoing maintenance. If support is not included in the original package, it is difficult to find the money later to finance adequate training.

In-house microcomputer support personnel need assistance in carrying out their multiple functions. In the mainframe environment, the division between managers and technicians is usually clear: the technicians build the systems and the managers manage them. This division frequently breaks down with microcomputers. Here, support personnel have to be both technicians and managers--and it is rare that one person has received adequate training in both fields. Some information and technology transfer between the two disciplines is needed.

The group suggested that technology support groups be formed in different parts of the country to serve as a resource for microcomputer support personnel in large agencies. These peer groups could give advice on what applications have worked well on what hardware and could help keep their members apprised of the most up-to-date technologies.

A number of advanced technologies are now available for microcomputers, and the shared experience of peers can help guarantee that they are used to the fullest extent possible--or not used before their time. Local area networks, for example, are at the frontier of technology. The software available does not appear to be sophisticated enough to make networks practicable in most transit-industry situations. Contact with peers can help agencies determine the right time to begin seriously considering implementing that particular capability.

# Part 3 Recommendations

## RECURRENT THEMES

Over the course of the workshop, there were several recurrent themes; three of the more prominent ones included:

1. Constraints on the development of transit-specific applications and hardware arising from the small size of the market and the need to find some way to lessen these constraints, whether by attempting to broaden the market or by offering a stronger profit incentive to developers, or a combination of the two;

2. The desirability for some degree of standardization within the transit-industry context--standardization of procedures, hardware, software formats, operating systems--whether more or less imposed from the state or federal level or through the action of market forces (e.g., the growing popularity of IBM, the lack of popularity of the p-system); and

3. The importance of adequate support for microcomputer users and would-be users at every phase from planning through post-installation and at every level from the most basic computer literacy courses to training in advanced applications.

## RECOMMENDATIONS

The following recommendations are based on the collective opinions of the workshop participants. Because there was overlap in the areas covered by the participants' recommendations, the recommendations are organized by general topic and not by discussion group. Where two or more groups made different recommendations on the same topic, the divergences are noted.

### Support

1. Recognizing that a large majority of transit systems have not yet installed microcomputers, UMTA should maintain introductory training programs, even though some software groups have observed that the demand for training is declining.



2. Training in more sophisticated techniques (e.g., batch files, utilities, macros) should be offered to a greater extent, through courses or through publications.

3. The software group recommended that UMTA offer training courses planned along functional lines, such as financial planning, instead of courses limited to computer topics.

4. User-developed applications such as templates for spreadsheets should be located, documented, and disseminated.

5. In-house personnel should receive increased assistance, including a book of readings on the issues they are likely to face as they coordinate the introduction of microcomputers into their agencies; training materials for on-site use; and the creation of user groups for information exchange.

6. The TIME list of experts to whom questions about specific applications or technology can be referred should be continued and expanded.

7. The special support needs of small transit operators deserve attention. Local resources such as agricultural extension and adult education courses should be used to their fullest; innovative training formats and specialized courses should be developed to meet the needs of small transit operators. State departments of transportation should be especially involved with these operators.

8. To provide support for proprietary transit application programs, TIME should spark the formation of special interest groups among people using particular applications to assist one another and to help other agencies choose appropriate programs. Publication of application-specific newsletters is also recommended.

9. The close connection between microcomputer applications and methods should be recognized and dealt with. Training should be provided to help transit personnel interpret the data generated by applications and to understand the principles underlying advanced techniques made feasible by these applications. Case studies should be prepared to give readers some idea of how these techniques might apply in their own agencies.

## Benefits and Implementation

### General

1. UMTA should develop a book that documents successful microcomputer applications from a management perspective and that also provides at least a qualitative discussion of the benefits. A briefing for transit managers on microcomputers should be instituted.

2. In general, the introduction of microcomputers into an organization first as personal-productivity enhancers rather than in functional areas is recommended.

3. UMTA should develop a three-volume series of selected readings on needs assessment, systems procurement, and contracting for custom-developed software. This series should stress an incremental approach to procurement and implementation.

### Small Transit Systems

1. If a manager of a small system perceives benefits from using microcomputers in his agency, he should proceed without waiting until benefits are quantified.
2. Case studies indicating whether perceived benefits are in fact realized by small transit properties should be developed and disseminated.
3. Methodologies, tools, and procedures should be developed to allow small transit properties to assess where microcomputers can be of most benefit to them. These tools should also indicate which benefits can be quantified in monetary terms and which, while real, are not directly quantifiable.
4. General managers in small properties should have better information on what to expect when introducing microcomputers into their organizations. One suggested mechanism is the addition of a 1-day course as part of a general managers' meeting.
5. Peer assistance in planning and procurement should be facilitated through the Public Transportation Network (PTN) and other disseminating methods.
6. UMTA should engage a contractor to develop general specifications or guidelines for small agencies to use in carrying out internal management studies and in selecting consultants, vendors, hardware, and software. The guidelines should include general specifications in functional areas such as maintenance, finance, service monitoring, and personnel or human resource management, and so forth.
7. As one of the options, managers of small systems should consider a single contract that includes software, hardware, and after-sale support, with special emphasis on training in-house personnel as support staff.

### Large Transit Systems

1. When microcomputers are introduced into large systems, mainframe and microcomputer analysts should work together closely to build a coherent array of information resources.
2. General management practices regarding planning, implementation, evaluation, and redirection should apply to microcomputers as well as to the mainframe computer.
3. Agencies should set internal guidelines for the purchase of hardware and software, taking into account the need for software compatibility between the mainframe and microcomputers in long-range planning.
4. Security for microcomputers should be part of general computer security within an agency. The recommended priorities are security of ongoing operations, data security, documentation of ongoing applications, and hardware security.
5. Peer support groups for communication and resource sharing among users in large agencies should be encouraged.

6. Microcomputer support personnel in large agencies need training in both management and technical areas to deal with their dual roles.

### Software and Technology

#### Software Needs

1. Emphasis should be placed on the development of maintenance management information systems (MMIS) and scheduling and routing algorithms for real-time application on microcomputers for use by large paratransit systems (those with more than 25 vehicles).

2. Insofar as possible, commercial software packages should be used for microcomputer transit applications. Transit development should focus on industry-specific hardware and software, and strategies for effective organizational implementation of microcomputer applications.

3. Software consultants should examine the feasibility of developing inexpensive, more general purpose products with an emphasis on packaging, altering their marketing techniques to fit this lower-cost approach.

#### UMTA's Role

1. UMTA seed money is needed to meet software and other technology development needs. The software group recommended that development in high-risk areas (such as MMIS and scheduling/routing algorithms) be approached on a cost-sharing basis with the consultant--selected through a competitive process--retaining exclusive rights to sell the software at an agreed-upon licensing fee.

Participants in the technology group made a similar recommendation, without restricting the retention of rights to high-risk areas. They recommended that UMTA clarify its policy on local-agency development and ownership of technology and consider granting private concerns the ownership of the rights to the technology they develop.

2. UMTA should attempt to sponsor the development of simple, easy-to-use, inexpensive transit applications to be used as the initial applications in properties acquiring microcomputers for the first time. The two areas recommended are Section 15 reporting and parts inventory management.

3. UMTA should promote good examples of the use of commercial software in the industry through documentation and distribution of templates and should add to its Software and Source Book a matrix summarizing program capabilities to help transit systems choose appropriately.

4. UMTA should work with the industry to form consortia to develop, implement on a prototype basis, and market transit industry products. The consortia should include local and state agencies, private firms, universities, and other interests as appropriate.

5. UMTA should work with other federal government agencies, the transit industry, and the private sector to promote the export of microcomputer products and services developed by the transit industry. The U.S. Department of Transportation should take a lead role in stimulating international export of transit technology.

6. UMTA should work with other federal government agencies, the transit industry, and the private sector to promote cross-industry migration of transit microcomputer technology. To provide greater impetus for development, UMTA should take a lead role in exploring the possibilities of a domestic product forum for transit-specific technology--for example, a trade show to promote such technology--as well as inclusion of transit-specific technology in related industry trade shows.

### Standardization

1. Rapidly changing technology makes it counterproductive to select a microcomputer, operating system, or data base management system as a standard for the transit industry, according to participants in the software group. UMTA should distribute public domain software on the two or three most commonly used microcomputers and the two or three most popular operating systems at any given time.

Participants in the technology group, on the other hand, recommended that a level of standardization be established to promote development of microcomputer technology and effective interchange between functional areas without impeding the flexibility of property-specific implementation. UMTA should work with an industry consortium to establish standardization of data formats and data transfer protocols in maintenance and inventory, route performance, operations control, finance, and administration.

2. Commercial packages that can import ASCII and DIF formatted files are recommended to assist in software integration.

3. Before purchasing a new system, transit properties should determine which systems are commonly used in order to promote software and information sharing.

# Part 4 Special Presentation

## Microcomputer Tools and Powerful Ideas

Fred D'Ignazio

In speaking about computers to the children who are normally my audience, I very often talk about Luke Skywalker and Darth Vader, the light and the dark sides of the Force. Because computers are a neutral technology in themselves, it is important to give equal attention to their advantages and to their limitations and drawbacks. For the moment, however, the emphasis will be on the light side.

In the serious discussions and exploration that are to take place at this workshop, it would be easy to overlook the personal, as opposed to the organizational and necessary, reasons for being involved with computers--the excitement of working with them.

I would like to talk about microcomputer tools and fun. We have ended up acquiring about 26 computers and 30 or so robots in our house because they are fun; in a sense, they are just toys for us.

A toy is not just something trivial. An educational toy is very stimulating and evokes a sense of play that is not something reserved for the playground or for the weekend. It deserves a spot right in the middle of the daily work day. During this workshop, we should consider ways to inject that sense of play and of fun into our approach to using computers in the workplace. If we go into it enthusiastically, that sense of fun will be contagious and will carry over to the people we deal with, making policies more effective and making it easier to introduce computers.

A new standard is arising. Ten years ago I was an editor of a magazine in Washington, D.C. called The Futurist, published by the World Future Society. At that time the society had some 16,000 or 17,000 members who were consultants and highly placed people in government and industry whose job was to look at the future. Everyone was constantly using the word "computers"; computers were on the tip of everyone's tongue. But I quickly learned that although everyone talked about computers and paid lip service to them, few people among the futurists were practitioners who actually knew computers from day-to-day hands-on experience.

The new standard that is going to come into play more and more calls for policy makers who deal intimately with computer issues to be more personally involved with computers. But if computers strike you or your staff as grueling, dreary, or boring, you are not really going to get involved with them, play with them and use them every day. For that to happen, computers have to be fun, they have to be playful. There must be something energizing and exciting about them.

As you become more of a practitioner and use the computer daily and begin to enjoy it, both your enthusiasm and your expertise will carry over to those around you. You will not just be a Pollyanna who talks about the wonderful future of computers. Because you have to deal with computers on a daily basis, you will know the dark side, what happens every time the machine is down and every time all sorts of indecipherable gremlins come creeping out of the machine. You will know both sides, and that will give you a balanced perspective, but one that is very energized.

It is not computers per se that are so exciting; it is how our tools shape us. It is true that you should not use a computer when you can use a pencil; it is like taking a Mack truck to the grocery store. On the other hand, a pencil is a tool that has shaped us. A pencil is a simple tool that is almost universally accessible. How you write, how you create, how you do arithmetic, how you draw with a pencil, a magic marker, or a crayon is very much affected by that tool. Sometimes we are limited, or our children are limited, by the fact that the pencil was our tool at an early age and no one thought beyond that tool or put another tool in our hands.

The computer can be a totally new tool that shapes our mind differently, that shapes our thinking and communication processes. The computer can be that kind of tool if it has the same central place on the desktop that a pencil, a piece of paper, or a telephone does.

That is the standard that we must demand from the industry: the computer must be a central part of the work environment. The computer should not be like a toaster-oven that is used once a day and is then turned off. The computer should be on all day, and it should be something that you need to turn to, not that you strain to turn to, to perform all sorts of tasks during the day.

That situation is certainly an ideal, but it is where we could be headed. Certain products can help lead us in the direction of familiarity and intimacy with the computer as an everyday tool. Some of the new computer programs that are becoming available can help us see computers in a new image. In the old image--the way most people see computers, large or small--the computer was an impersonal workhorse for bulk processing of numbers, payroll and company records. In the new image of the computer as desktop, the computer is viewed as a personal mind amplifier. It is a personal tool not just to help you organize data but to help you think better and communicate better, with the emphasis on person-to-person communication.

The big fear right now is that the computer will put itself between two individuals or an individual and a group and insulate them, changing transit, for example, from an eyeball-to-eyeball industry. A similar danger exists in the classroom, where the computer can come be-

tween the teacher and the student. That is the negative side. But the computer can also facilitate person-to-person communication, although not enough people are looking at ways that it can do that.

Those who use tools such as word processors, spreadsheets, and file managers should think of them in a less typical way. A word processor really is a general purpose tool that makes it possible to edit any kind of symbol, in this case, written symbols of the English language. But computers can also be used to edit musical symbols, graphics, and visual symbols. All of these facilitate our ability to express ourselves and to communicate with others.

A spreadsheet is a wonderful organizational tool, but it also is a "what if?" machine. You can plug in individual data values and instantly see the effect of those new data points all over the system.

File managers, too, have an ability that goes beyond just sorting and relating information according to like categories. If you can be playful with your filing system, it can be almost like having an intellectual debating partner or sparring partner. It can stimulate you to look at information in new ways.

The multi-tasking desktop environment embodied in machines such as the Macintosh is seeping through to all the other machines, whether they are Commodore 64's or TRS-80's or Apples. You can have several different tasks running simultaneously on the computer. The functions are in the form of windows that can be opened, closed, or shared. You can move back and forth smoothly and easily to these tasks as your mind makes associations. We are not computers; our computing power is in our ability to associate concepts--a much broader and more complicated data base than we have inside any computer. This ability to associate and move fluidly from task to task or computer program to computer program can be very powerful.

There are now outline processors, such as ThinkTank, MaxThink, and Frames in Framework, that allow us to take information and put it into a hierarchical form like a tree structure. Using these processors is not like working with the old outline systems with roman numerals; it is just like writing with a word processor. A good program allows you to structure information fluidly, without worrying about all of the mechanics.

Graphics tools allow us to express ourselves visually. These tools include DR Draw; Fontrix; PC PAINT; and, from Digital Research, Presentation Master, which allows you to create slides from the data or graphs that appear on your screen.

For information management, there is Filevision, which runs on the Macintosh; and Infoscope, which runs on all the IBM computers. Filevision allows you to organize your information visually. If you have, for example, a wine cellar, you first can draw the wine bottles, which become, in a sense, records in the filing system that can then be expanded into a window. The program gives you drawing tools that allow you to create the wine bottles swiftly, without struggling. In a bus system, such a tool would be especially good for anything dealing with maps and schedules. Filevision is also a data base management system. It is a very exciting concept, because you do not work with numbers or even with language, essentially; you work with pictures first. The combination of visual and verbal modes creates a very powerful tool.

In voice and electronic mail, a new product called Watson allows you to turn your computer into a very sophisticated answering machine and electronic mailbox. It also allows you to send voice messages. This program is great for anyone who has played telephone tag or who feels chained to a telephone. One person using such a tool puts himself out on a limb, but if two or more people use it, it becomes a practical tool.

Memory-resident desktop programs such as Sidekick can be loaded into the computer while another program is being run. The desktop program sits in an unused part of memory and can be called up with a couple of keystrokes at any time. Such programs generally include such features as a notepad, a phone directory and auto-dialer, an appointment calendar, and a calculator.

The best example of integrated software is Framework, which uses an outlining procedure that makes it possible to structure various functions such as word processing, spreadsheets, communications, and graphics and organizes them on the desktop.

It is unrealistic at this time to talk about artificial intelligence, but expert systems and natural language are now being implemented. Products such as Expert Ease, Savvy, and Clout allow you to deal, for example, with data base management situations by using plain English. The drawback is that sometimes when you use English, which is a fuzzy language, you get the wrong results. But most times, by just referring a query to the computer, you get back exactly what you want, without having to remember exactly the coding situation to allow you or a staff member to query your data base.

There are also psychology tools that use expert systems. Products such as Communications Edge, Sales Edge, Management Edge, and Mind Probe allow you, using expert psychologists and psychiatrists, to work out problems that you face daily on the job.

The last area is robotics. The idea that robots have to be human-like creations is a misconception. The future of robotics is not in that direction. A robot is any device that has a computer-programmable brain, sensors that make it aware of some facet of its external environment, data storage capacity, and the ability to communicate with other computers and with human users. A robot could be a miniature device that fits inside a pocket or something that could be implanted inside a person's ear, or it could be something that could go inside a bus or a motor. Microchips are the source of the revolution, but the practical application is in all sorts of robotic devices that will look anything but human.

Computers can be very, very liberating, because you can shape them yourself. The price of the computer units is not that great compared to so many other expenditures that you have to make, and the software is beginning to become good enough that you can afford a core library of productivity software that will change the way you do your job.

But it is up to you. The crucial factor is how you approach the use of computers.



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